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The Concept 'Poverty' towards Understanding  
in the Context of Developing Countries '*Poverty qua Poverty*':  
with Some Comparative Evidence on Britain

Brian-Vincent IKEJIAKU

Research Institute for Law, Politics and Justice

Keele University, Keele, Staffordshire, ST5 5BG, UK

Tel: 44-79-4476-5923 E-mail: b.v.o.ikejiaku@ilpj.keele.ac.uk OR ike.bvo06@yahoo.com

**Abstract**

The major problem facing developing countries is poverty; therefore, this paper attempts to conceptualise poverty in the context of developing countries. The paper provides an absolute definition of the concept as suitable for the poverty situation in developing countries, what this paper coins the term *poverty qua poverty* to explain. Four works (Sandbrook, 1982; Oppenheim, 1993; Spicker, 1992 and Alcock, 1997) were reviewed extensively in an attempt to resolve some controversy surrounding the understanding of the concept 'poverty', while reference made to the works of other scholars in less detail. This paper employs some comparative evidence with Britain (which obviously eliminated poverty at absolute level '*poverty qua poverty*' as far back as at the end of 1950s) on this subject in order to achieve its conceptual analytical effects.

**Keywords:** Poverty qua poverty, Governance, Development, Sub-Saharan Africa, Britain

**1. Introduction**

Generally, recognising what something means in practice is much easier than defining or analysing it, this has made many writers explain concepts with illustrative examples rather than giving tight definitions. Spicker attests to the above submission when he notes:

When we say that people are poor, deprived, suffering from hardship, or in need, we usually have a fairly good idea of what we mean. But words like this may well mean different things to different people, and it is difficult to take this kind of ordinary language and make it perform the precise functions that are required in social analysts (Spicker, 1992).

Therefore, before considering various definitions of poverty as provided by writers and scholars, it will be helpful to comment on certain contentious issues surrounding the concept 'poverty' in order to understand it. There are so many writers, who have written on the issue of poverty (for example Hoogeveen & Ozler (2006); Bhorat, H and Kanbur, R (2006); Greer and Thorbecke (2001); Alcock, Peter (1997); Oppenheim, Carry (1993); Sandbrook, R (1982) that it is impossible to cover all of their works. In this study, my concentration will be on a few of these works (Sandbrook, 1982; Oppenheim, 1993; Spicker, 1992 and Alcock, 1997), because they are very helpful in understanding Britain's poverty, which is divergent to poverty situation in developing countries, though other works will also be commented on in less detail.

**2. Existing Debates**

The major argument of most of these works are centred on the various existing debates on the 'problem of understanding poverty', and of the policies that have been developed in response. It is clear from the analyses of these works that there is no one scientific and universally agreed definition of poverty. This is because, depending on the perception of the writers, it is a political, as well as socio-economic concept. As Alcock states: 'it is the issue of definition that lies at the task of understanding poverty, we must first know what poverty is before we can begin to do anything to measure it and before we can begin to do anything to alleviate it' (Alcock, 1997). This statement depicts the indubitable problem of finding a definition of poverty.

*2.1 On relative or absolute definition of poverty*

There is a serious controversy among these writers over whether the definition of poverty should be absolute or relative. While Alcock appears to favour the relative, Oppenheim agrees that both should be synthesised in the definition of poverty. However, Sandbrook argues in support of a definition of poverty that is absolute.

Oppenheim begins by citing the words made in Faith in the City:

Poverty is not about shortage. It is about rights and relationships; about how people are treated and how they regard themselves; about powerlessness, exclusion and loss of dignity. Yet, the lack of an adequate income is at its heart (Oppenheim, 1993: 28).

Oppenheim continues,

An absolute definition of poverty assumes that it is possible to define a minimum standard of living based on a person's needs and not on broader social and cultural needs. Absolute poverty is when people fall below this level-when they cannot house, clothe or feed themselves (ibid: 28).

As Oppenheim points out, Seebohm Rowntree used such a definition in his study of poverty in York in 1889, when he devised a 'primary' poverty line based on a standard of minimum needs for food, clothing, heating and rent, to show that many families had incomes below this level. Oppenheim maintains that such an absolute view of poverty is still a definition valued by many commentators (Ibid, those commentators include Joseph, 1976; Taylor, 1990 and Roll, 1992).

In Oppenheim's definition of 'relative poverty', an excerpt from the same report, Faith in the City was cited:

Poor people in Britain are not, of course, as poor as those in the Third World. But their poverty is real enough none the less. For poverty is a relative, as well as an absolute concept. It exists, even in relatively rich western societies, if people are denied access to what is generally regarded as a reasonable standard and quality of life in that society (Oppenheim, ibid: 67)

Oppenheim noted that in this instance poverty is defined in relation to a generally accepted standard of living in a specific society at a specific time and goes beyond basic biological needs. Oppenheim is of the view that this aspect of poverty has a long heritage, having been shared by people across the political spectrum; and gives the example of Lady Chalker's statement: 'it is not sufficient to assess poverty by absolute standards; nowadays it must be judged on relative criteria by comparison with the standard of living of other groups in the community...beneficiaries must have an income which enable them to participate in the life of the community' (ibid: 9).

## *2.2 On measurement of poverty*

Another area of contention is how poverty could be measured, and the question of drawing the line of measuring poverty. Oppenheim cites Meghnad Desai's 'Excluding the Poor' (1986): 'Measuring poverty is an exercise in demarcation. Lines have to be drawn where none may be visible and they have to be made bold. Where one draws the line is itself a battle field'. In response to this, two possible poverty lines were debated. While Sandbrook argues for the use of the poverty line based on low income families (LIF - The numbers of people living on, below or just above the supplementary benefit income support level), to that based on the household below Average Incomes (50% of average income after housing costs as a proxy for the poverty line), both Alcock and Oppenheim see the above two demarcating points (poverty lines) as useful. These lines were used by Child Poverty Action Group (CPAG) in 1972-85 in United Kingdom. A brief analysis on the distinction between Relative and Absolute poverty will be helpful in understanding the debate.

An 'absolute poverty line' aims to define a minimum standard, usually based on a needs assessment, such as the cost of a basket of food items that provide a basic level of nutrition. It is a fixed measure, an income or expenditure threshold below which a household is seen as poor; the threshold remains the same even if there is a change with a rising standard of living in a country. Thus, economic growth distributed uniformly across society will result in a decreasing poverty rate, as households that were previously considered poor climb above the poverty line. Greer and Thorbecke note that this fixed quality of an absolute poverty line is particularly useful in informing policy, because it provides a stipulated target for poverty interventions. They maintain that policy-makers can assess the impact of current or proposed social assistance programmes by using an absolute poverty datum line to measure changes in the poverty rate. Furthermore, they argue that an absolute poverty line may be a more accurate measure of commodity deprivation than a relative measure, as it is often directly linked to consumption of specific basic items. Whether a household or individual consumes enough of basic needs (food) may arguably be a more accurate and intuitive measure of impoverishment than where the individual falls on the income distribution (Greer and Thorbecke in Mlambo 2001:4).

A relative poverty line according to Wooland and Leibbrandt can be defined as that income level that cuts off the specified poorest percentage of the population. The poor are those persons who suffer deprivation relative to others in the poverty domain. They provide as an example that the World Bank generally defines the 'poor' as the bottom forty percent of households, and defines the 'destitute' as the bottom twenty-percent of the income distribution. And that relative poverty line is generally more widely used than the absolute poverty line, as it is much easier to construct. Furthermore, they maintain that calculations using the relative poverty line are less likely to be controversial, as they

avoid the subjectivity associated with determining what income or expenditure threshold constitutes a minimal acceptable standard of living (Wooland and Leibbrandt, 1999)

### *2.3 On causes of poverty*

There is also a keen debate on the causes of poverty that affects its conceptualisation. Oppenheim (1993) identified such causes as unemployment, the cost of bringing up children, disability, sickness and old age. Alcock (1997) mentioned such causes of poverty as the dynamics of deprivation, pathological causes, structural causes and ideological perspectives. Sandbrook (1998), generally, opined that it is the neglect of what he referred to as the 'basic need approach' that causes poverty, that is to say, the need for the essentials of life such as food, shelter and clothing.

### *2.4 On history of poverty*

Another area of argument that affects the concept is on the history of poverty. Alcock (op cit), states that 'it is possible to extend the history of poverty as far back as the history of society itself, but most of those writing historically about poverty (in Britain) trace the current development of poverty and poverty policy from the period of gradual replacement of feudalism by capitalism as the modern economy began to develop in the seventeenth and eighteenth centuries'. This is because during this period many were separated from land, and depended on wages from paid labour, but those who could not work for wages could not support themselves and thus were destitute. Making reference to Novak's book on history of poverty in Britain, he argues that it is only at this point that poverty was created as an academic concept (Novak, 1988). Sandbrook (op cit), in exploring the historical root of the poverty problem in urban Africa, contends that, 'the imbalance between productive employment and the burgeoning labour force is a facet of the process of underdevelopment'. For more analysis on this issue, see the 'stagnation thesis' as expounded by Baran (1957) in his 'Political Economy of Growth', and others, such as Frank (1971) who specifically developed the idea of Capitalism and 'Underdevelopment' (the notion of moving backwards).

## **3. Criticisms**

Having presented a brief summary of the predominant arguments in some of the existing literature in order to understand the concept of poverty, I will proceed to forward a few constructive criticisms, and as well, pose a few relevant questions based on their analyses, particularly on the importance of employment.

### *3.1 The importance of employment*

My first criticism would be levelled on the work of Alcock (op cit: 12), particularly about his view that 'employment has never of course been a guaranteed means of avoiding poverty'. Though he cited in support of this claim the studies of Bowley and Burnelt Hurst, I want to point out that rationally employment is of course a means of avoiding poverty both in policy and practice, so long as the pay received is not derisory. This view becomes glaring when we appreciate that unemployment is the greatest cause of poverty the world over. Oppenheim (op cit: 56) attests to this view himself, when he notes 'unemployment means poverty'. In support of this statement, he argues 'Daniel found that unemployment, however brief, caused both hardship and trauma. When people were asked in a study in Britain, how they viewed their experience of unemployment, the group as a whole ranked it close to the worst experience they had endured' (Daniel, 1990).

This argument holds ground because even where wages are low, or people are underemployed, they are guaranteed a living wage. Even, peasants and farmers could be said to be some how employed, considering the important of self-employment to an economy, especially when we appreciate that there could be payment made in kind. But the true position is that only peasants who earn wages, that is rural proletariat or peasants who in addition to their toiling in the land earn some money from additional day-labouring. In other words, only wage labourers can be unemployed. In line with this view, it is worth noting that the peasants or the labouring poor that are unsure of any wages face critical problems, particularly in many developing countries of Africa, where the so called social welfare packages for the non-wage earners is lacking. Their condition is pathetic because even those who are well positioned (the rich or the high; the political elites/class) are not ready to help the poor peasants.

Duodu (1967) writes about these problems of the peasants in developing countries (this class - the peasants or labouring poor, range from the petty producers, to petty traders and providers of petty services, casual labourers, subsistence farmers, urban cultivators, and illicit and parasitical occupations – prostitutes, bootleggers, dope-peddlers, beggars and petty thieves), with reference to Ghana, in his work 'The Gab Boys':

The fact was that so far as we low, uneducated people were concerned, they were all the same; they enjoyed the same things though they attached labels to one another. None of them ever thought of giving up some of their privileges so that we could enjoy a little ourselves. They had, and we didn't have; (i.e. money, power, wealth etc) and the words they talked (i.e. their decisions/policies) were meaningless to us. Neither communasocialism nor neocolosciencism (imposing) meant that somebody would stop people dying because they didn't have money to go to hospital; or prevent them from living in houses without ceilings, where ten people had to share one room; or give to public toilets and water

supplies the same attention as to income tax and propaganda.... They did not mean the coming of a time when there would be no more 'high' or 'low' but only people – the people of Ghana (ibid).

Alcock (p.12) himself disclosed that 'many of those who are poor and out of work are far from feckless idlers revelling in dependency. They are 'looking for- and hoping for – work, but are unable to find it' (the very fact that they are searching for work, shows that there is something greener in employment). The views of some authorities can be used to buttress this criticism. For instance, in his listing of certain guidelines which serve to identify the greatest concentration of poverty, McConnell (1969) stated that a very high percentage of the families of the unemployed and partially employed are living in poverty. Employment provides the individual with the chance, at least, of overcoming absolute poverty (because the chances are that one would be in a position to take control of immediate basic needs). Absolute poverty will be the concentration of this study: absolute poverty in its practical sense – '*poverty qua poverty*'.

The weight of this criticism is better appreciated in the ugly and deplorable situations in the developing countries, where the greatest numbers of the poor are related to unemployment. This is worse in the case where the unemployed receive no social security benefits, as obtainable in virtually all developing countries (which is generally the case in Africa). Thus the lamentation of Justice Aguda (1998):

I take it as most inhuman and degrading for an able-bodied man and woman willing and able to work to find himself or herself a victim of unabated and frustrating prolonged unemployment. Such a situation leads progressively from optimism to pessimism and from pessimism to fatalism... when that stage of helplessness and failure is reached that surely must be a state of torture (ibid).

Even in the developed world, in a country like Britain where there are reasonable benefits for the unemployed, 'benefits for the unemployed have generally required recipients to demonstrate that whilst receiving state support they are also seeking employment' (Alcock, op cit: 12). This statement reveals the importance of getting employed, at least, in order to alleviate *poverty qua poverty*. Seers (1969: 4) also points out that '...to be chronically unemployed, to be chronically dependent on another person's productive capacity, even for food, is incompatible with self-respect'.

#### **4. The Term Poverty qua poverty and its Application to Sub-Saharan Africa**

For application to Africa, Alcock's and Oppenheim's definitions of poverty as relative poverty are also questionable. A relative conceptualisation could not be used to define what I refer to as '*poverty qua poverty*' (*PQP*), that is the poverty situation in the developing countries, essentially that of Africa. Anyone who is in absolute poverty (*poverty qua poverty*) is more or less being blindfolded by its devastating state or impact, and therefore quite oblivious to relative poverty. By this concept of *poverty qua poverty*, poverty also means hunger, thirst, poor health and living without decent shelter. Extensively it means not being able to read. It means chronic sickness. It means not finding any opportunities for you or your children; it is about being pushed around by those who are more powerful.

*Poverty qua poverty* (*PQP*) is the term I coin to describe the practical absolute poverty of Africa, particularly Sub-Saharan Africa where the majority find life very excruciating because it is difficult to meet or satisfy their basic needs, such as food, clothing, shelter, health and education. Those in *poverty qua poverty* are the people who experience such persistent poverty that it is almost impossible to break free of it using their own resources. They hardly have enough to eat, now about to save. They are reliant on day labouring. They have no education and few assets. Their entire futures appear to be bleak. Indeed, many of them feel frustrated and worthless, seeing little or no prospect of escaping their wretched lives.

Let us take a look at the following illustrations. About one-sixth of the people living in Sub-Saharan Africa are in *poverty qua poverty* (Report of the Commission for Africa, 2005: 101). In Ethiopia, for example, these families are known as 'those who cook water'. In Ghana, they are called 'those with two bags' – one for begging in the hungry season, and another for begging in the season of plenty. In Nigeria they are seen as those who patch a living: 'patching poverty'.

A relative definition of poverty, Alcock (p.69) explains, is associated in particular with Fabian critics of the post war achievement of the welfare state in eliminating poverty in Britain: 'although state benefits had provided enough to prevent subsistence poverty, for most, in terms of their position relative to the average standard of living in society.... Thus, in a society growing in affluence, as was post war Britain, remaining as far behind the average as before continued to constitute poverty'.

My conceptualisation of poverty in the developing countries concentrates on absolute poverty, because the idea of relative poverty, which relates to post war Britain and other developed countries, is relevant because in these countries poverty has been eliminated at the absolute level. Alcock (p.69), citing Booth (1889) and Rowntree (1901), makes reference to Secretary of State John Moore's statement in 1989, as regards to the elimination of poverty (at subsistence level) in Britain when he noted that 'The evidence of improving living standards over this country is dramatic, and it is incontrovertible. When the pressure group says that one-third of the population is living in poverty, they cannot be saying that one third of people are living below the draconian subsistence levels'. This statement was made by John

Moore, in 1989, but was cited by Alcock (1997: 68). Moore, was the then Secretary of State for social security in Britain, and in his speech called 'the end of the line of poverty', he castigated relative notions of poverty as 'bizarre', because they seemed to be suggesting that as poverty was related to average standard of living, it would continue to exist, no matter how wealthy a country becomes. Yes, I agree in totality with John Moore, (Though, some may argue that this may be a political statement, in practice the impact is greatly felt) because relative poverty is a 'mirage'. In other words, you cannot surmount or eliminate diametrically relative poverty, but absolute poverty in the developing countries (*poverty qua poverty*) can be completely addressed if conscientious and practical approach is employed, as it follows; the case of Britain has shown.

Moore's statement however is consistent with Seers position. Seers (op cit: 7-8) noted that the explanation (for the elimination of this absolute poverty) lies largely in the fact that by about 1950 the great economic problems had been brought under control in the industrial countries. Unemployment had been reduced to historically very low levels; absolute poverty in the sense I use the word had been largely eliminated. The reason according to Seers is that these countries benefited from world economic leadership and political power. These social scientists in Britain stretching over more than a century such as Booth, Rowntree, Boyd-Orr, the Webbs, Keynes, Beveridge and Tawney, concentrated sharply on poverty and its corollaries – unemployment and inequality. Sub-Saharan African countries should first concentrate in providing the basic needs of the masses; this is an indispensable stepping stone for other development efforts.

It is Sandbrook's position, therefore, that appears more reasonable to me, understandably because he carried out his study in the developing countries of Africa and therefore had a personal knowledge of the plight of African poor. Sandbrook (op cit: 3-4), commenting on the notion of absolute or 'subsistence poverty' was of the view that 'the poor comprise those households whose income falls below a level necessary to satisfy the basic needs of their members in housing, nutrition, and clothing. Any stipulation of basic needs will of course be arbitrary to a degree, but it will at least provide some rough measure of the dimensions of human misery'. Sandbrook observed that Tropical Africa contains a disproportionate share of the world's poor, whether these are defined by reference to absolute or relative standards.

Sandbrook (ibid: 3), cited the World Bank to support his argument. In the World Bank's view, for instance, the 'absolute poor' in 1975 included 'those individuals with an annual international purchasing power of under \$279. While 53 per cent of the world's absolute poor lived in densely populated South Asia, the next highest portion, 20 per cent, resided in Sub-Saharan Africa. Approximately half of the latter region's total population was absolute poor'. So, while relative poverty may be used to characterise all countries, whether developed or developing, absolute poverty (*poverty qua poverty*) is a major feature of developing countries. And this is where this paper, therefore concentrates.

Though absolute and relative poverty are not the same, I believe that the poor think about the relativity of their poverty when they have surmounted the problem of absolute poverty. Even Alcock (op cit: 8) himself indirectly admitted this '... What is more, people at the bottom of income distribution in Britain may not see themselves as poor, particularly, if they make comparison with those elsewhere in the world who face starvation and destitution...' As argued, for Africa *poverty qua poverty* captures the notion of poverty well: I thus proffer that this term be used for the poor in Africa.

In relation to the poverty situation in Nigeria, South Africa and other developing countries, the relative aspect of poverty holds little or no weight in comparison to the case of Britain. Just as Sandbrook writes, the International Labour Organisation (ILO) economists have in practice been willing to offer their own definitions of absolute poverty which concerns the present poverty problem of developing countries and which fits with the absolute definition for it relates to fulfilling the immediate needs. Sandbrook quoting the ILO:

Material basic needs include certain minimum levels of private consumption of food, clothing and shelter, such as pure water, sanitation, public transport, and health and education facilities. Technocrats have expended considerable efforts in seeking to quantify these needs and to establish national and international targets for each, but these rather arid exercise cannot detain us here.... The rationale for a preoccupation with the fulfilment of material needs is quite simple: these are foundation of all other human needs because their satisfaction is essential for survival. (Sandbrook, op cit: 2). All 'other human needs' include overcoming the relative poverty, which I say is a mirage.

Seers puts it this way; 'As undernourishment, unemployment and inequality dwindle, these educational and political aims become increasingly important objectives of development. Later still, freedom from repressive sexual codes, from noise and pollution, become major aims. But this would not override the basic economic priorities, at least for really poor countries, with large numbers of undernourished children' (p.6).

Spicker (op cit: 10) also agrees when he argues 'it should be supposed, though, that the idea of 'poverty' is used indiscriminately, or that it does not really mean anything. People may disagree about the nature of poverty, but there are cases in the Third World – cases where people are without food, clothing or shelter – where there is hardly any disagreement, and which in many ways are paradigmatic of poverty'. This is what I mean by absolute poverty: *poverty qua poverty*.

I believe that some 'open questions' remain in the poverty debate. Though all the commentators (academics and campaigners) as cited by Alcock were of British origin, or from other rich countries, I wonder whether commentators on the 'poverty debate' who are from developing countries (especially in Africa), would see themselves as not being poor or rather, being very much unwilling to accept having experienced poverty practically all their lives because of the stigma it carries. As Alcock explains:

To perceive oneself as poor, of course, is to put oneself within an undesirable or negative situation – to be the victim of an unacceptable state of affairs. Those who are poor by some objective criteria may therefore, understandably not want to identify themselves and their experience with such a negative, exclusionary and even stigmatising situation. It might not be much comfort to admit to being poor... (p.8). In the proper sense, these academic and commentators that were previously poor, before succeeding in life, would rather be proud to say that they were poor, but through determined efforts have surmounted their poverty. This confession will act as an engine of inspiration and motivation to the poor, particularly the younger ones that are down there struggling to make it in life.

I do not know to what extent other commentators in the politics of poverty from the developing countries, especially Africa, and specifically Nigeria and South Africa, would agree with Alcock's view. As for my individual perspective, I would not mind admitting that I have experienced absolute poverty merely for the consequential reason of avoiding stigmatisation relating to poverty (it is even unethical to stigmatise the poor). When, even in practice, virtually all developing countries will admit that absolute poverty has not been eliminated in their society; in order to receive the assistance of international community in form of poverty alleviation. Do you think that poor nations have better standard of living than rich nations? In fact, since the answer is 'No', it is when one admits that one has a problem, and explains the nature of the problem, that such a problem would be looked into and hopefully solved, with the person's involvement. For example, if African countries had pretended that they are not poor (this paper recognises that countries in Africa are not equally poor), in order to avoid stigmatisation, the level of pro-poor programmes (under the global poverty campaign) already embarked upon by international community, like debt relief, investments on provision of social amenities, and others would not have been possible. Though, it needs to be emphasised that these pro-poor programmes are highly inadequate, but would have gone a long way to minimizing the absolute poverty in Africa, but the situation is worsened and compounded because of weak governance.

The fact is that 'poverty' does not describe a particular kind of attribute that people do or do not have; the term is used to describe a range or cluster of conditions. A person starving in Uganda, a discharged motor accident victim (from a hospital) living in a derelict house because there is nowhere else to go, a Nigerian farmer, a South African single parent trapped in an isolated council estate, or a pensioner unable to afford heating, might all be said to be experiencing 'poverty' (be poor) in some sense, but it is not necessary to suppose that they are all poor in exactly the same sense. The kinds of problems they face, the reasons for those problems, and the sorts of response that have to be made, may well be different. That is not to say that the problems are not interrelated, but they are not all alike, either, and conditions found at one edge of the cubicle may appear, on a closer examination, to have little directly in common with features found at the other end. In fact, conditions regarded as 'poor', cannot be brought into one tight compartment (Alcock, 9). As opposed to the above (relative) description and as stressed above, the aspect of poverty that borders this paper is that with common features such as lack of food, clothing, health and shelter: *poverty qua poverty*.

In practice, poverty has been variously measured and not surprisingly so given the above discussion. As an Oxfam (2003) report points out 'Poverty is complex and multidimensional, and has various perceptions. It is experienced differently by men and by women and can differ according to geographical area, social group, and political or economic context. Therefore, it is safe to agree that the poor are not a homogenous group'.

Numerous assessment indices can be used to determine income levels and human poverty, and therefore enable us categorise individuals in terms of their poverty ranking. This is based on assessing the Income-Expenditures Poverty as carried out by the World Bank, and that of Human Development and Human Poverty (i.e. human deprivation, as carried out by UNDP). For example a measure of income inequality within a country is calculated by the Gini Index. When the Gini Coefficient is close to 1, it means that a great proportion of the national income is eluding the poor. The Human Development Index (HDI) measure the incidence of human poverty in a country; while the Human Poverty Index (HPI) concentrates on calculating deprivation in terms of 'longevity', 'knowledge', and 'standard of living'. The Gender Development Index (GDI) assesses disparities between males and females in relation to the HDI result. The closer to the HDI, the lower the gender disparity prevailing in a country, while the Gender Empowerment Index (GEM) measures the gender inequality in economic and political opportunities in a country; for a detail explanation (Oxfam, Ibid).

Citing the United Nations Development Programme, Oxfam warns of the danger of discounting a hierarchy of poverty which demands the identification and inclusion of all sections of society; the report observes that general strategies for alleviation may not incorporate the needs of all poor people. According to the report, the poorest among the poor are, people who are the worst in terms of physiological deprivation, suffering from income poverty, social exclusion and a lack of freedom. The report concludes with a definition of the poor as those who are unemployed and are unskilled,

whose daily meals cannot be guaranteed except with the assistance of others because their incomes are extremely low or nil (ibid).

Onibokun and Kumuyi (1996) argue that 'poverty is linked to a shortage of vital breakdown of economic, demographic, ecological, cultural and social systems and bad governance'. Chelliah and Sudarshan (1999) note that there has been much debate about how exactly poverty should be defined. However, they argue that 'in popular understanding, poverty is identified with lowness of income which prevents a family from obtaining and enjoying the basic necessities of life, food, clothing, shelter and water'. They see the above conceptual definition as income-poverty and informed us that for a more comprehensive picture of poverty, those other deprivation, such as in relation to health, education, sanitation and insurance against mishaps, must be taken into account (ibid).

The World Bank (online) measures poverty in relation to the proportion of the developing world's population living in the extreme economic poverty as 'living on less than \$1 per day'; (and \$1.08 in 1993 dollars adjusted to account for differences in purchasing power across countries). In the World Bank's view, 'poverty is also hunger, poverty is lack of shelter, poverty is being sick and not being able to see a doctor' (ibid).

Ask poor people themselves what poverty means to them and these are the answers they give: Poverty means hunger, thirst, and living without decent shelter. It means not being able to read. It means chronic sickness. Poverty means not finding any opportunities for you or your children; it is about being pushed around by those who are more powerful. It is about having little control over your life. And it can mean living with the constant threat of personal violence (Narayan, Petesch and Shah, 2001).

In summary, what is striking is that some of these views incorporate some aspects that emphasise relative poverty, while others are absolute definitions, (this include Chelliah, Sudarshan, World Bank, Sachs and People's definitions), which is the lack of basic necessities of life, such as food, clothing, shelter, health and water, as well as extremely low income. It is an understanding of the meaning and dimensions of poverty along this framework, and the numerous challenges on all its dimensions, that compel me to employ the absolute definition approach to explaining African poverty (*poverty qua poverty*).

The conceptualisation of poverty in this perspective (absolute or *poverty qua poverty*) is supported by Sachs. Sachs, while commending Malaysia's success recently in the fight against poverty, said that by 2010 poverty would be a thing of the past in Malaysia, but he was quick to clarify that he was only talking about erasing 'extreme poverty' and not relative poverty. Sachs explained that extreme poverty meant living in an environment without food security, clean water, sanitation, basic health service, literacy and basic income (in Yeow, 2007, online). Sachs further observed that 'it can serve as an example for other developing nations, especially sub-Saharan Africa'. That is to say, Sachs was emphasising on the elimination of poverty in Africa on absolute terms (*poverty qua poverty*) not relative; this is the position of this paper (ibid). It is this *poverty qua poverty* that causes conflict and other instability in most African countries (for the relationship between poverty, conflict and development, see Ikejiaku, 2009).

For most people in Africa, poverty is something they are born into, with little opportunity to escape. They have seen themselves forever living in the family of poverty. The poverty rotates in a family when there is low capacity; and its basic needs exceed its available means of satisfying them (Chinese Embassy in South Africa, 2002). Therefore, the low capacity causes a multiplier effect, as McConnell notes:

Poverty breeds poverty. A poor individual or family has a high possibility of staying poor. Low incomes carry with them high risks of illness... poor parents can not give their children the opportunities for better health... Thus the cruel legacy of poverty is passed from parents to children (1961: 671).

Where the large majority of the population is poor, and the economy is stagnant, individual characteristics of poor people are less important than the overall context in determining the overall incidence of poverty. Because the individual becomes a mere segment of the entire context of the poor people, and as Africa's economies stagnated while the population grew rapidly, the percentage of people living in poverty grew. This trend persisted into the 1990s, despite the stirrings of economic amelioration towards the end of the decade that helped in boosting growth in some other regions with large populations, such as in Asia (CFA, 2005: 102).

An examination of the poverty standard line initiated by some organisations, together with some practical examples help further to explain why the absolute definition of poverty (*poverty qua poverty*) is chosen for this paper. Note that reasonable reference will be made to Awake Magazine; this is because this paper concentrates more on the practical aspect of poverty, than theoretical analysis. Therefore, it is my view that the kind of survey carried out by Awake, provides the vital empirical report necessary or relevant for the purpose of analysing *poverty qua poverty*; however this will be supported by academic literature.

The first practical examples to be used will be the shelter (housing) problem of poverty. *Awake* (22 September, 2005) reported that 'the number of people living in slums world wide is estimated to be more than a billion' (and this is mainly in Africa and Asia). For example, there are Nigerian cities (such as Ajegunle and Omoroko) where more than 80

percent of the population live in slums and squatter settlements. Brazilian experts in urbanisation fear that the ever growing 'favelas', or slums, in that country will soon 'become larger and more populous than the cities in which they were first established' (ibid, 4). 'If no serious action is taken', said UN Secretary – General Kofi Annan in 2003, as *Awake* reports 'the number of slum dwellers world wide is projected to rise over the next 30 years to about 2 billion' (ibid).

*Awake* observes that cold statistics like this, however, do not even begin to communicate the devastating personal burden that substandard living conditions exact on the world's poor. According to the United Nations Habitat Agenda, 2002 cited in *Awake*, 'more than half of the people in developing countries lack basic sanitation; a third do not have access to clean water, a quarter lack adequate housing, and a fifth do not have access to modern health services. Most people in developed lands would not even let their pets live in conditions like that' (ibid).

Again, *Awake* presents a striking illustration:

On the outskirts of a large African city, 36 year old Josephine lives with her three boys, ranging from 6 to 11 years of age. To make a living, she collects empty plastic containers, which she sells to a nearby recycling plant. This backbreaking labour earns her less than two dollars a day. In that city, this is hardly enough to feed her family or pay for their schooling. At the end of the day, she returns to what she is forced to call 'home'. Its walls are made of baked mud bricks and clay held together by twigs. Loose, rusty iron sheets, along with tin and plastic, serve as roof. Pieces of rock, wood, and metal plates are stacked on top to keep the roof in place during strong winds. Her 'door' and 'window' are torn gunnysacks, which offer no real resistant to bad weather – let alone would be intruders. Even this modest home, though, does not truly belong to her. Josephine and her children live in constant fear of eviction. The land on which their inadequate home stands is to be used for the expansion of a nearby road. Sad to say, similar situations exist in many lands through out the world (ibid: 5).

This is particularly the case in Africa ( For example, around 72% of the total urban population of Africa live in slums, nearly all the urban populations in Chad and Ethiopia live in slums. Cities like Nairobi where almost a million people live in Kibera and places like Ajegunle Lagos, the largest contiguous area of slum settlement are socially unsustainable and inhabitable (RCA, op cit: 50). Awolowo (1981: 76) argues that among the inhuman socio-economic paraphernalia and exigencies of the poor were the fact that they had structures made for shelter that are unsuitable for modern poultry or pigs.

Consider also the lively comparative illustration below between Mary who lives in a developed country, United States and Dede who lives in an undeveloped region, Africa (as presented by the United Aid West Africa), in order to appreciate *poverty qua poverty*.

Mary, who lives in the United States, begins her day with a shower, brushes her teeth with the water running, flushes the toilet, and then washes her hands. Even before sitting down to breakfast, she may use enough water to fill the average bathtub. By the end of the day, Mary, like many others who live in the States, has used over 350 litres of water, enough to fill a bathtub two and a half times. For her, a clean, plentiful water supply is no farther away than the nearest tap. It is always available; she takes it for granted. For Dede, who lives in West Africa, it's another story. She gets up long before dawn, dresses, balances a large basin on her head, and walks eight kilometres to the nearest river. There she baths, fills the basin with water, and then returns home. This daily routine takes about four hours. For the next hour, she filters the water to remove parasites and then divides it into three containers – one for drinking, one for household use, and another for her evening bath. Any washing of cloth must be done at the river. 'Water hunger is killing us here' Dede says - 'having spent almost half of the morning fetching water, how much of the day is left for farming or other activities? (United Aid for Africa, 1996 in *Awake*, August 22, 1997:4).

Dede's situation is hardly unique. In other words, it is a common predicament of *poverty qua poverty* in many developing countries. In support of this, as argued, evidence shows that 200 million Africans have no access to proper health care, and proper hygiene. Another 47% are without access to safe water. In some parts of Africa the power supply is constantly interrupted or almost non-existent. This is *poverty qua poverty* (Marke, 2007).

In African countries devising a 'primary poverty band' (e.g. \$1-\$3) based on a standard of minimum needs for food, clothing, shelter, health and schooling rather than a poverty line would serve better (primary poverty band is a wide income/expenditure margin), a poverty line is generally defined as a minimum level of income or expenditure below which an individual or household is designated as 'poor'. This is because most of the families have incomes below the various poverty line levels. This is particularly important when it is appreciated the difficulty in defining an 'adequate' minimum when the standard of living itself changes over time. Thus, the very determination of what is required for rational and reasonable human subsistence for each country or area within a country is to a large degree a matter of judgement and subjectivity.

When it is appreciated that reliable statistics on poverty are missing in many African Nations the futility of providing a rigid poverty line becomes even more convincing. Let me take Nigeria and South Africa, the two most strategic

countries in Sub-Sahara Africa and the areas that I will go on to expand as case studies, as illustrations, in the consideration of the Organisations' poverty line study (these countries are indeed strategic in Africa, for example, they account for more than half of Africa's GDP in 2004, The World Bank, 2006).

The International Development Association and International Monetary Fund in liaison with National Economic Empowerment Development Strategy (NEEDS) in Nigeria provide us with below statistics:

Poverty diagnosis in NEEDS is constrained by weak statistics on poverty, particularly on income poverty. Surveys in 1980 and 1992 showed an increase in percentage of Nigerians living below the relative poverty line (defined as expenditure of less than 2/3 of the average per capita household expenditures), from 28 percent to 43 percent. A 1996 survey suggested a further increase in this level to 67 percent, but this is likely to be an overestimation in the light of the trend in GDP per capita over the same period.... The available data on non-income indicators are weak as well, but they also suggest a high incidence of non-income poverty, especially in the rural areas. Life expectancy is a mere 54 years, and infant mortality (100 per 1000 live births) and maternal mortality (704 per 100,000 live births) are among the highest in the world. Only 64 percent of school age boys and 58 percent of girls attend primary school. These outcomes vary widely by income and by geographic location (IDA and IMF, 2005).

In South Africa, it was noted that, despite the same considerable controversy over what constitutes an acceptable 'minimum' living level, the Household Subsistence Level Survey (HSL) is one of the frequently cited surveys used by social science researchers to quantify the prevalence of consumption poverty in South Africa. For example, in 2000, the HSL varies substantially over the different urban centres, from a low of R1274.11 per month for a family of five (two adults, three children) in Pietermaritzburg to a high of R1456.16 per month for a family of five residing in Germiston.

We can see the inconsistency in the above statistical reports, and this is virtually the case in most African countries (though there could be changes from year to year).

Even the World Bank poverty line of US \$1 a day, though the internationally accepted poverty line for developing countries is inadequate to meet the notion of absolute poverty giving that standards of living change overtime. This World Bank's poverty line stipulation, even if it is met by the world's poor countries, will not solve the problem of *poverty qua poverty*. For example, the conversion rate (for \$1) in Nigeria is around N130 and can only afford one average good meal in a day and is therefore quite insufficient for overcoming absolute poverty.

For low-income groups, particularly in developing countries, food expenditure constitutes a large portion of total household expenditure. This just shows the need to focus on absolute poverty and that different people need to eat different quantities. See Table 1 at the bottom of the paper.

The Table 1 lists the specified quantities of selected food items that are deemed necessary to meet the nutrient requirements for different age and gender groups (the monthly food ration approach used by the HSL is derived from the nutritional requirements outlined by the Department of National Health and Population Development in 1993 that were originally conceived by the Department of National Research Council in the USA, and adapted by the DNH to account for South African dietary norms; see Economic Policy Research Institute, 2004).

Therefore, in the African context, instead of debating over a poverty line, there is a 'band' over which definite poverty shades into economic sufficiency. For specific programmes, a basic nutritionally adequate diet or calorie intake must be established. Therefore, the 'band' margin will cover the establishment of specificity for reasonable changes overtime. What I am saying in effect is that even if an income poverty line were to be used, this should be adjusted every year, in order to meet cost of living changes overtime.

## 5. Conclusion

Therefore, based on the above considerations, argument and analysis, this paper conceptualise poverty in the context of Sub-Saharan Africa as: *food intake, housing, clothing, health, plus low real per capita income and poor income distribution, unemployment and absences of schooling beyond primary school level*. This agrees with Sachs extreme definition of poverty in Malaysia in 2007 as argued in the course of this paper. The various African governments should endeavour to eliminate poverty at this level – *poverty qua poverty*, to enable the continent face the contemporary wave of development in the globalising world.

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Table 1. Minimum monthly ration scale for low income groups in South Africa:

FOOD ITEM	Male	Female	Child	Child	Child	Female	Female	Male	Male
Quantities=grams or ml	19+	19+	1-3	4-6	7-10	11-14	15-18	11-14	15-18
Skimmed milk powder	1200	1200	1200	1200	1200	1200	1200	1200	1200
Meat (red and chicken)	795	795	245	398	577	795	795	795	795
Fish	397	397	123	195	289	397	397	397	397
Eggs (1eggs=50g)	650	650	650	650	650	650	650	650	650
Fresh vegetables	9000	9000	3600	5550	7650	9000	9000	9000	9000
Fresh fruit	1083	1083	823	823	823	1083	1083	1083	1083
Margarine	600	450	300	450	450	450	450	600	600
Cooking oil (ml)	606	606	260	433	606	606	606	606	606
Brown bread (800g)	8400	4200	1650	2100	3150	4200	4200	5250	8400
Maize meal, Samp (12.5:2.5kg)	7200	5400	3600	5400	5400	5400	5400	5400	7200
Sugar and Jam (2500:900g)	2100	1200	900	1050	1200	1200	1200	1350	2100
Peanut Butter	433	433	260	260	260	433	433	433	433
Legumes (Beans & Peas)	390	390	65	130	139	390	390	390	390
Coffee and Tea	217	217	-	-	139	217	217	217	217
Salt	130	130	65	65	139	130	130	130	130
Spices and condiments (e.g. pepper, curry, etc)	44	44	22	22	44	44	44	44	44
Fluids (e.g. Vinegar)	87	87	44	44	87	87	87	87	87

Source: Potgieter (2000).

The Table 1 lists the specified quantities of selected food items that are deemed necessary to meet the nutrient requirements for different age and gender groups.



## Energy Efficiency Technologies – Air Source Heat

### Pump vs. Ground Source Heat Pump

Ruqun Wu

OEP

Faculty of Land and Environment, The University of Melbourne

Victoria 3010, Australia

Tel: 61-43-371-3541 E-mail: r.wu6@pgrad.unimelb.edu.au

#### Abstract

Heat pump deserves the name of eco-innovation. It uses ‘free energy’ - warmth collected in the soil or in the air to provide heating and cooling. There are two main types of heat pumps – air source heat pump and ground source heat pump. How do they work? What are the benefits of each system? How do they compare? First of all, questions like “what is heat pump, how does it work, what are ASHPs and GSHPs” will be answered. Then a detailed comparison between ASHPs and GSHPs will be carried out, from technological parameters to social, practical, economical parameters. Finally, the conclusions are drawn from these parameters as to decide which kind of heat pump is better off under different conditions.

**Keywords:** Heat pump, Efficiency, Air Source Heat Pump, Ground Source Heat Pump

#### Nomenclature

$Q_e$ : condensation heat rate,  $\text{kJ s}^{-1}$

$Q_c$ : evaporation heat rate,  $\text{kJ s}^{-1}$

$W$ : compressor input energy, kW

**COP**: coefficient of performance

$\dot{m}$ : mass flow rate,  $\text{kg s}^{-1}$

$h$ : enthalpy,  $\text{kJ kg}^{-1}$

$\dot{Q}$ : the rate of heat transfer,  $\text{kJ s}^{-1}$

$U_{c/e} A_{c/e}$ : overall heat transfer coefficient of condenser / evaporator,  $\text{kW } ^\circ\text{C}^{-1}$

**K**: constant, equals  $U_e A_e / U_c A_c$ .

$T_c$ : temperature in cold region(heat source),  $^\circ\text{C}$

$T_h$ : temperature of warm region (heat sink),  $^\circ\text{C}$

$T_{re}$ : temperature of refrigerant in evaporator,  $^\circ\text{C}$

$T_{rc}$ : temperature of refrigerant in condenser,  $^\circ\text{C}$

$T_{\text{out}}$ : temperature of outlet fluid in evaporator,  $^\circ\text{C}$

$T_{\text{out}}$ : temperature of outlet fluid in condenser,  $^\circ\text{C}$

#### 1. Introduction

The physical law tells us that heat normally flows from a warmer medium to a colder one. But can we move heat from our cooler house and dump it to a higher outside environment in summer? And can we extract heat from a lower temperature outside, to our warmer rooms in winter? The answer is yes if we use a heat pump. The heat pump does so by essentially “pumping” heat up the temperature scale, transferring it from a cold material to a warmer one by adding energy, usually in the form of electricity. The most common type of heat pump is the air-source heat pump, which transfers heat between indoor and the outside air. Ground Source heat pumps (GSHPs) have been in use since late 1940s, they use the constant temperature of the earth as the exchange medium instead of the outside air temperature.

2. Background

2.1 Heat Pumps

Heat pumps (vapor compression heat pumps) transfer heat by circulating a phase changing substance called a refrigerant through a cycle of evaporation and condensation (Figure 1).

A compressor pumps the refrigerant between two heat exchanger coils. In one coil, the refrigerant is evaporated at low pressure and absorbs heat from heat source, the refrigerant is then compressed en route to the other coil, where it condenses at high pressure, at this point, it releases the heat it absorbed earlier in the cycle to the heat sink(NRCOEE,2004,p.4).

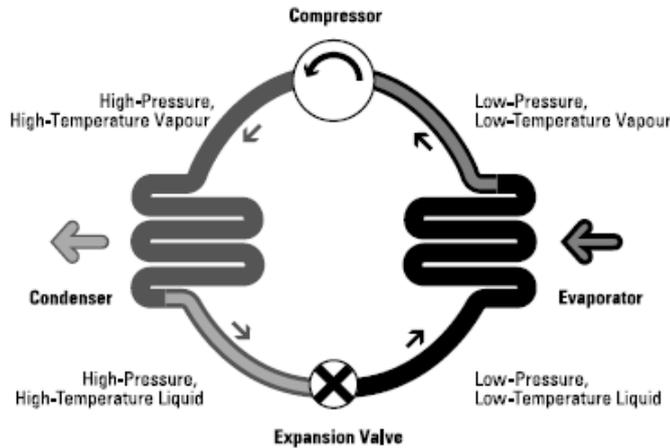


Figure 1. Basic Vapor Compression Cycle

Source: NRCOEE (Natural Resources' Canada Office of Energy Efficiency), 2004, p.4

2.2 Energy Balance and Efficiency of Heat Pumps

From the laws of thermodynamic, the Energy Balance of a heat pump system is:

$$Q_c = Q_e + W \tag{1}$$

Where  $Q_e$  is the heat absorption rate by the evaporator and  $Q_c$  is the heat given off at the condenser (Figure 1).

The operating temperatures of the vapor-compression refrigeration cycle are established by the temperature  $T_c$  to be maintained in the cold region and the temperature  $T_h$  of the warm region to which heat is discharged; the refrigerant temperature in the evaporator must be less than  $T_c$  and the refrigerant temperature in the condenser must be greater than  $T_h$  to allow heat transferring (Figure 2).

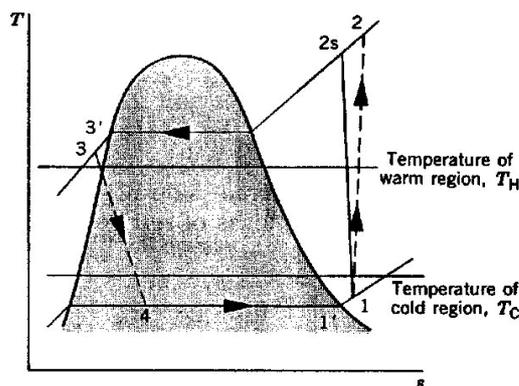


Figure 2a. Vapor-compression refrigeration cycle: T-S diagram

Source: Refrig. Lab of Queen's University,2007, p.9

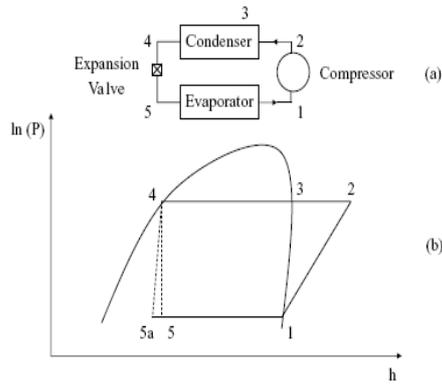


Figure 2b. Vapor-compression refrigeration cycle: ln(p)-h diagram

Source:Rademacher,2005, p.70

As fluids pass through evaporator and condenser, which are two heat exchangers that exchange heat between refrigerant and surrounding fluids. The rate of heat transfer from refrigerant to the surrounding fluid in condenser and the rate of heat transfer from surrounding fluid to the refrigerant in evaporator can be expressed by  $\dot{Q}$ :

$$\dot{Q} = \dot{m} \cdot \Delta h = U A \Theta LMT \tag{2}$$

Here  $\dot{m}$  is the mass flow rate of refrigerant,  $\Delta h$  is the enthalpy change of refrigerant,  $U$  is termed the overall heat transfer coefficient,  $A$  is the area of the surface separating the fluids through which the heat transfer occurs and  $\Theta LMT$  is the mean differences between the temperatures of the two fluids.

The classic parameter that has been used to describe the performance of a heat pump is the coefficient of performance(COP), which is the ratio of the quantity of heat transferred to the heat sink (useful energy output) to the quantity of work driving the compressor (total energy input)(Reynolds 1977, pp. 287-289).

$$COP = \frac{Q_c}{W} = \frac{Q_c}{Q_c - Q_e} = \frac{1}{1 - Q_e/Q_c} \tag{3}$$

### 3. Air Source Heat Pumps

Air Source Heat Pumps are the most widely used heat pump nowadays, ambient air is free and widely available, and it is the most common heat source for heat pumps.

In an air-to-air heat pump system, heat is removed from indoor air and rejected to the outside of a building during the cooling cycle, while the reverse happens during the heating cycle (Figure 3).

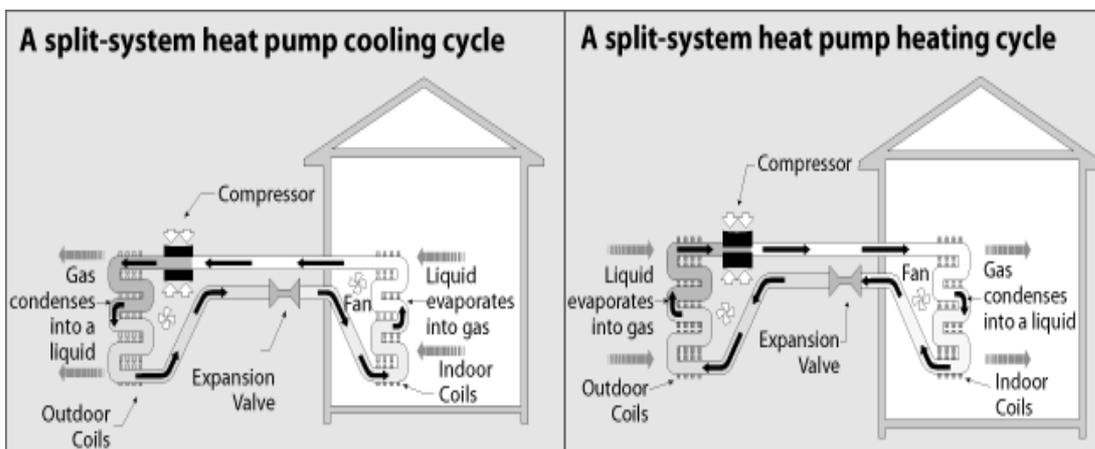


Figure 3. ASHP - Split system

Source: EERE(Energy Efficiency and Renewable Energy),2008a

For application, ASHP is typically roof top units either completely packaged or split packaged systems. Split package heat pumps are designed with an air handling unit located inside the conditioned space while the condenser and compressor are packaged for outdoor installation on the roof. Packaged systems usually have both coils and the fan outdoors. Heated or cooled air is delivered to the interior from ductwork that protrudes through a wall or roof (EERE,2008).

In reality, the capacity and performance of air-source heat pumps decrease rapidly with decreasing ambient temperature during heating season, and with increasing ambient temperature during cooling season. Especially over extended periods of sub-freezing temperatures, as the air source temperature drops below 4°C there is potential for the evaporators to suffer performance degradation due to ice formation(Lu Aye,2003).

Nonetheless, compared with conventional heating methods, an ASHP has following benefits:

- Typically draws approximately 1/3 to 1/4 of the electricity of a standard electrical heating for the same amount of heating, reducing utility bills and greenhouse gas emissions accordingly (HyperPhysics 2005).
- Typical COP of an ASHP is about 200%-400% compares to 100% for a resistance heater and 70-95% for a fuel-powered boiler (HyperPhysics 2005).
- As an electric system, no flammable or potentially asphyxiating fuel is used at the point of heating, reducing the potential danger to users, and removing the need to obtain gas or fuel supplies except for electricity (HyperPhysics 2005).

#### 4. Ground Source Heat Pumps

Like any heat pumps, ground source heat pumps are able to heat, cool the house. Although public awareness of this beneficial technology is low, GSHPs in fact have been in commercial use for over 50 years. The first successful demonstration of GHPs occurred back in 1946, at the Commonwealth Building in Portland, Oregon(Stuebi 2000).

##### 4.1 Components of GSHP Systems

-The Earth Connection:

The earth connection transfers heat into or out of the ground or water body. It often takes the form of an outdoor heat exchanger. This is a coil or pipe carrying water, an antifreeze mixture, or another heat transfer fluid. It may be buried in the ground, in which case it is called a ground-coupled system, or submerged in a lake or pond, in which case it is called a surface water system(NRC(Natural Resources Canada),2008).

-A Heat Pump:

This is the heart of a GSHP Systems, they operates according to the same principle as conventional heat pumps. All the components of the heat pump are typically housed in a single enclosure which includes the earth connection-to-refrigerant heat exchanger, the compressor, controls, the fan, an air filter, an air handler, and refrigerant-to-air heat exchanger(NRC,2008).

-The Interior Heating or Cooling Distribution System:

The distribution system is needed for distributing heating and cooling inside the building. GSHP systems typically use conventional ductwork to distribute hot or cold air and to provide humidity control(NRC,2008).

##### 4.2 Types of Ground Source Heat Pump Systems

There are different ways to categorize GSHPs. Depending on the “heat source/sink”, they are either from earth or water. When it uses earth as heat source/sink, the earth connection could be either horizontal or vertical, and they are both closed-loop. When it uses water as heat source/sink, it could be closed-loop or open-loop (Fig 4).

-Horizontal (Closed-Loop)

This type of installation is generally most cost-effective for residential installations, particularly for new construction where sufficient land is available(EERE,2008b). It requires trenches at least four feet deep(EERE,2008b).

-Vertical (Closed-Loop)

Vertical systems are used when land area required for horizontal loops would be prohibitive or the soil is too rocky for trenching, they are widely used for large buildings(NRC,2008). Although it requires less surface area, it requires much deeper trenches than horizontal loops(NRC,2008).

-Pond/Lake (Closed-Loop)

A closed pond loop is not as common, it uses water as heat source/sink(NRC,2008). If the site has an adequate water body, this may be the lowest cost option (EERE,2008b).

-Open-Loop System (Open-Loop)

An open loop system pulls water directly from a well, lake, or pond. Water is pumped from one of these sources into the heat pump, where heat is either extracted or added and the water is then pumped back into the ground or source body of water(SEW(Shanky Engineering Works),2008). This type was the first to appear on the market, is the simplest to install, and has been used successfully for decades(NRC,2008). However, environmental regulations and insufficient water availability may limit its use in some areas(NRC,2008).

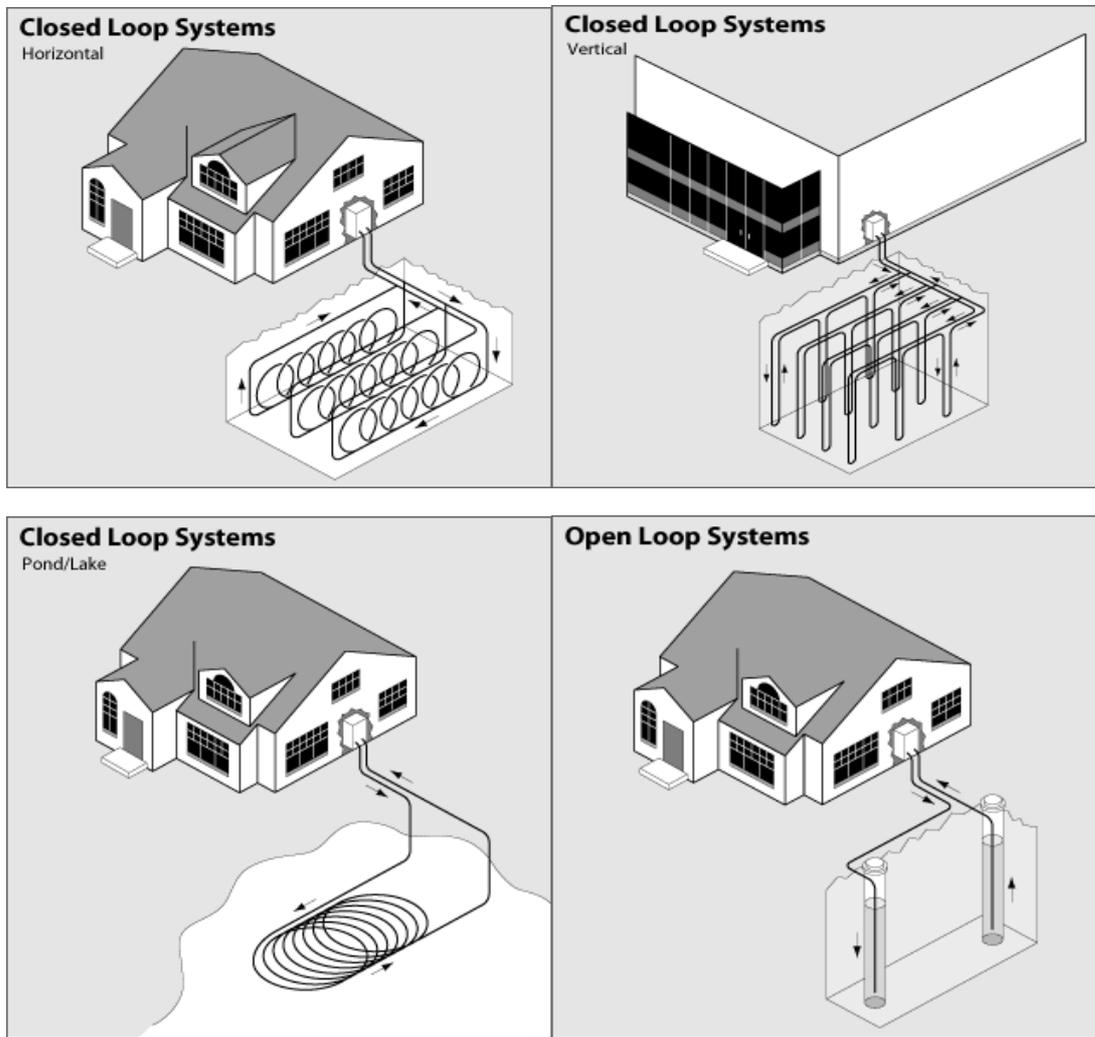


Figure 4. Types of Ground Source Heat Pump Systems

Source: EERE 2008b

**5. Comparisons**

*5.1 Efficiency*

From equation ②, 
$$\frac{Q_e}{Q_c} = \frac{U_e A_e \Theta LMT_e}{U_c A_c \Theta LMT_c}$$

For simplification,  $\Theta LMT$  can be substituted by  $(\Delta T_{in} + \Delta T_{out})/2$ , where  $\Delta T_{in}$  is the inlet temperature difference and  $\Delta T_{out}$  is the outlet temperature difference (Figure 5 and Figure 6).

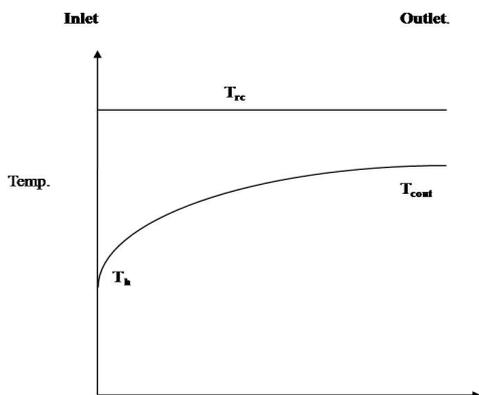


Figure 5. Heat exchange in Condenser

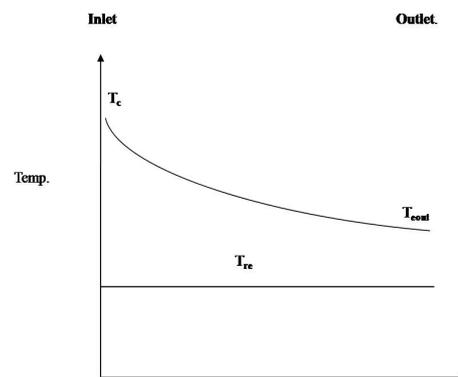


Figure 6. Heat exchange in Evaporator

Assuming that refrigerant temperature in condenser and evaporator are constant, the inlet fluid temperature in evaporator is  $T_c$  and that in condenser is  $T_h$ .

$$\frac{Q_e}{Q_c} = \frac{U_e A_e (\Delta T_{e_{in}} + \Delta T_{e_{out}})}{U_c A_c (\Delta T_{c_{in}} + \Delta T_{c_{out}})} = \frac{U_e A_e (T_c - T_{re} + T_{e_{out}} - T_{re})}{U_c A_c (T_{rc} - T_h + T_{rc} - T_{c_{out}})} = K \frac{(T_c - T_{re} + T_{e_{out}} - T_{re})}{(T_{rc} - T_h + T_{rc} - T_{c_{out}})} \quad (4)$$

Where  $T_c$  is the temperature in cold region (heat source),  $T_h$  is the temperature of warm region (heat sink);  $T_{re}$  is the refrigerant temperature in evaporator,  $T_{rc}$  is the refrigerant temperature in condenser;  $T_{e_{out}}$  is the fluid outlet temperature in evaporator and  $T_{c_{out}}$  is the fluid outlet temperature in condenser;  $K$  is a constant, equals  $U_e A_e / U_c A_c$ .

To compare between ASHP and GSHP in winter, it is assumed that except  $T_c$ , all other parameters are the same for the ASHP and the GSHP.

GSHP has higher  $T_c$  than ASHP because ground has dampening effect on temperature variation (see Appendix 1), then by using equation (4), we can see that  $Q_e/Q_c$  of GSHP is higher than that of ASHP. Also by equation (3), we see that COP is directly proportional to  $Q_e/Q_c$ , thus, GSHP has higher efficiency than ASHP.

Furthermore, in the vertical configuration of GSHP, the heat exchanger is buried deeper in the ground, where, as we can see, temperature is more stable year-round. In contrast, the heat exchanger of the horizontal configuration is near the surface ground and is therefore influenced by atmospheric temperature. As a result, the vertical exchanger permits the heat pump to operate most efficiently.

### 5.2 Design Criteria

- Pre-construction study (feasibility study)

ASHPs do not incur any civil ground works for the installation and lying of pipe.

GSHPs need investigation of the soil or groundwater conditions and it is an important part of a feasibility study. For ground coupled systems, soil conditions will influence not only the feasibility of drilling and trenching, but also the performance of the earth connection. Similarly, ground water availability, and regulations concerning its use, will determine the feasibility of a groundwater earth connection.

But for GSHPs, building designers have much greater flexibility. Architects are not faced with the prospect of unattractive HVAC equipment on rooftops, and can consequently employ a wider variety of roof types (such as sloped roofs) (Stuebi 2000).

- Construction Difficulty Index

For ASHPs, it is very simple to install but for GSHPs, since earth connections in a GSHP system are usually very difficult to reach after installation, the materials and workmanship must be of the highest quality, which in some cases, may block the application of GSHPs.

### 5.3 Cost

- Installation cost

ASHPs has a much lower installation cost than GSHPs (see Appendix 2). And cost for different GSHP types also varies (see Appendix 2).

- Operation Cost

Due to high efficiency and high heating/cooling capacity of GSHP, GSHPs can save owners' operational cost by reducing energy cost significantly (see Appendix 3).

- Maintenance Cost

GSHPs have a stable geology environment, not affected by such climate disasters like snows, hailstorm, Typhoon etc, while ASHPs are vulnerable to the external environment and thus require more maintenance cost.

- Life Cycle Cost

Overall, GSHPs has a much lower LCC than ASHPs (see Appendix 4).

### 5.4 Environment

Environmentally, GSHP represent a superior alternative in many aspects. Lower refrigerant charges and reduced leakage when compared to air-source systems are two advantages they share over these systems (Phetteplace 2007). And since they use less energy, they produce less CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>x</sub> emissions indirectly (see Appendix 4). But GSHPs can cause land disturbance when ground-coupled system is implemented and water contamination problems if water source/sink is used.

5.5 Reliability

The expected lifespan of an ASHP is 15 years(EERE (2001) p.3). Dr. Gordon Bloomquist of Washington State University observes that GSHP installations dating back from the mid-1950’s “are still providing a high level of service to building owners”, and suggests that “system reliability of 25-30 years is easily attainable if routine maintenance procedures are followed”(Stuebi 2000).

In conclusion, the comparison between ASHPs and different types of GSHPs are listed below:

Table 1. Comparison between ASHPs and different types of GSHPs

		ASHPs	GSHPs		
			Vertical	Horizontal	Open-water
Efficiency		√	√√√	√√	√√
Design Criteria	Feasibility	√√	√	√	√
	Construction Difficulty	√	√√√	√√	√√
Life Cycle Cost	Installation	√	√√√	√√	√√
	Operation	√√	√	√	√
	Maintenance	√√	√	√	√
	Total	√√	√	√	√
Environmental	CO2 Emissions	√√	√	√	√
	Land Disturbance	no	√√	√	√
	Water Contamination	no	no	no	√
Durability		√	√√	√√	√√
Practical Issues	Operating restrictions	√√	√	√	√
	Aesthetics	√	√√	√√	√√
	Quietness	√	√√√	√√√	√√√
	Vandalism	√	no	no	no
	Indoor Comfortability	√	√√	√√	√√
	Safety	√√	√√	√√	√√

Note: The more √ means more efficient, more feasible, more difficult, higher cost, longer durability, more restrictions, more beautiful, quieter, more comfortable, and much safer.

6. Conclusions

Through the detailed comparisons between GSHP and ASHP, we can see that GSHP has several advantages over ASHP from following aspects: higher efficiency; lower life cycle cost; lower impact on environment; better reliability and other practical convenience.

GSHP is recommended to be considered a priority choice under new construction, especially for large buildings where the upfront cost is not a pressure to the owners and good qualified construction team is available; the local climate indicating large seasonal variation in temperature; with feasible soil or water condition.

Nonetheless, ASHP are suited if customer’s criteria for cost-effectiveness is depending on short payback periods; the local climate is mild; or there is difficulties in earth connection.

Last but not least, no matter air source or ground source heat pump, they are far more efficient, environmental friendly than conventional heating/cooling systems. And under the current trends, with a global focus on climate change and energy resources depletion, heat pumps are one of the most potential green technologies.

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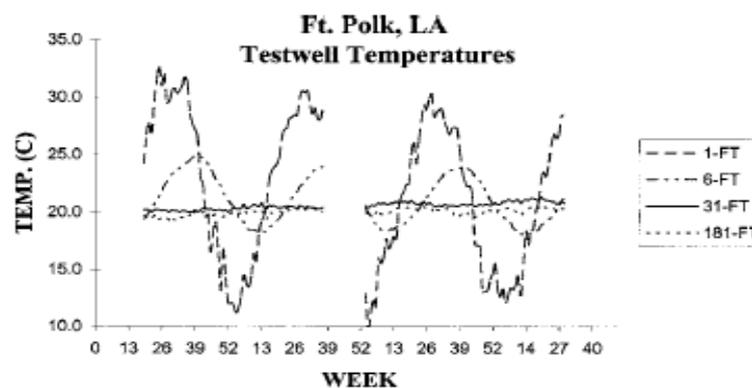
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## Appendixes

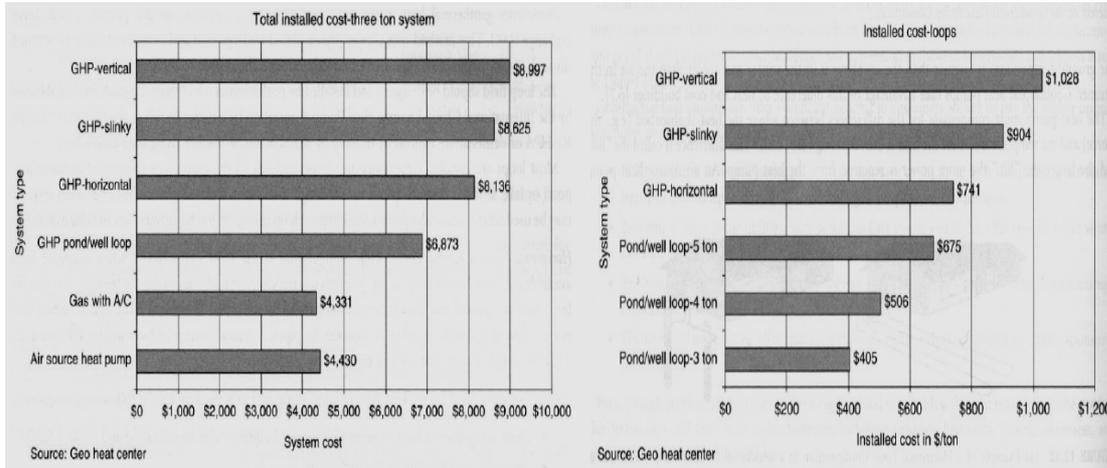
### Appendix 1 Soil Temperature

The figure below shows soil temperatures recorded from heat pump demonstration projects conducted at Ft. Polk, La. (Phetteplace 2002). It's clear from that the soil temperature does not vary significantly over the annual cycle below a depth of about 1.8 m (6 ft)



Appendix 2 Installation Cost Comparisons

As depicted below, GSHP has much higher installation cost than ASHP(US\$4,430), with vertical type the highest(US\$8,997).



Total Installed Cost for GSHP Systems by Type

Average Loop Costs by GSHP System

Source: (Kreith and Goswami 2007)

Appendix 3 Operation Cost comparison

Case Study 1: The following data were developed for three U.S. locations with widely different climate. The values shown are annual kilowatt hours(KWh) consumption for the different system types-conventional, air-source heat pump(ASHP), single and variable speed(v.s.) and geothermal or ground source, heat pump(GHP), standard and high efficiency(Consumers' Research Magazine, 1999).

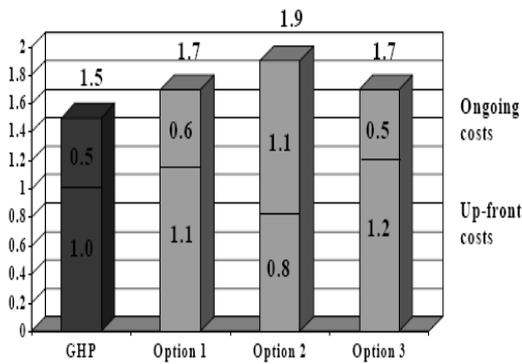
	Cooling(KWh)	Heating(KWh)	DHW(KWh)	Total(KWh)
<i>Atlanta, GA</i>				
ASHP	3409	7369	4120	14925
ASHP(v.s.)	2499	5540	4120	12159
GHP(std. eff.)	2598	4236	2620	9455
GHP(high eff.)	2079	3510	2509	8098
<i>Spokane, WA</i>				
ASHP	773	11475	4120	16458
ASHP(v.s.)	435	9295	4120	13850
GHP(std. eff.)	451	5562	3150	9163
<i>Portland, OR</i>				
ASHP	513	6666	4120	11299
ASHP(v.s.)	285	4706	4120	9111
GHP(std. eff.)	337	3549	4468	7354

Source: (Consumers' Research Magazine, 1999)

Appendix 4 Life Cycle Analysis

Case Study 2: Engineers determined that the 20-year life-cycle costs of a GHP system for a new elementary school in Nebraska could be \$200-400 thousand lower than three other more conventional HVAC options(Stuebi, 2000), the result shows that either considering from LCC or emissions, the GSHP(red one) is superior to other choices for the school:

COMPARATIVE ECONOMICS FOR SCHOOL HVAC  
\$ millions, 20 year life

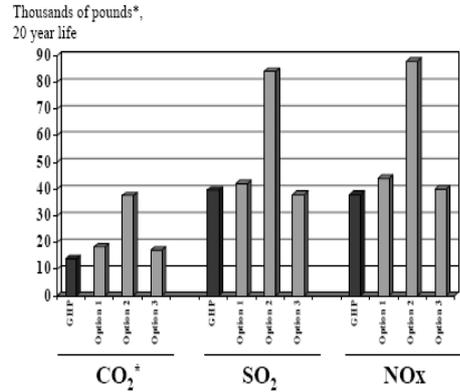


Source: Shonder, Hughes, McLain and Campbell

Life Cycle Cost

Source (Stuebi 2000)

COMPARATIVE EMISSIONS FOR SCHOOL HVAC



\* CO<sub>2</sub> in millions of pounds  
Source: Shonder, Hughes, McLain and Campbell

Life Cycle Emissions



## Paradigms of Development and Their Power Dynamics: A Review

Md. Saidul Islam

Department of Sociology

The College of William and Mary

PO Box 8795. Williamsburg

VA 23187. USA

Tel: 757-221-2594, 757-903-4641, Fax: (757) 221-1007 E-mail: msislam@wm.edu

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### Abstract

Development and power are two most fundamental ingredients and processes of social life. While the pervasiveness of power in the discourse of development has largely been obscured and camouflaged by paradigms of modernization and neo-liberalism, dependency theory has actually discovered that power-relations. Recently, with the emergence of post-modern critique of development, power has become an important subject in the discourse of development. Nevertheless, a full theoretical understanding of the relations between power and development is still in its nascent stage. Though highly apparent in human societies, social power *per se* is a polythetic discourse with no unified definition and implication, which led different proponents of development paradigms to understand power differently. This paper is a comprehensive survey of how power is understood in different paradigms/schools of development.

**Keywords:** Development, Power, Modernization, Dependency, Post-Modern, NGOs, Community based resource management

### 1. Introduction

Despite mounting criticisms (Note 1), development is still a master concept and one of the most indispensable ingredients of human society. The concept of development was popularized through expansion of colonization, and underwent various transformations as the socio-political structure of the world changed over time. During the era of colonization, development was understood as *having colonies*, organizing the European societies and its labour and market forces by disorganizing the non-European colonies. (Hoogvelt 2001; Cowen and Shenton 1996; Scott 1998; McMichael 2000). After the end of World War II, a new phase of development emerged, as the newly independent countries, for the sake of political legitimation, adopted the western notion/model of development. They had to depend on the technologies of the former colonial masters. The adoption of European model across the formerly colonial world in the post World War II era was the underpinnings of what McMichael (2000) calls the "development project". The USA was a powerful reality at that time. Asian and African decolonization started at the time when USA was at the height of its power and prosperity, and eager to reconstruct the postwar world to expand markets and the flow of raw materials. Reconstructing a war-torn world was an international project, inspired by a vision of development as a national enterprise to be repeated across the world of newly independent states (McMichael 2000; Hoogvelt 2001; Griffin 1989).

From the part of the West, especially from the USA, this development was viewed as a concept based on "*democratic fair dealing*" (McMichael 2000, p. 23). For the Americans and their allies, this was a liberal vision projected globally—a vision of universal political opportunity to pursue national economic growth. Therefore, the discourse of development assumed additional meanings—understood more *as a natural process, with universal application*, than the colonial initiative. That is, development could be administered by non-Europeans. This new development paradigm, however, ignored and obscured the contribution of former colonies to European development. In short, the development projects, as summarized by McMichael (2000, P. 75), were understood as: (a) an organizing concept to provide universal meaning (e.g., development as emulating Western living standards, rationality, and scientific progress); (b) a national framework for economic growth; (c) an international framework of aid (military and economic) binding the

developing world to the developed world; (d) a growth strategy favoring industrialization; (e) an agrarian reform strategy encouraging agro-industrialization; (f) central state initiatives to stimulate and manage investment and mobilize multi-class political coalitions into a development alliance supporting industrial growth.

Whatever is the outcome, western intellectuals formulated and accepted this western notion of development as the only standard for the globe. If we evaluate the development project, we can discern at least three significant points: first, the projects has been modified in various ways since 1950s, as the world has changed; secondly, it is increasingly questioned as some of its expectations have failed to materialize, which gave rise to the emergence of neo-Marxist dependency school; and third, the founding assumptions and practices of development project represented *historical choice* rather than an inevitable unfolding of human destiny. The development project was an organized strategy to overcome the legacies of colonialism. Development became an organizing principle to shape world politics and to determine relations, mostly power relation, between the Third World (Note 2) countries and industrialized developed world.

Over the last few decades, the field development studies embraced a diverse range of intellectual pursuits, albeit no sense of common purpose and direction. First, the field has fragmented into area studies, in which the success of East Asian “developmental” states offered a promising focus for theoretical renewal, albeit rather more to the field of comparative political economy than to the subject of development studies itself. Second, there were meta-theoretical critiques of those theoretical constructs that had long constituted the toolbox of development theory. Dependency, exploitation, unequal exchange, mode of production, modernization, rationalization, progress—all these came under the deconstructing axe of post-modernists, post-Marxists, and post-structuralists alike. Third, some development literature merged with the literature of the international political economy. Fourth, the inclusion of gender and environment is very evident in the development literature today (Hoogvelt 2001). And finally, pervasive notion of power inherent in the discourse of development has been uncovered by the post-modern theorists. This paper is a comprehensive survey of the literature and understanding of how power is understood in different theories/schools of development.

## 2. Development and Power

### 2.1 Liberal/Modernization Framework of Development

Modernization is a theory of social and economic development that follows functionalist or consensus assumptions that societies need to have harmony among their components. This assumption leads to the belief that modern economies (capitalist) demand special characteristics in their culture and the structure of social relationships (Cowen and Shenton 1996; Hoogvelt 2001). For example, family systems are assumed to change toward a narrow conjugal form, and away from extended structure, in order to accommodate the individualism and occupational flexibility that is demanded by a modern complex economy undergoing continual transformation.

Modernization theory evolved from two ideas about social change developed in the nineteenth century: the conception of *traditional vs. modern* societies (*gemeinschaft vs. gesellschaft*), and *positivism* that viewed development as societal evolution in progressive stages of growth (Rostow 1960; Hoogvelt 2001). The unique characteristics of *modern* capitalist society, as viewed by Max Weber, is its “formal rationality”, the best means (rational calculation) to achieve given ends (profit) as opposed to “substantive rationality” of *traditional* society; and “organic solidarity”, of *modern* society, which is based on the recognition of difference, contractual laws, and individual rights rather than shared identity, as opposed to “mechanical solidarity” based on homogeneity and collective consciousness of *traditional* society as viewed by Emile Durkheim (Collins and Makowsky 1998).

In Modernization theory, problems that held back the industrialization of poor countries were related to the “irrational” way in which resources were allocated in a traditional society. Traditional societies became modern by rationalizing resource allocation, and by the elimination of cultural, institutional and organizational roadblocks that did not allow countries to develop. Developing countries with traditional societies could evolve by starting in a stage with an *undeveloped* and traditional society, and through an evolutionary linear process change its society by rationalizing it, becoming a country in a stage with a modern and developed society. The theory identified different stages, variables and process through which a society develops. Positivist evolution implied that all societies would pass through the same set of stages that the western society had passed: from a traditional to a modern society. The modernization stages were: 1) the traditional society, 2) preconditions for take-off, 3) take-off, 4) the drive to maturity, and 5) the age of high mass consumption. These five stages of modernization were known as Rostow’s stage theory (Rostow 1960, Hunt 1989). From a Modernization perspective, the degree of industrialization, urbanization, and cultural values are the main indicators of changes in development in a country. Therefore, the level of use and access to information technologies within a society is captured by these indicators, but use is basically determined by the degree of rationalization of a society and cultural values towards science and technology.

According to Modernization theory, changes in openness to ideas and a more global sense of belonging would occur when changes in development occurred. Modernization also implies that a society’s culture value system and

institutional configuration determines its potential for development. It places the ideas and differing value systems, and not the material conditions, at the center of the explanation of the disparities in development (Hoogvelt 2001; Cowen and Shenton 1996).

There are various paradigm shifts or transformation within modernization/ capitalist framework. During the twentieth century, the two-sector (traditional vs industrial) model vividly identifies the capitalist or industrial sector as the engine of growth and development for the developing world. Capitalism in the mid-20th century was defined by an era known as Fordism, marked by intense relationships between governments, unions, international capital; this type of economics is still under state control. WWII gave a boost to industries that required mass production (chemicals, steel, etc.), and Fordism's heyday was between 1945 and 1973. Since the 1970s, Fordism has given way to Post-Fordism characterized by: 1) Business switch from industry to service; 2) New patterns of industrial distribution; 3) Intensifying globalization: a) global capital floats all over the world, states often lose control (e.g., Black Wednesday). b) fewer and fewer people control more and more production. 4) Weakened power of trade unions, less secure jobs, increase in low-paid jobs, etc.; and 5) Contemporary capital is hypermobile and hyperflexible (Hoogvelt 2001, Rist 2002).

Behind the backdrop of the earlier theoretical development, a paradigm shift has occurred during the mid and late 20<sup>th</sup> century known as Neo-liberalism. Neo-liberalism has been designed, pushed and implemented by some of the biggest and most powerful institutions in the world like the International Monetary Fund (IMF) and the World Bank (WB). The policies of Neo-liberalism include privatization, marketization, and globalization (Lefebvre 2003). The story of neo-liberal economics and globalization also includes the Kuznet's (1955) "Inverted U" hypothesis. The Kuznet's theory says that when a country begins developing economically, its income inequality worsens. But after a few decades when the rich begin investing more in the economy and wealth begins to "trickle down", income equalizes and people are wealthier than they would have otherwise been. The multilateral financial institutions, which have adopted this theory, namely the IMF, enforce structural adjustment programs on heavily indebted third world countries. These programs aim to get the state out of the economy through a number of measures known as "*shock therapy*" and at the same time create conducive environment for the forces of globalization to take off (Hoogvelt 2001; Cowen and Shenton 1996).

Modernization framework of development was considered by some as an oversimplified and generalized theory with strong racial stereotype and cultural bias. It ignored specific historical experiences and phases of prosperity in societies that had not changed their "traditional culture". Modernization theory was attacked as *ahistorical*, (ignoring phases of prosperity from a broader historical review), and *ethnocentric* (assuming that only one culture and one path were ways to development) (Hoogvelt 2001; Rist 2002; Pett and Hartwick 1999). *World Systems Theory* contested Modernization theory by suggesting that development differences were largely explained by taking into account the initial conditions and the relations of dependency in trade relations among countries in a whole system, i.e. the "world system". According to World Systems Theory, the global digital divide is really a reflection of the divides already present better explained by the degrees of *peripherilization* (a country's position in the core, semi-periphery or periphery). Countries in the wealthy core were bound to forge ahead in the use of new information technologies leaving behind countries in the deprived and dependent periphery. In consequence, the digital divide is a predicted consequence of the structure of the world system, in which less developed countries become more peripherilized when they are penetrated by interests located in the core: information and communication technologies are no exception to the core-periphery relation (Hoogvelt 2001; Rist 2002). Most importantly, modernization theory obscures the production and relations of power between developed and developing nations that pose a major hindrance to development of "traditional societies" as many claim. Paradoxically, others claim that the same sort of power relation is needed for the development of the traditional societies. Power and development are both related dialectically and reciprocally.

## 2.2 Modernization Paradigm and Power

How power affects, and is affected by, development is very complex yet interesting. Surrounding power, one of the first in-depth critiques of capitalism's inequities was by Karl Marx. Marxism was a Hegelian-inspired philosophy that concentrated on political economy, calling attention to *unequal power relations* between classes in capitalist society. It was an economic-deterministic perspective of the world. Marx's base-superstructure theory (economic base provided for cultural superstructure) was later elaborated by theorists such as Antonio Gramsci (Note 3), who elaborated post-Marxist theories of hegemony. Gramsci elaborated Marx's base-superstructure theory (economic base provided for cultural superstructure) with his theory of hegemony, i.e., that in modern society the subjugated classes willingly accept their exploitation by their rulers in society (Fontana 1993).

"Hegemony"—the willing acceptance of one social group's dominance and control by another and the dominating group's main vehicle of control—can be seen in terms of the more complex view of social structure, elaborated for the analysis of popular culture, developed in recent years within the Gramscian tradition and articulated by theorists such as Stuart Hall. However, an understanding of the more fundamental use of the term is also important. While it is difficult to find an adequate definition for hegemony, Todd Gitlin (2003, p. 253) gives a sense of how the concept works:

[H]egemony is a ruling class's (or alliance's) domination of subordinate classes and groups through the elaboration and penetration of ideology (ideas and assumptions) into their common sense and everyday practice; it is the systematic (but not necessarily or even usually deliberate) engineering of mass consent to the established order. No hard and fast line can be drawn between the mechanisms of hegemony and the mechanisms of coercion... In any given society, hegemony and coercion are interwoven.

In the 1920s, the Frankfurt School developed as a German Marxist critique of capitalism in ideological terms (as opposed to economic terms). The Frankfurt School's position broadly was that people are easily fooled by capitalism and the culture industry. Reality was that created by bourgeois society in capitalism—culture is processed through culture industry. This is quite different from enlightenment ideas of affirmative culture, harmony, authenticity, encompassing the best of the people when authentically free. The school looked at ideology as characterizing distortions of reality -its purpose is to camouflage and legitimate unequal power relations. The work of the Frankfurt School laid the basis for many more recent critiques of capitalist-inspired mass culture (Fontana 1993).

Proponents of modernization paradigm, however, have a modest understanding of power, though no consensus among themselves. Unlike Marxian perspective, which views power as *limiting*, proponents of modernization view that power is something *contributing* to the entire social fabrics. They view it is the mass population that has the ultimate power: power to consume, power to boycott products, power to elect their leaders to govern themselves. Development is thus a *democratic fair dealing* (McMichael 2000) with power centered in the opinion of the masses. Some proponents of modernization paradigm subscribe the *elitist perspective of power*, which rationalizes the fact that in order for survival and smooth functioning of a society, it must be run by an *efficient* few elites who are elected by the majority of its citizens. This model of understanding power and development pervades till late nineteenth and early twentieth century.

Another, mostly recent, cohort of proponents think that power is something prevalent in every stages of development activities, not centered in the "bourgeoisie" as Marx claims. They subscribe a pluralist model of power in development discourse. The donors of development projects, the researchers, the activists, the local populations or indigenous communities, academic personnel- all possesses power of their own and can influence each other. Development is pursued through a complex web of power exertion with one influencing other. This model is generally presented in response to the post-modern critique of development discourse.

### 2.3 Dependency Theory

Although dependency theory, like modernization theory, emerged in the post-war period, based on Marxian understanding of power, it had intellectual roots stretching into the past. Classical theories of imperialism had also addressed relations of domination and subjection between nations. According to dependency school, underdevelopment is seen as the result of *unequal power relationships* between rich developed capitalist countries and poor developing ones. In the past colonialism embodied the inequality between the colonial powers and their colonies. As the colonies became independent the inequalities did not disappear. Powerful developed countries such as the U.S., Europe and Japan dominate dependent powerless least developed countries (LDCs) via the capitalist system that continues to perpetuate power and resources inequalities (Hoogvelt 2001).

Dominant most developed countries (MDCs) have such a technological and industrial advantage that they can ensure the global economic system works in their own self-interest. Organisations such as the World Bank, the IMF and the WTO have agendas that benefit the firms, and consumers of primarily the MDCs. Freeing up world trade, one of the main aims of the WTO, benefits the wealthy nations that are most involved in world trade. Creating a level playing field for all countries assumes that all countries have the necessary equipment to be able to play. For the world's poor this is often not the case (Khor 2001, Hoogvelt 2001).

Unlike modernization theory which blames the culture of the underdeveloped, in dependency model the responsibility for lack of development within LDCs rests with the MDCs. Advocates of the dependency theory argue that only substantial reform of the world capitalist system and a redistribution of assets will "free" LDCs from poverty cycles and enable development to occur. Measures that the MDCs could take would include the elimination of world debt and the introduction of global taxes such as the Tobin Tax. This tax on foreign exchange transactions, named after its proponent, the American Economist, James Tobin, would generate large revenues that could be used to pay off debt or fund development projects (Khor 2001; Hoogvelt 2001).

There are some problems in this model as well and hence it is very difficult to implement. First, power is not easily redistributed, as countries that possess it are unlikely to surrender it. Secondly, it may be that it is not the governments of the MDCs that hold the power but large multinational enterprises that are reluctant to see the world's resources being reallocated in favour of the LDCs. Thirdly, the redistribution of assets globally will result in slower rates of growth in the MDCs and this might be politically unpopular.

#### 2.4 Post-Modern Critique: Development as a Regime of Knowledge/Power

The postmodern critique of development by writers like Ferguson (1990), and Escobar (1995) see development discourse as nothing more than an apparatus of surveillance and control. Even though they do not identify themselves as purely Marxist, or Foucaultian, they are highly influenced by intellectual traditions of Marx and Foucault. In order to maintain a focus on the notion of power and domination, as well as on the most pervasive effects of development, they see development in terms of discourse, as discourse analysis creates the possibility of, as Escobar (1995) quotes from Foucault (1986), 'stand[ing] detached from [the development discourse], bracketing its familiarity, in order to analyze the theoretical and practical context with which it has been associated' (p. 6). Escobar sees development from discourse analysis:

To see development as a historically produced discourse entails an examination of why so many countries started to see themselves as underdeveloped in the early post-World War II period, how "to develop" became a fundamental problem for them, and how, finally, they embarked upon the task of "un-underdeveloping" themselves by subjecting their societies to increasingly systematic, detailed, and comprehensive interventions. As western experts and politicians started to see certain conditions in Asia, Africa, and Latin America as a problem—mostly what was perceived as poverty and backwardness—a new domain of thought and experience, namely development came into being, resulting a new strategy of dealing with the alleged problems. Initiated in the United States and Western Europe, this strategy became in a few years a powerful force in the Third World (1995, p. 6).

Escobar (1995) nicely delineates how 'poverty' was discovered and 'problematized' and the 'Third World' was constructed in the discourse of development, and how two-third of the world population was put under the regime of control by discursive practices. 'The poor increasingly appeared as a social problem requiring a new ways of intervention in society' (p. 22), and 'the treatment of poverty allowed society to conquer new domains' (p. 23). The management of poverty called for interventions in education, health, hygiene, morality, and employment, and the instilment of good habits of association, savings, child rearing and so on. The result was a panoply of interventions that accounted for the domain of knowledge and intervention. Not only poverty, but also health, education, hygiene, employment, and poor quality of life in towns and cities were constructed as social problems, requiring extensive knowledge about the population and appropriate modes of social planning (Escobar 1992). 'The most significant aspect of this phenomenon was the setting into place of apparatuses of knowledge and power that took upon themselves to optimize life by producing it under modern, "scientific" conditions' (Escobar 1995, p. 23).

The result of these construction and practices was very pervasive. The poor countries started defining themselves in relation to the standard of wealth of the more economically advantaged nations. This economic conception of poverty (comparative statistical operation) found an ideal yardstick in the annual per capita income. Thus 'two-third of the world's people were transformed into poor subjects in 1948 when the World Bank defined as poor those countries with an annual per capita income below \$100. And if the problem was one of the inefficient income, the solution was clearly economic growth. Thus poverty became an organizing concept and object of new problematization' (Escobar 1995, pp. 23-24).

If we delve deeply into this construction, we will find an inherent power relation. The Third World is constructed by *distancing* it away from the civilized and developed West. This distance, which is not a simple marker of cultural diversity, is branded with inferiority and negativity (backward, underdeveloped, poor, lacking, traditional...). When these kinds of negative images are constructed on a group of people, they automatically become preamble to certain treatments and interventions, and thus, the former justifies the latter. Due to the construction of the Third World, the power relation between the agency who constructs, and constructed subjects becomes "father-child" or "doctor-patient" (Escobar 1995, p. 159).

With the construction of the Third World, as Escobar (1995) sees, the rich countries of the West 'created an extremely efficient apparatus for producing knowledge about, and exercise of power over, the Third World' (p. 9). New form of power and control, more subtle and refined, were put in operation. The poor people's ability to define and take care of their lives was eroded in a deeper manner than perhaps before. The poor became the target of more sophisticated practices of variety of programmes that seemed inescapable' (p. 39). Various programmes, institutions, centres of power proliferated in the West to study these 'poor subjects' and their conditions. The Third World then witnessed 'a massive landing of experts, each in charge of investigating, measuring, and theorizing about this or that little aspect of the Third World societies' (p.45).

To understand development as a discourse, one must look not at the elements themselves, but at the system of relations established among them. 'It is a system that allows the systematic creation of objects, concepts, and strategies... the system of relations establishes discursive practices that sets the rule of the game: who can speak, from what point of view, with what authority, and according to what criteria of expertise. It sets the rules that must be followed for this or that problem, theory, or object to emerge and be named, analyzed, and eventually transformed into a policy plan' (pp.

40-41). However, not all have the authority to do that. ‘Some clear principles of authority were in operation. They concerned the role of experts, from whom certain criteria of knowledge and competence were asked; institutions, such as UN, which had the moral, professional, and legal authority to name subjects, and define strategies; and international lending organizations, which carried the symbols of capital and power’ (p. 41). The principle of authority also concerned the governments of the poor countries, which commanded the legal political authority over the lives of their subjects, and the position of leadership of the rich countries, who had the power, knowledge and experience to decide on what was to be done. Therefore, the exercise of power/power-relation is evident between and within developed nations, and poor countries. In Escobar’s (1995) word:

Economists, demographers, educators, and experts in agriculture, public health, and nutrition elaborated their theories, made their assessments and observations, and designed their programs from these institutional sites. Problems were continually identified, and client categories brought into existence. Development proceeded by creating “abnormalities” (such as the “illiterate”, the “underdeveloped”, the “malnourished”, “small farmers”, or “landless peasants”), which it would later treat and reform. Approaches that could have positive effects in terms of easing material constraints became, linked to this type of rationality, instruments of power and control (pp. 41-42).

Patriarchy and ethnocentrism, the obvious manifestation of power and control, are inherent in the discourse of development. The indigenous people have to be modernized in line with the appropriate ‘values’ (western-white). It gives them an understanding of their own culture as ‘backward’, or ‘evil’ or ‘inimical to development’ (McMichael 2000). A sense of inferiority complex permeates over their body and soul. It has profound effects on their lives and way of thinking, and becomes a sophisticated way of exercising power and control. As Lohmann (1999) says, ‘racism is a process of social control, not a set of beliefs and feelings’ (p. 70).

The subordinate power relation is normalized in such a way that it goes uncontested and accepted as usual. The subject people often accept that as their fate. The history has witnessed the fact that development planners (most economists-75% in World Bank), and Engineers, by their economic mind-set, create models, calculations, and formulate plans, which often has no relation to the actual population, the subjects, and to how they (the subjects) see their own problems and solutions. Due to this problem, most development projects become unsuccessful and create tensions. Interestingly, when any project fails to materialize its target, the blame goes to the victims and their culture, not the planners. It is the organization, which plans, creates categories, and finally also constructs the blames. For example, for ecological disasters caused by development programmes, the poor are blamed and ‘admonished for their “irrationality” and their lack of environmental consciousness’ (Escobar 1995, p. 195). Institutional Ethnography is, as Escobar suggests, helpful to study the organization, especially its ideology.

From the discussion, it appears that what development reveals is intended to hide or occlude something. It is constantly expanding its power by constructing new domains. The conspicuous process is *problematization*: creating knowledge in a very efficient way, *institutionalization*: bureaucratization and managerialism, and finally *normalization of power*. This is what Michel Foucault (1979, 1986) discovers and explicates the relation and exercise of power in the modern society. One of the apparent implications of this extension of power is that it ‘privilege[s] certain actors, and marginalize[s] others’ (Brosius 1999, p. 38).

Apart from the above critiques, since 1980s there emerged another group, the group who might be called “ultra-modernist”. It consists of economic theorists who insist that the laws of economics have been proven valid, that the invisible hands of the market allocate resources optimally. Therefore, there is only economics, not development economics. When governments and outside agencies try to make the market work better, they introduce doctrines, which make it work worse. The free market does not guarantee equality of income, they say, but it produces as optimal an allocation of resources as is possible (Cooper and Packard 1997).

### 3. Development Projects and their Power Negotiation

Over past few decades, development faced mounting criticism because of its failure to bridge the gap between developed and developing nations. One of the key criticisms is surrounding unequal power relation. The harshest criticism came from under-development/dependency theorists. They not only indicated the problems and flaws inherent in the capitalist paradigm, but also advocated an alternative vision of development. But after the demise of USSR and its eventual entry to global capitalist club, and secondly China’s gradual penetration to, and acceptance of, free-market economy, their alternative vision is losing market currency. The post-modern critics of development, despite their thoughtful explication to equate development with power exertion, failed to suggest any development agenda alternative to capitalist paradigm. As different criticisms appear, the capitalist paradigm is now undergoing different transformations and trying to adopt and show a pluralist model of power relations involving and empowering the locals. Here are some key models and current debates surrounding them.

### 3.1 “Empowering” Civil Society and Ensuring “Good Governance”: Role of NGOs

NGOs are more popular than ever in official circles these days. However, while ten years ago, their popularity lay largely in their supposed efficiency in meeting the basic needs of the people at the grassroots—i.e., in ‘tackling poverty’,—today they are being trumpeted, according to UNDP Human Development Report (1993), as representative *per excellence* of civil societies in the so-called Third World. In the post-Cold war era, international institutions and donor agencies are turning their attention increasingly to concerns about democratization and popular participation. As UNDP report dramatically puts it, “Greater people’s participation is no longer a vague ideology based on the wishful thinking of new idealists. It has become an imperative—a condition of survival” (Keck and Sikkink 1998). But again, NGOs involvement in development projects and influencing national politics raises numerous questions and skepticism.

Wood (1997) is quite skeptical regarding the proliferation of NGOs in the developing countries. According to him, for NGOs to operate, for markets to penetrate and to hold authority, for private organizations to take hold of the societies’ power, the first thing that should be done is to diminish the power and authority of the state by curtailing its role in providing services to its citizen, and by reducing its control on resources. This is a neo-liberal agenda, and to do that it advocated the rhetoric of “good governance” which is paradoxical in meaning and operation. Wood calls this scenario “franchise state” (state franchising its responsibility to NGOs).

In the West “Good governance” is explained as “democratic process with strong accountability between state and people, removing the prospects of dictatorial oppressive governments and underpinning, therefore, the protection of fundamental human rights” (Wood 1997, p. 97). Wood calls it “hypocrisy” embodied in the western preoccupation of the theme “good governance”. He argues that the “good governance” represents a revival of ethnocentric, modernizing ideology, attempting to make the myths of one society reality in another. Giving the example of UK, he says, “Good governance is more possible elsewhere than in those countries which purport to be the keepers of the discourse” (p. 80).

When one talks about ‘good governance’, there arise many questions and problems, especially the problem of accountability. First of all, “good” is not universal, rather relative, and contingent upon cultural expectations and distributional outcomes. The paradoxes in the notion of ‘good governance’ include,

- (a) The thrust of policy is to undermine the monopoly of the state in service provision and allocation of resources, thereby creating more opportunity for exit choices and thus reducing the necessity for government to be good.
- (b) The preoccupations with privatizations and markets on the one hand, and good governance on the other, do not easily sit side by side.
- (c) Adherence to neo-liberal views about the efficacy and the responsiveness of the market as an allocator of public goods crucially slides over the issue of responsibility. However, markets tend to ignore responsibility, and have been proven to be failure in distributing resources. Markets rather serve the capitalists for accumulation and legitimation (Panitch 1977).
- (d) “Good governance” is geared to improve “participation”. It is very contradictory, as most NGOs are operated in an authoritative manner.
- (e) “Good governance” undermines and limits the capacity and power of the state, but state remains responsible for defining, guaranteeing, and regulating entitlements on the one hand and delivery on the other. NGOs which are operating to improve ‘good governance’ are basically working to “break the state monopolies in both service and goods delivery and to remove regulations and licensing to allow market to breath” (Wood 1997, p. 86).

Wood further (1997) argues that the “Franchise Model” cannot be alternative to state and market, because markets have been proven to be inefficient allocator. Other skeptics argue that policies of IMF and World Bank in the developing countries virtually created more tensions and problems. East Asia, Russia, and Latin America are some examples (Lefebvre 2003; Grinpun 2003; Stiglitz 2000; Weisbrot et al 2000), and they think that NGOs have close link with donors and other capitalist institutions, and hence they are mostly operated by the outsiders. It is dis-empowering for the locals as it erases their ability in a deep manner to define themselves and to take care of their own lives. Experience from the Orangi Pilot Project (OPP) (Hameed 1997), and Agro-forestry Outreach Project (AOP) (Murray 1997) shows, top-down approach is mostly ineffective.

Despite criticisms and skepticism, there are empirical proofs that NGOs play a vital role in empowering the locals, creating vigorous civil societies, ensuring participation of the local community in development activities and in making development more meaningful and accepted for them (Keck and Sikkink 1998).

### 3.2 Community Based Natural Resource Management (CBNRM)

In the midst of the exploitation of the natural resource as well as the local people/ forest or upland dwellers that results in severe environmental and social damage on the one hand, and direct control, and sometimes aggressive deployment of ‘development projects’ by the development agencies, community based natural resource management (CBNRM)

paradigm has been proposed by many. It offers to (a) promote democracy and participation among the local people, including women, who are historically excluded, (b) create mechanism for their empowerment, (c) claim the natural resources that is extracted mainly by the state elite, (d) reorganize the local communities in legal entities/frameworks for the management of resources, (e) create networks from local to the international level, (f) make the development projects more fruitful by ensuring the participation of the local people, and thereby make it meaningful and accepted to them (Brosius et al 1998; Lynch and Talbot 1995; Li 2002).

Recognizing the fact that CBNRM offers an excellent paradigm to create voice for the historically excluded and oppressed local communities in the development projects, there arise lot of questions, concerns, paradoxes and some dangers. The key debates surrounding this model are as follows:

First, Owen Lynch (1995) adumbrates a concern that the impoverished rural communities in the developing world are denied the fundamental rights to substantive participation in decisions that impact on their well-being and livelihoods, and through CBNRM, their important participation can be ensured. The question arises: does participation really ensure democracy and lay any impact on decision-making? There is a need to look at how far their participation really affects decision-making. The danger is that the state and the development agencies can use participation for legitimacy. To me, the notion of participation is so complex that the community chiefs can be privileged, while the other vast number of people remains impoverished. Brosius et al (1998, p. 164) raised important questions, "How are powerful institutions, including multilateral financial organizations, bilateral aid agencies, national and transnational conservation organizations, and private sector actors appropriating community based natural resource management projects and policies to advance their own diverse, sometimes intersecting, interests? What are the political, cultural, environmental, and economic consequences of these appropriations and manipulations?" By engaging the local communities in the development activities, the development projects get unquestioned acceptance, and if the projects fail, blame goes to the local people as if they are not ready for the development. The question then arises, is CBNRM a legitimate guise or an 'ideological device', in Marxist term, to conquer the local terrain?

Secondly, the success of disseminating the paradigm of CBNRM has raised new challenges, as "the concepts of community, territory, conservation, and indigenous are worked into politically varied plans and programs in disparate sites" (Brosius et al 1998, p. 157). 'Indigenous' or 'native' is one of basic elements in the program of CBNRM, which is often used for resource claim. For example, Lynch (1995) made a distinction between Hispanicized and un-Hispanicized ethnic groups in Philippines. However, the notion of 'indigenous' is subject to contestation, as human history entails the fact that people are always in mobile often by better future and displacement by human and natural forces. Old and new migrants often interspersed among them, and cross-marriage, hybridity etc. are common phenomena in almost every community (Li 2002).

Tania Li's (2000) argument is that a group's self identification as tribal or indigenous is not natural or inevitable, but neither is it simply invented, adopted, or imposed. It is, rather, "a *positioning*, which draws upon historically sedimented practices, landscapes, and repertoires of meaning, and emerges through particular patterns of engagement and struggle" (Li 2000, p. 151). She elaborates that the conjectures at which some people come to identify themselves as indigenous, realigning the ways they connect to the nation, the government, and their own, unique tribal place, are the contingent products of agency and the cultural and political work of articulation. The concepts of *articulation* and *positioning*, which she draws from Start Hall (1991, 1996), are central to her analysis. Moreover, in the era of borderless world and transnational citizenry, the notion of 'indigenous' is gradually losing its market value. Incorporation, integration into a new society is a very common picture of the modern society. Market citizenship is a new concept that contests the notion of 'indigenous' (Strange 1996).

On the other hand, the notion of 'indigenous' can be used for exclusionary purposes. Malaysia is a good example where the so-called "bumi-putra" (indigenous) gets extra-privilege, while the discursively constructed *non-bumi-putra* are historically excluded in many respects. Claiming or constructing 'indigenous identity' may lead to more complexity and conflict. Both Palestinians and Israelis are claiming to be indigenous that resulted in the circles of violence for long decades.

Another danger lies when the project of CBNRM uses ethnicity for land or resource claims, as again the 'ethnicity' is a very fragile term on the one hand, and construction of an ethnicity (for land/resource claims) may lead to an *essentialized* identity, on the other.

Third, one of the assumptions of CBNRM is that indigenous peoples' life is based on the forest resources (Lynch 1995). This kind of assumption is highly contested. "The characterization of indigenous people as forest resource dependent is more problematic" (Li 2002, p. 267). The question arises: does it suggest that the forest dwellers should remain traditional and forest-dependent? In the era of advanced technology, science, and high communication, as well as decent and healthy style of life, can we imagine a life in the forest? The CBNRM talks about the management of forests by the forest-dwellers, but in reality the "tribal people are not being asked if or how they want to manage their forests" (Brown

1994, p. 59). Li (2002) explicates that many tribal people in Indonesia and elsewhere denounced their tribal identity, as they do not want to pursue their future on the forests/hills.

Fourth, in projects of CBNRM, we see that community, territory, indigenous, traditional etc. are defined and constructed by the outsiders. It entails a regime of control and authority/power over them. The local people are turned into an 'object of knowledge' and lose their ability to define themselves in their own terms and to take care of their own affairs. The agencies decide who to speak, from what point of view. In Escobarian (1995) way, behind the construction and reconstruction of the local community in discourses and practices in the name of creating voice for them or to ensure their participation in the development projects, lies the lucrative interest of the powerful development agencies.

Escobar (1995) explicates how development expands by creating different domains of thought and discourses. The process includes *problematization* (creating knowledge in a very efficient way), *institutionalization* (bureaucratization and managerialism), and finally *normalization of power*, as we have elaborated before. One can argue that by deploying the regime of CBNRM, the local communities, who were outside the direct domination of development agencies, are now under the direct control and power.

Fifth, does CBNRM further lead to 'institutionalization' and 'managerialism' where the local communities become the objects of policies? Schroeder (1995) raises the concern that the language of community and conservation has, upon occasion, served to help shift resources away from local strategies for livelihood and empowerment towards resource management that served powerful institutional interest, whether corporate, scientific, military-administrative, or northern consumer-oriented. There is a need to explore how CBNRM, if goes towards institutionalization and managerialism, 'privilege a fortunate few and preclude other', if we quote Brosius (1999); how it affects the state government, and fate of the local communities; and how, if any, multilateral institutions and bilateral lending agencies have influenced national governments to enforce CBNRM by decree.

Sixth, the paradigm of CBNRM is based on a common assumption that state is an oppressive regime to the local community, and in order to create voice for the local communities, the state power needs to be subverted (Lynch 1995; Li 2002). Hence, we find various writings to construct state as an 'alien' to the local community. However, states may not always be aliens to local communities. Many think that undermining the state is necessary to create a vacuum for the market to penetrate and to take over the activities previously done by the state.

We are yet to be convinced that we have to oppose the state in order to create voice for the oppressed communities. However, one can argue that state is the still a legitimate organization/ institution to organize the people, to work for their well-being. Viewing state always as oppressive regime is a kind of simplification. We do not afford to ignore that in many developing countries, many local communities are oppressed, and many of them have already been displaced by the state. For instance, hundreds of Penan people in Sarawak, Malaysia (Brosius 1999), the forest-dwellers in Thailand (Lohmann 1999; Vandergeest and Peluso 1995, Islam 2003), and so-called Hispanicized people in Philippines (Lynch 1885) and others are in acute manipulation by the state. However, McMichael (2000) shows that most of the displacement and oppression is because of the aggressive deployment of development projects, and it is not the state that needs to be blamed alone, the powerful development agencies that deployed the development projects should be blamed. For instance, the agony of the highlanders in Thailand is mainly due to development agencies' proposal to "reduce the population of people in mountainous areas and bring them to normal life" (Lohmann 1999, p. 70). Rather than viewing state as a separate entity and hence subverting the power of state, we can think of a democratic state with equal and meaningful participation from all communities. Both state and community can be mutually constitutive. Here how nicely Li (2002) explicates:

A core concern of CBNRM has been to strengthen the capacity of the communities to protect their natural resource base from the more destructive and rapacious activities of ruling regimes, among others. The model envisages a shift in power from states to communities, conceived as separate entities. Instead, as I have argued, states and communities are mutually constitutive. CBNRM offers state system an opportunity to rearrange the ways in which the rule is accomplished, while also offering the communities an opportunity to realign their position within (but not outside) that system. Where citizens are indeed up against "vicious states", the potential of CBNRM to empower them is very limited. Older vocabularies about peasant struggles, class conflict, and democracy are better able to name the problem, and to indicate the forms of collective action through which it might be addressed (p. 281).

The above are some of critical points with regard to CBNRM. Scholars of CBNRM, the donor or development agencies, as well as the nation states need to keep all these in minds. We can envisage a fruitful collaboration and mutual power sharing between these three groups: communities, donor agencies, as well as the state, and that should be the goal of CBNRM, as well as development projects. We can conclude here by quoting Li (2002), "CBNRM serves as a vehicle for negotiating the responsibilities and rights of the citizenship. It is not, however, the only possible vehicle and its strengths and weaknesses need therefore be evaluated in relation to the alternatives" (p. 270).

#### 4. Discussion and Conclusion

“The development process has from its inception been self-critical, and subjects to critiques” (Cooper and Packard, 1997, p. 2). From the analysis of development and power above, we can discern different accounts of history and analysis. In conventional analysis, development can be seen in terms of evolution of theories and ideas, or as the succession of more or less effective interventions (Leys 1996). For political economists, the same history reflects deferent ideological responses to allegedly deeper contradictions, dictated by capital accumulation and circulation, or also capital accumulation and legitimation (Panitch 1977). This history, however, can also be seen from the perspectives of the changes and transformations in the discursive regime, even if these changes are circumscribed by discursive practices tied to political economies, knowledge traditions, and institutions of ruling (Escobar 1995), and wherein lies the notion of power.

Hence, development is, in no way, a monolithic discourse. As it has different accounts of outcomes and gains, so has criticisms from different perspectives. It is accepted by a wide range of people, and simultaneously contested by many as well, while some have an ambivalent position. The prevalence of different accounts on the discourse of development certainly entails the fact that *development is not all about power* (knowledge-power-regime) as propounded by Escobar (1995) and his associates. From our analysis, we can safely say that development is rather both empowering and disempowering operated and functioned in a very complex interwoven ways of power relations. It empowers certain actors, spaces, and species, while disempowers others. “All development projects involve reorganizing the meaning and control of space” and have “the potential of causing displacement” (Vandergeest 2003, p. 47), not only for human beings but also for other species. With powerful vocabularies and various discursive practices, development creates categories, makes different spaces, disempowers those that appear inimical to, or compete with, development projects. Thus, in the process of reorganizing nature—by both empowering and disempowering—

Plants that are valued become “crops”, the species that compete with them are stigmatized as “pests”. Thus, trees that are valued become “timber”, while species that compete with them become “trash” trees or “underbrush”. The same logic applies to fauna. Highly valued animals become “game” or “livestock”, while those animals that compete with or prey upon them become “predators” or “varmints” (Scott 1998, p. 13).

The arguments of dependency school as well as postmodernist critics are framed in such an impressive way that it often lead us to think that development is all about top-down power exertion and there are no other possibilities. It closes all the doors of viewing other perspectives. It is hence reductionistic, and stagnationistic. Unlike postmodernist critique of development (knowledge-power-regime), theorists of “underdevelopment/ dependency” propose a more radical alternative, quite akin to Marxist explanation of capitalism that we discussed before. The theory of ‘underdevelopment’, however, lost a considerable amount of market currency after the demise of USSR, and subsequently China’s shift towards free-market economy, and capitalism remained the only viable alternative.

Rather than closing the door by deploying the discourse of ‘dependency’ or ‘knowledge-power-regime’ on development, we need to go further. The best way to view development is, to quote Cooper and Packard (1997), “neither to bury development, nor to praise it” (p. 4). They explain that over the past few decades, development encountered some passionate confrontations and criticisms, though in a limited scale, it, to some extent, if we view positively, provided a kind of ‘check-and-balance’ to development projects/endeavors. The debates are still on: the post modernists criticize developers for imposing undesired modernity, while developers reject the post-modernists’ nihilism and statism of the more orthodox. Postmodernists attack on the developers that they, without interacting the target people, make calculation, create client groups, and prepare model for development, which eventually fail; while people engaged in development projects constantly insist that they are doing practical work interacting with the local people, and need models and more practical framework to make the progress more coherent and fruitful. In Cooper and Packard’s words, “no side in these tussles has a monopoly of virtue, and all have something to gain by a more introspective, contingent view of the terrain upon which these battles have taken place” (1997, p. 4).

In the milieu of arguments and counter-arguments, critiques and counter-critiques, it is simplistic, we think, to be caught up on a single discourse, like the discourse of ‘knowledge-power-regime’ of ‘dependency’ or even ‘modernization’ hype. Sugata Bose (1997) elucidates India’s historical experience of development in a comparative manner, and mentions that the development that India experienced over the century is neither simply a knowledge-making apparatus, nor enhancement of dependency. Development there created lot of possibilities, and has numerous achievements. Consequently, India, being powerful enough, is not only capable of managing its own economic affairs, but also provided the world with eminent experts in development economics. Gupta (1997), on the other hand, explains that development in India gave rise to different social movements among the poor who demanded for reform, sometimes, opposed projects, like building a dam, which are hazardous to the communities. From the discussion of Bose (1997) and Gupta (1997), it appears clear that development is more than the relation of power in an extreme hierarchical order, like “father-child”, and “doctor-patient” (see Escobar 1995, p. 159) rather a complex web of power exertion both influencing and being influenced, popularly expressed as “pluralist” model of power exertion.

The power relation and the regime of control as explicated by Escobar and Ferguson seem one-sided, solid, and vertically monolithic: the developers at the top and the Third World at the bottom. To them, development strengthens this power relation in a deeper manner. However, evidence shows that power is dynamic, and is exercised in different angles, and in variety of ways. Development does not always make the third world powerless, rather make them regain power. Women, beset by patriarchy, for example, gained a considerable amount of power due to development (Packard 1997). Cooper (1997) shows that the image of the African farmers survived is much evidence of innovation and the arrival of Africans in power.

Moreover, “within the world of development, power is distributed in a highly uneven manner” (Cooper and Packard 1997, p. 20). It is, therefore, important to see how institutions from World Bank to the local levels operate. Evidence shows that local level community networks (social movements) were able to evade, reject, or reform development projects (see, for example, Gupta 1997). Therefore, communities are not just the passive recipients of the development projects imposed by the developers; they have also choice and power.

According to Escobar (1995), the production and dissemination of development knowledge is always top down: from World Bank to the Third World/local, for example. They have the legal authority to name subjects, make client groups, and define strategies... (pp. 40-41). But this materialistic and simplistic explanation does not grasp all. It ‘overlooks the specific networks of communication through which ideas circulate internationally. The power of an institution like World Bank is based as well on its position within overlapping global networks of research, communication, and training. The bank recruited internationally from developing and developed countries... and projects review documents... are disseminated globally’ (Cooper and Packard 1997, p. 21).

The production and dissemination of development ideas is not always unilinear as Escobar sees. There are instances in which the local people provide knowledge to the World Bank. Gupta (1997) argues the development knowledge prevalent in India was not entirely produced and disseminated by the World Bank. On the one hand, India refined, and restructured the development knowledge provided by the World Bank, and produced some unique knowledge on development by the local expert, on the other hand, and contributed to the world arena. Therefore, the production and dissemination of development knowledge is not unilinear, rather reciprocal, contextual and subjects to revision. Furthermore, as Cooper and Packard (1997) explain, the successful transmission of ideas emanating from the powerful development organizations was also fostered by global political shifts. The end of Cold War narrowed development options by discrediting socialist alternatives. It is perhaps historically significant that the earlier post-war push for market-led development was short circuited by the rising “fear of communist expansion”, and the need for more interventionist development, while the second coming of market driven development and the willingness of the leaders of the USA and elsewhere to accept whatever consequences the market may have- became politically feasible, in part, through the demise of communism.

We cannot, however, afford to deny that the intensity of global governance, power and control by the development organizations. But one can argue that it is because of the fluidity of the market. The nature of the present-day market system demands more control and surveillance as many argue. Interestingly, one of the shifts of the development organizations is remarkable: from ‘good economics’ to ‘good government’. Despite concerns and criticisms, many think that this move is directed towards a positive outcome. For example, Cooper and Packard (1997) see:

The insistence on ‘good government’ reproduces much that was previously said about ‘good economy’: a bland assertion that the West has defined objective standards for others to meet, a generalized set of categories (elections, multiple parties) that define those standards, irrespective of the actual debates that might be going on in specific contexts over how more people might acquire meaningful voice in their own lives (p. 23).

Escobar (1995) claims that all development projects are economic, as economics has the monopoly of authority in the area of development, which excludes other disciplines of social science. ‘About 70% of the World Bank’s professional staffs are economist; a good portion of the remaining 30% are engineers’ (p. 165). If this is true, this is alarming in deed. Recent years, however, witnessed a remarkable shift as researchers from different other disciplines (Sociology, Anthropology, Political Science, Environmental Studies...), not only as critics but also as contributors, ventured to penetrate into the border of development economics, and hence the new border of development area is blurring. The area of development is now interdisciplinary in nature. The point we want to make here is that though the area of development is still dominated by Economics, the domination is subverted to a great extent. Lot of development activists, who are not economists, are working to create voice for the local people.

Both development and power are pervasive, yet complex, phenomena in our society. Complex character of both concepts as well as ideological orientations of scholars have led them view these concepts from different perspectives. Rather than rejecting one and accepting another, a comprehensive analysis of, and debate around, all perspectives has a good possibility to provide us a better understanding of the interwoven relations between these two most important concepts in our society.

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#### Notes

Note 1. For example, Wolfgang Sachs (1992) writes: "The idea of development was once a towering monument inspiring international enthusiasm. Today, the structure is falling apart and in danger of total collapse" (p. 5).

Note 2. It has become commonplace to note that the 'Third World' and 'Second World' have ended as coherent entities. Secondly, many might think that using 'Third World' exposes its subordinate power relation with the so-called 'First World'. We use Third World here for no other reason than convenience.

Note 3. Gramsci is an Italian political activist and theorist who wrote much of his most influential work while incarcerated in a fascist prison, Gramsci has left an enduring legacy. His notion of hegemony is quite similar to Althusser's participatory model, where even the oppressed classes happily accede to their oppression. However, Althusser's differs insofar as he thinks social change is rendered unlikely. Gramsci's theory, on the other hand, allows a much greater role for resistance to dominating influences/power from within the hegemonized groups, and recognizes the opportunity for social change within a capitalist system.



## Current Status of Environmental Protection Measures in China

Chao Liu, Shenggao Cheng & Kefeng Zeng

China University of Geosciences, Wuhan 430074, China

### Abstract

Human activities affect the environment more or less negatively due to thriving engineering constructions such as resources exploitation, municipal projects and so on. It is encouraging that, by applying some environmental protection measures to decrease pollution in cities and prevent disturbance from geo-environment due to constructions, have made big progress for the present. However, it is far from our utmost expect of environment protection. The inherent complexity and varied nature of geo-environment challenge policy makers how to assess the active effectiveness of environmental protection in scientific approaches. This paper, starting from antecedents achievements in China, outlined the present situation of environment protection in China, and featured the types and purposes of 21st century environmental sures in terms of their natures and functions, thereby comprehensively proposed research respective. Research conclusions were included: 1) the awareness to environmental protection measures is increasing and it present higher growth rate in 2006 and 2007 in terms of analyzing publications focused on environment protection; 2) "passive" environmental protection measures account for most of human activities, while less attentions were paid to the precaution for the source; 3) Awareness to the economic applicability and efficiency of environmental protection measures

**Keywords:** 21<sup>st</sup> century, Environmental protection, Measure, Progress trend

### 1. Introduction

Environmental protection is now a major focus for the whole world. These years, Chinese government and Chinese people have invested great workforce and material resources in environmental protection, consuming a lot of time and money. The environmental protection measures in China start from construction of environmental protection facilities. Back in 1972, the State Council demanded that construction of factories should be accompanied by the project of utilizing three wastes via simultaneously designing, constructing and putting into construction (called "three-simultaneous"), in approving and transferring "*The Report by State Planning Commission and National Construction Committee about the pollution in Kwanting Reservoir and its solution*". From then on, there are varies of regulations, laws and other forms of interference such as the management system of simultaneously designing, constructing and putting into production, "Law of Environmental Protection of the People's Republic of China" and economic, media, education and so on. With varies forms, there is only one purpose, that is to protect the environment in different methods.

This paper made searches based on documents cited by China National Knowledge Infrastructure (CNKI) full-text databases from 2000.1 to 2007.12. The time of search was a.m. on December 31st, 2007, with "environmental protection measures "and" environmental protection +measure" as key words for "superscription" and performed accurate matching in selected database, which is China Journal full-text database. Two searches resulted in total 322 documents, and after weeding out classified documents, which can not be downloaded and read, and the overlaps, there are 227 documents left. After printing, checking and counting page by page for environmental protection measures, it was found out that 23 documents do not contain specific environmental protection measures, for they are just news reports or simple slogans of environmental protection. So the actual samples involved in the statistics are 204.

### 2. Statistical Methods and Statistics

#### 2.1 Document Statistics

204 samples are given a digital cod according to the year: year 2000, 1-20; year 2001, 21-36; year 2002 37-56; year 2003, 57-81; year 2004, 82-105; year 2005, 106-128; year 2006, 129-165; year 2007, 166-204. For example, code 20 represent that the measure appears in the 20<sup>th</sup> document.

According to the statistical Fig.1 of the number of documents in different year, the general trend is growth, indicating that there is more and more attention to the environmental protection measures. In statistics, there are the highest document numbers in 2006 and 2007, indicating the most attention in these two years.

## 2.2 Environmental protection measures Statistics

This paper drew statistics according to each and every specific method, measure or management advice in 204 sample documents and each method is counted as one environmental protection measure (normally there are various such measures in one document). And the environmental protection measures are classified according to their nature into regulation, policy and law measures, technique reform measures, planning layout and regional management measures, and educational, propaganda and awareness measures. The environmental protection measures with higher appearing rate are as follows, and the others is as data source in classified statistics analysis, which does not be talked about in this thesis.

### I) Regulation, policy and law measures

Based on environmental management system of China, it can be classified into environmental management system such as environmental law and "three-simultaneous" system, contamination draining fee system, environmental impact assessment system, and industry policy and economic policy and so on. Specific measures which appear more than 10 times are: (1) pollutant standard emission and total emission control (ZHU D-M, 2000, pp.3-5; SHAO F., 2000, pp.39-41; WU X-F., 2005, pp.72-76; HAO M-J, ZHAO Y-Q, ZHANG L-J, et al., 2006, ), 31 times; (2) to improve environmental protection laws and regulations, complete standard emission system, manage environment according to laws and standard (ZHAO X-M., 2004, pp.5; YU X-F, LI M-F., 2006, pp.54-55; Ge C-Z, GAO S-T, et al., 2007, pp.23-25), 30 times; (3) environmental impact review system (ZHANG H-Y., 2005, pp.7-8; LIU Y-L., 2007, pp.40-42), 28 times; (4) to readjust industry and product structure by using economic and industry policy, wash out enterprises and projects with heavy pollution and low efficiency on energy and resource utilization by force (ZHU D-M, 2000, pp.3-5; MAO N-H, LIU B, CHEN X-G., 2003, pp.58-59), 27 times; (5) environmental protection "three-simultaneous" system (PENG H, PENG X., 2002, pp.23), 20 times; (6) implement environmental protection goal responsibility system, and thus environmental protection is an important part in assessing cadres' achievement, 17 times; (7) pollutant draining fee and environmental tax system (WANG N, LIU J-S., 2000, pp.12-14), 16 times; (8) ecological environment compensation system (GENG Y., 2006, pp.62-65) 10 times.

### II) Technique reform measures

This kind of measures optimize and alter resource utilization means, decrease generation of pollutants and dispose pollution and ecological damage through engineering technique reform. This includes not only various engineering technique reform in different departments and production links such as in mining, road construction, bridging, building, industry and agriculture production and so on, but also the technique reform in waste utilization process. Specific measures which appear more than 10 times are: (1) restoration and treatment of damaged land (HUANG R-Y., 2007, pp.73), 55 times; (2) waste recycling method reform (HUANG B-T, WEI T., 2004, pp.105-109), 50 times; (3) ground sill and slope protection (ZHENG G-H., 2001, pp.46; WANG L, WANG B-J., 2004, pp.8-9; WANG X, XING H-T., 2004, pp.45-46; CHEN H-D, LIU X-B, YU L., 2007, pp.16-18), 45 times; (4) noise prevention measures (HUANG R-Y. 2007, pp.73-75), 38 times—among which 30 articles referred putting shield, sound insulation woods, acoustic barrier, vibration reduction slot and other ways to reduce noise pollution, and 15 articles mentioned mechanical maintenance to remain the lowest acoustic level; (5) applying advanced production facilities, environmental protection equipments, and techniques to decrease emission of pollutants, 25 times; (6) to select new raw materials to get cleaner material and environmental protection products, 16 times; (7) to optimize the time for construction (YU X-G, LI C-H, SUN C-S, et al., 2005, pp.226-227), 15 times; (8) to use advanced monitoring and control equipment and information processing technology, 15 times; (9) to update and optimize the dust removal equipment system, 15 times; (10) to optimize the environmental protection design of project construction, instrument and equipment (LIU Y-L., 2007, pp.40-42), 13 times—among which 9 articles mentioned providing passing channels for wild animals; (11) to optimize construction or exploitation methods (ZENG J-X., 2006, pp.66-67), 13 times; (12) to utilize new technologies to increase resource utilization efficiency and decrease energy consumption and pollutant emission, 12 times; (13) to alter the system obturation, 11 times; (14) to ascertain industry type and scale according to environment carrying capacity, 10 times.

### III) Planning, layout and regional management measures

This kind of measures include establishment and management of nature reserve, ecology protection planning, urban function partition, construction of regional infrastructure, resource protection, mine management and so on. Specific measures which appear more than 10 times are: (1) construction organization and management, 56 times—among which 18 theses mentioned reasonable layout of construction encampment, soil excavating and depositing site, and strictly control of temporary land use scale, and 15 theses mentioned environmental project supervision and inspection of environmental protection bureau; (2) vegetation planting and greening management of slope, factory zone, mine zone, community, river source and other areas (YANG J-B., 2007, pp.14-16), 53 times; (3) reasonable planning, scientific siting and route selection concerning landform and surface features (LIU Y-L. (2007, pp.40-42), 38 times; (4) cleaning and classified management of domestic sewage and garbage, 36 times; (5) planning of environmental protection and sight construction (ZHAO X-M., 2004, pp.43), 28 times; (6) perfection of environment management and supervision institution

and environmental management system(YANG J-B.,2007,pp.14-16); 27 times;(7)disposal of project construction waste water, road surface water, waster water of vehicle mechanical maintenance cleaning, 23 times;(8)traffic, transport and road management, 19 times;(9)perfection of national environment monitor network and environment information system, and precaution of disaster and monitor of regional resource and environment, 19 times;(10)establishment of nature reserve in places such as swamp, forest, river source, geological relics and other places(YANG J-B.,2007, pp.14-16), 14 times;(11)project management by bringing environmental protection activities into contracts, 13 times;(12)reasonable layout of enterprises and factory area, 12 times;(13)management of agriculture and livestock husbandry production, 11 times;(14)making resource utilization plans to use resource reasonably(YANG J-B.,2007, pp.14-16), 10 times;(15)equipment check and maintenance, 10 times;(16) construction of environmental protection infrastructure, 10 times.

#### IV) Education, propaganda and awareness measures

This kind of measures concerns with education and propaganda, in order to promote environmental protection consciousness of the entire people. Specific measures that appear more than 10 times are: (1) environmental protection common sense and ideological education, and technical measures training(YANG J-B.,2007,pp.14-16), 24 times; (2) ubiquity of environmental protection knowledge, and mobilization of public for environmental protection campaign, 23 times. Other theses concerned with measures such as improving decision making of project planning and environmental protection consciousness of prospective designer; strengthening propaganda of hygiene and disease control and security training; consciousness of energy saving and consumption reduction propaganda and education; promoting greener consumption and harmonious development and so on.

### 3. Analysis and Classification

#### 3.1 Classification Statistics Chart

This paper makes statistics on all kinds of data in two methods separately. Both methods make statistics according to different year and then perform contrast to make sure the total number of environmental protection measures is consistent in each year so as to assure the veracity of the statistics.

Based on environmental protection measures (as data source) in 204 sample documents, we classify them according to the method mentioned in section 2.2 into regulation, policy and law measures (type I: the statistics are 23, 25, 10, 22, 22, 31, 59, 69, from 2000 to 2007), technique reform measures (type II: the statistics are 16, 14, 19, 46, 55, 34, 91, 81, from 2000 to 2007), planning layout and regional management measures (type III: the statistics are 20, 24, 21, 66, 79, 96, 125, 142, from 2000 to 2007), and educational, propaganda and awareness measures (type IV: the statistics are 3, 12, 6, 9, 9, 9, 15, 15, from 2000 to 2007), and drew the statistics about the number of environmental protection measures as shown in Fig.2. According to the function of environmental protection measures we can divide them into front-prevention measure (type a: the statistics are 13, 18, 18, 35, 39, 47, 72, and 80, from 2000 to 2007), end treatment measure (type b: the statistics are 10, 11, 12, 33, 43, 38, 68, and 67, from 2000 to 2007), process optimization measure (type c: the statistics are 14, 10, 9, 24, 39, 23, 49, and 58, from 2000 to 2007) and comprehensive measure (type d: the statistics are 23, 36, 17, 51, 44, 61, 102, and 108, from 2000 to 2007), and the statistics are shown in Fig.3. Both statistics show that the total number of environmental protection measures in each year is consistent. In these 8 years-from 2000 to 2007-the statistics are 62, 75, 56, 143, 165, 170, 290, 313 separately, indicating that the statistical definition and the count of these recorded environmental protection measures are the same and accurate.

#### 3.2 Statistical Analysis

(1) analysis of total environmental protection measure number: from 2000 to 2002 the total number remain stable with 62, 75, 56 respectively; in 2003 there is a clear increase in total number which reached 143; during year 2004 and 2005 there are slow increase; in 2006 and 2007 the increase rate soared and break through 300 in 2007.

(2)classified data analysis: during 8 years the curve of type IV goes mild for about 10 times each year; from 2000 to 2002 type III remained stable, while from 2003 the number started increasing; generally speaking type II has been increasing while in 2002 and 2005 there were lower points; type I shows a stable increase in 8 years. If we just consider the number, type a and d shows apparent increase every year, while type b and c rises and falls.

(3) Combining two classification method, the statistics are as Tab. 1. Id, IIB, IIIa and IIId show higher rate, followed by IIc, IIIc and IIIb.

### 4. Conclusion and Discussion

The following conclusion can be drawn via data analysis:

(1) During 2000 and 2007, Chinese academic periodicals' attention to environmental protection problems are increasing, and the increase can be divided into three phases. From 2000 to 2002, it is stable phase with 16-20 theses and 56-75 environmental protection measures a year. From 2003 to 2005, it is the increase phase with 23-25 theses and 143-170 environmental protection measures a year. From 2006 to 2007, it is soaring phase with 37 and 39 theses and 290 and

313 environmental protection measures each year.

(2) Most measures are planning, layout and regional management measures (III), with apparent increase. This indicates that in recent years scholars were more concerned with researching the effect of planning, layout and regional management on environmental protection. The least measures are education, propaganda and awareness measures (IV), which indicates that the attention to these aspects is inadequate.

(3) There is a lot of type Id environmental protection measures with apparent increase, which indicates that there are more and more broad attention to environmental laws, regulations, policies and systems which are comprehensive and concerning overall process. There are also a lot of type I Ib measures with apparent increase, indicating there are more attention to technique reform measures while these measures are still end treatment measures. There are many type IIIa and III d measures with increase, indicating the effect of planning, layout and regional management measures on environmental protection are mainly shown in front-prevention and comprehensive management measures.

Problems deserving further discussions are:

(1) It may due to national policy that in 2003 and 2006 there were great increase in the number of environmental measures, especially the attention from the entire people brought by "environmental protection storm". However, "passive" measures played a major part in that it is policy-oriented and mainly rule of man with inadequate prevention measures. There should be more thoughts and research on the structure of measures, the methods of protection and on more effective way to protect the environment.

(2) It is worthwhile to discuss which measures are low cost, highly efficient and suitable to the development of our society and how to frugally protect the environment.

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Table 1. Environmental protection measures classification statistics of respective year

sort	2000	2001	2002	2003	2004	2005	2006	2007
<b>I</b>	Ia	4	3	5	1	0	7	11
	Ib	0	1	0	0	1	0	3
	Ic	6	4	1	1	4	2	9
	Id	13	17	4	20	17	21	39
<b>II</b>	IIa	2	2	2	5	5	2	9
	IIb	8	9	10	25	31	21	52
	IIc	5	2	6	13	15	6	21
	IId	1	1	1	3	4	5	9
<b>III</b>	IIIa	8	5	7	25	32	33	42
	IIIb	2	1	2	8	11	17	16
	IIIc	3	3	1	10	19	14	19
	IIId	7	15	12	23	17	32	49
<b>IV</b>	IVa	1	8	4	4	2	5	10
	IVb	0	0	0	0	0	0	0
	IVc	0	1	1	0	1	1	0
	IVd	2	3	1	5	6	3	5

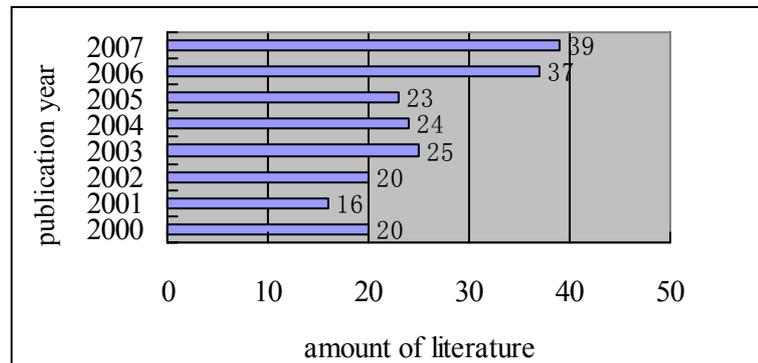


Fig.1 statistical chart of literature

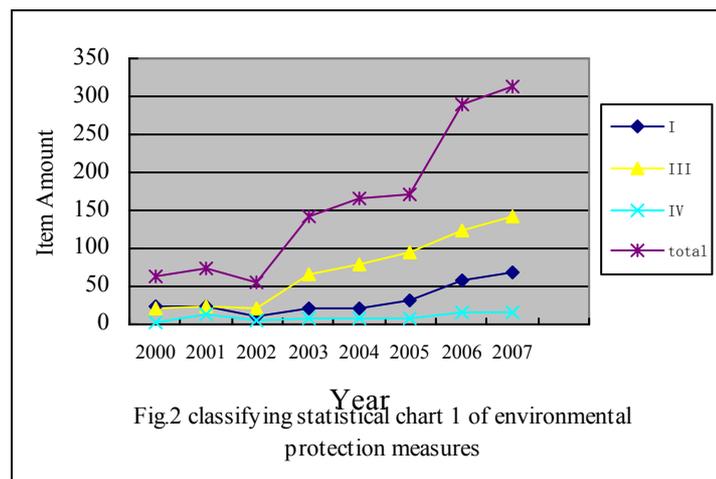


Fig.2 classifying statistical chart 1 of environmental protection measures

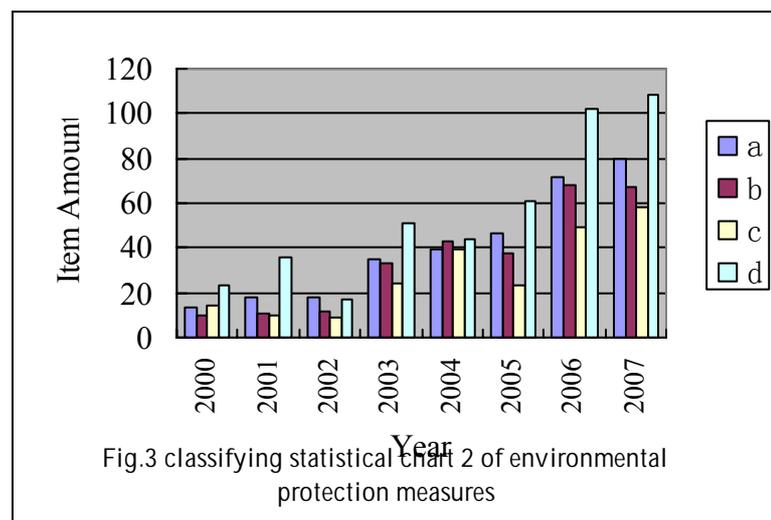


Fig.3 classifying statistical chart 2 of environmental protection measures



## Geopolitics and Shifts in Development Aid Policies: The Effects on Poverty in Nepal

Ritendra Tamang

Faculty of Communication Studies

Mount Royal College

4828 Mount Royal Gate SW, Calgary, AB T3E 6K6, Canada

E-mail: rtamang@mtroyal.ca

### Abstract

Current debates on global poverty reduction have renewed scholarly interest in foreign aid. As a result of recent concerns over global security, donors and aid agencies have redirected aid funding to countries of strategic political interest. To comply with the political agendas of the North, major aid donors (such as USAID, CIDA, and the EU) have shifted their priorities from humanitarianism and sustainable development to freedom and international security. Such shifts undermine interventions critical to easing widening socioeconomic disparities, and poor countries like Nepal have experienced a significant decline in international development aid. This paper explores the implications of current aid policy on the division between Northern and Southern countries. The use of a multidisciplinary approach in the analysis of development aid policies is beneficial for understanding the complexities and tensions involved in the provision and distribution of development aid.

**Keywords:** Aid, Development, Geopolitics, Conflicts, Nepal

### 1. Introduction

Issues concerning current practices in international development aid have received attention from scholars in various disciplines. By examining the shifting geopolitical interests of donor countries and the effects these interests have on the provision of aid, this paper generates new insights into the complex relations between international development aid and geopolitics. This paper will argue that development aid is politically motivated and often used as a tool to promote donor countries' interests, and that it thus contradicts the humanitarian aspect of aid itself.

In the post-Cold War era, issues of poverty, inequality, and social exclusion increasingly dominated discussions about geopolitical relations and international development aid. As competition between the West and the East subsided in the late 1980s, development aid was generally regarded as less geopolitical and more humanitarian in motive (Brunel, 2001, p. 241). However, a shift in patterns of aid provision and distribution in recent years reflects changes in geopolitical relations between donors and recipients. Furthermore, international aid agencies such as the Canadian International Development Agency (CIDA) and the United States Agency for International Development (USAID) have shifted their priorities from sustainable development and provision of aid on the grounds of humanitarianism to interventions based on the promotion of freedom and international security.

Using Nepal as a case study, this paper will demonstrate how changes in the priorities of donor countries and international development agencies have contributed to the widening socioeconomic disparities among Third World countries. It will be argued that donors' interest in promoting freedom and security through aid in recent years overshadows the humanitarian needs of recipients, particularly the Nepalese. These changes pose new challenges to development and aid.

### 2. Theorising International Development Aid

Following Matthew B. Fielden, this paper uses the term *aid* to refer to diverse

forms of humanitarian and development assistance, provided in a short term emergency context and longer term capacity building context. This includes food rations, water, shelter, health care, education and general infrastructure. (Fielden, 1998, p. 460)

The provision of aid operates within a system that 'mainly includes the organisations, their political owners and civil servant managers, as well as their sources and uses of funds' (Rogerson, Hewitt, & Waldenberg, 2004, p. 1). Rogerson

and his colleagues developed a four-part framework that proved to be useful in analysing changes in aid system over time:

multiple foreign and security policy objectives, loosely bundled with anti-poverty goals, with no common weighing system; the continued existence of institutional barriers insulating aid programmes to different extents from hard budget constraints[;] reduced willingness, or ability, to use aid in its current form at both ends of the client spectrum: more advanced countries reject foreign intrusion; much weaker countries badly need aid but cannot demonstrate ability to use it[;] new cosy relationship with private and voluntary organisations, funded by official aid, and competing with it for taxpayer and commercial support. (Rogerson et al., 2004, p. 9)

These changes further highlight the politics involved in the provision and distribution of aid and demonstrate how competing interests among donors contribute to the widespread inequalities among Southern countries.

The majority of current foreign aid policies are aimed at accomplishing a series of development goals, such as

- i. to stimulate economic growth through building infrastructure, supporting productive sectors or bringing new ideas and technologies,
- ii. to strengthen important sectors, such as, education, health, environment or political system,
- iii. to support subsistence consumption of food and other essential commodities, especially during relief operations or humanitarian crisis, or
- iv. to help stabilize an economy following economic shocks. (Chowdhury & Garonna, 2007, p. 5)

Despite the emphasis on broader objectives of foreign aid, 'economic growth has always been the main criterion used to measure aid effectiveness' (Chowdhury & Garonna, 2007, p. 5). To fully understand the complexities in the shifting priorities of international development aid within the geopolitical context, it is necessary to understand the motives and the intentions of donors (Fielden, 1998). Analysis of aid provision in Nepal reveals diverse interests and motives of donor countries and agencies.

In analysing motivations for the provision of aid, four theoretical approaches prove to be useful: the power-political hypothesis, the political stability and democracy hypothesis, the development and performance hypothesis, and the strategic-defensive or Cold War hypothesis. These approaches provide important insights for examining donors' motivations to provide aid and how aid is politicised. The power-political hypothesis explains how aid is given to gain support from the recipients. Alternatively, the political stability and democracy hypothesis suggests how aid should be viewed within the context of human rights. The development and performance hypothesis explains how aid should be approached from the perspective of future prospects of development. Finally, the strategic-defensive or Cold War hypothesis explains how differences in the provision of aid reflect the competition between the West and the Soviet Union in asserting influences over Third World countries; this hypothesis thus closely aligns with Cold War political ideology (Fielden, 1998). Together, these theories are useful for examining shifting patterns of aid provision and distribution among donor countries and international aid agencies over recent years. This aspect will be explored in more detail in the discussion of changes in patterns of development aid to Nepal (section 6).

Fielden (1998) rejects the idea that the provision of aid is humanitarian based. He suggests that decisions by donors to assist developing countries are mostly influenced by geopolitical motives rather than humanitarian ones. Ngaire Woods (2005) found that recent changes to aid flow in developing countries coincided with the shift in priorities and goals among donors and international aid agencies. This shift has important implications for aid provision and distribution among aid recipient countries. Recent increases in aid funding to places like Afghanistan and Iraq reflect U.S. and other donors' interest in asserting political influences over these countries. Diverting aid flow to these geopolitical hotspots places long-term development projects in other recipient countries (e.g., Nepal) at risk.

The governments of aid recipient countries often do not 'have sufficient information, mobility, or power to make choices among aid providers' (Rogerson et al., 2004, p. 7). Donors, on the other hand, can classify aid recipient countries into different categories in order to exert political leverage and simultaneously impose constraints on recipient countries. Recent global political events such as the war on terrorism led to the

growing subset of low-income countries, which are labeled 'difficult partners' or 'countries under stress'. Donors believe that these countries, despite substantial increases in aid flows, are unable to put aid to good use, owing to their weak institutional and policy performance based on their chronic vulnerability to unrest, conflict and state failure. (Rogerson et al., 2004, p. 6)

However, research has shown that the notion of 'poor performance is not supported by evidence. . . . It is very difficult to identify a group of countries performing poorly on both of the key indicators (growth and infant mortality reduction)' (Rogerson et al., 2004, p. 6). Given the difficulties of classifying countries as poor performers, the criterion for denying

aid should be ‘the institutional inability of donors to engage with [aid recipient] countries, linked mainly to defects in the sovereignty of the recipients’ (p. 7).

### **3. Geopolitical Motivations for Development Aid**

Ideologies concerning development began to change after 1945 as a result of the rise in anticolonial movements in different parts of Asia, Africa, and Latin America. For the Soviet Union and other countries within the Soviet bloc, development was seen as a form of socialism, the final phase before communism. Alternatively, Northern countries such as the United States perceived development as economic development. At the same time, Northern countries began to offer aid and advice to Southern countries (Wallerstein, 2005). However, provision and distribution of aid was largely shaped by donors’ political interests. Under these circumstances,

aid-receiving countries enjoy greater leverage vis-à-vis their foreign patrons. . . . Threats to make aid conditional on fulfillment of democratic reforms may not be credible, because withholding aid from autocratic countries could mean losing clients to Cold War powers. (Dunning, 2004, p. 411)

Competition among donor countries has proved to be an advantage for aid provision and distribution in Nepal. Multilateral and bilateral Overseas Development Aid (ODA) agencies have been used by donor countries since the Cold War to form political and economic alliances with recipient countries. Through these aid agencies, development assistance was often used to promote donors’ political interests. In response to the Soviet occupation of Afghanistan in 1979, the United States provided financial and arms assistance to Afghan resistance forces (Fielden, 1998). These aid provisions enabled the United States to exert and secure its influence over the country’s political landscape. Further confirmation that U.S. aid is closely aligned to political interests was provided by the previous director of Afghan aid: ‘The US aid package is putting a lot of money into the political arena and away from direct humanitarian aid’ (quoted in Fielden, 1998, p. 467). International aid is often portrayed as ‘humanitarian, independent, impartial and neutral, so that the underlying geopolitical agenda remains obscured’ (p. 469); however, humanitarianism has been replaced by the politicisation of international aid provision and distribution.

During the Cold War, the West was indifferent to issues of human rights and democracy in order to ‘avoid jeopardizing its economic and strategic interests and to facilitate its obsessive search for allies’ (Dunning, 2004, p. 413). The emphasis on strategic interests reflects how ‘aid is allocated primarily on geopolitical grounds and not as a result of rational humanitarian planning’ (p. 417). The provision of aid to countries of strategic interest thus enabled Northern countries to pursue their own political agendas.

### **4. Shifting Development Aid Policies**

The end of the Cold War, marked by the collapse of the Soviet Union, has contributed to significant changes in global development aid. Although major donor agencies claim to be apolitical, they are still ‘bound by the geopolitical agendas of the donors upon which they depend’ (Fielden, 1998, p. 479). This connection further demonstrates how aid continues to be politicised and how the provision of aid increasingly targets countries of interest to donors.

The political changes in the post-Cold War period produced a global trend in development aid, whereby

countries of the former USSR and Eastern Europe are much less capable of supplying aid funds, with detrimental results for former Soviet allies such as Cuba, Afghanistan and Vietnam. On the other hand, many countries of the former Soviet bloc have become aid recipients in competition with countries of the South. (Slater & Bell, 2002, p. 336)

Recent concerns about security threats in strategically interesting countries (e.g., Afghanistan and Iraq) have altered the flow of foreign aid. Geopolitical hotspot countries are increasingly portrayed in the Western media as the countries in need of the most international assistance. The focus on these countries effectively undermines the humanitarian aspect of foreign aid and bypasses the needs of other poor countries. Shifting priorities and goals among donors and aid agencies have further reaffirmed North–South differences and inequalities. Consequently, poor countries like Nepal, which do not have the same strategic value, are excluded from media attention and from international donors’ aid budgets.

The current practices of provision and distribution of foreign aid are also criticised for their

tendency toward top-down and spending oriented approaches at the expense of local capacity building and ownership, fragmented aid delivery with large numbers of insufficiently coordinated sources of assistance and projects relative to absorption capacity, questionable allocation patterns and sobering experience with conditionality. (Ferroni, 1999, p. 11)

The lack of coordination between donors and aid agencies reveals some of the important reasons why development projects fail at improving the lives of the intended aid recipients. Concerns have been raised that the cost of the war on terror and the war in Iraq may soon have a negative impact on the overall global aid budget (Woods, 2005). Together, these issues place the global development aid system at a crossroads in the twenty-first century.

In recent years, donors have agreed that aid would be more effective under conditions of greater cooperation with recipient governments, and that recipient governments should have more control over the distribution of aid. The emphasis on cooperation was expressed through the establishment of the Millennium Development Goals, in which donors and recipient governments agreed to tackle urgent global issues such as poverty, disease, illiteracy, and human security (Woods, 2005). There is also agreement among multilateral institutions such as the UN, the IMF, and the World Bank in making poverty reduction the top priority of the international agenda. Along with these changes, the UN also entered a partnership with the corporate sector with the hope that the UN would benefit from private sector expertise and improve diplomacy with countries in the South. An example of this joint effort is the creation of the Global Alliance for Vaccines and Immunization programme, through which vaccines are provided to children in the poorest countries. This programme has brought together various multilateral institutions and the private business sector, including the Bill and Melinda Gates Foundation, the Rockefeller Foundation, the International Federation of Pharmaceutical Manufacturers and Associations, the World Health Organisation (WHO), the United Nations Children's Fund (UNICEF), and the World Bank. Such alliances reflect increased involvement of the corporate sector in development and multilateral institutions (Therien & Pouliet, 2006). Other aid programmes, such as the

Global Fund to fight AIDS, Tuberculosis and Malaria built on radically different premises of what constitutes effective aid delivery, . . . are arguably incompatible with the aid system that preceded them. . . . [These changes] could reshape the 'system' considerably. (Rogerson et al., 2004, p. 1)

In addition to these new aid programmes, the International Financing Facility recently called for an increase in aid flows, which 'would be allocated from a single central point; this is of crucial importance for how the aid system adjusts to what could be a whole new "market" in its own right' (p. 1).

New wars and post-conflicts have had devastating effects on the lives of many people and pose new challenges to the provision of aid. Although during the Cold War foreign aid policies were closely aligned with donors' interests, donors are increasingly realising the interconnection between poverty and human security. This recognition has proved to be important in promoting further cooperation between governments. However, research demonstrates that this goal is not always easily achieved. Outbreaks of civil wars require immediate assistance from donors and aid agencies. Under these circumstances, local officials are often left out of decisions concerning the provision and distribution of aid (Woods, 2005). The exclusion of local officials further perpetuates recipients' dependence on donors and aid agencies.

Since 2002, attempts have been made to harmonise aid donors' practices in ways that will 'lower costs of transactions to recipient countries' (Rogerson et al., 2004, p. 10). In particular, some donors agreed to 'deliver aid as budget support rather than project or sector investment finance' (p. 10). This practice of aid provision is aimed at enhancing 'the quality of flexibility of aid' (p. 10). However, critics argue against the new practice, which they perceive as 'unwise, or at least premature. Because project funding is mostly fungible with domestic resources, the government can redeploy it to offset much of the narrower concentration the donors intended' (p. 10). Also, the majority of budget support projects 'have a very short time limit and are not closely tied to ultimate development outcomes. Aid flows overall are still more volatile than recipient country growth patterns, when they should be less' (p. 11). These criticisms raise important questions about the implications that current aid practices have on long-term development projects in recipient countries.

The leading international development aid agencies, such as CIDA, have made efforts to ensure that the goal of human security is achieved. These efforts include a shift in aid provision to developing countries. CIDA's (2008) mandate includes 'poverty reduction, democratic governance, private sector development, health, basic education, equality between women and men, and environmental sustainability' (What is Canada's Mandate? section). Accordingly, helping people in developing countries to meet their basic needs (i.e., shelter and food) has been CIDA's main goal. In recent years, concerns over global security altered Canada's aid policies. Between 2001 and 2004, about 28% of Canada's total new aid resources were allocated to countries that were considered political hotspots—such as Afghanistan and Iraq (Simpson & Tomlinson, 2006). It is clear that CIDA's decision to align its aid policies to the United Nations Secretary General's High Level Panel on Threats, Challenges and Change (HLPTCC) in 2004 represents a change in international aid focus from sustainable development to the promotion of donors' political interests (e.g., national security). Within the same year, Canada's first 'National Security Policy . . . proposed a role for development assistance in countering terrorism. [Thus] Canadian aid spending has been under corresponding pressures to conform to a security logic' (Simpson & Tomlinson, 2006, ¶ 6). In 2005, Canada joined other donors in the Organization for Economic Co-operation and Development (OECD) to narrow 'the criteria for what can be counted as ODA, particularly for military and security aspects of peace operations' (¶ 5). The shift in aid funding effectively undermined CIDA's and the Canadian government's previous commitment to eliminating worldwide poverty and raised important questions about their current priorities and practices in the provision and distribution of aid.

In addition to major donor countries such as the United States, Japan, and Canada, the European Union (EU) is often considered one of main aid providers in the world (Chowdhury & Garonna, 2007; Woods, 2005). Much of EU aid has been bilateral and multilateral. Each of the fifteen main EU member states has its own bilateral aid programmes and

positions on multilateral agencies (Woods, 2005). It should be noted here that bilateral aid programmes are designed by individual donor governments and therefore operate according to different and often competing interests and priorities. As a result, current EU aid policies are in a state of 'disarray, lacking political thrust, strategic purpose and institutional support. This has created perverse incentives inhibiting the innovation and boldness that is required to promote sustainable development and democratic governance in poor countries' (Chowdhury & Garonna, 2007, p. 8). Viewed within this context, the lack of coordination and cooperation among EU member states has detrimental effects on the delivery of effective aid. Donors need to reassess their priorities and goals and work together with governments of recipient countries toward reducing the number of poor people and improve their living conditions through long-term and sustainable development projects. Recent attempts have been made to improve coordination between donors. So far, efforts have been made by Canada, the Netherlands, Britain, and the United States to join together various diplomatic, military, and development initiatives in a more effective manner. Despite the change, the absence of recipient governments from discussions about restructuring the aid framework reflects the ongoing failure of donors to deliver effective aid (Woods, 2005).

### **5. The Politics of U.S. Development Aid**

Given that aid is always a political instrument, U.S. aid has been and continues to be politicised. By focusing on forming an alliance with countries that are of strategic interest, the United States has failed to provide assistance to other poor countries such as Nepal.

Prior to the tragic events of September 2001, much of U.S. aid was aimed at achieving humanitarian development. Since 2001, the U.S. government has perceived global security to be under threat. In response to this new security threat, the United States sought to increase aid funding to projects that were designed to improve national and global security. For example, from 2002 to 2005 the United States spent approximately \$32 billion on projects in 'countries on the front line of Afghanistan, to build support for the war on Iraq or to fund reconstruction of Iraq and Afghanistan' (Woods, 2005, p. 397). This shift posed new challenges to aid organisations 'in responding to what they perceive as threats to aid's impartiality vs. the humanitarian imperative to respond without regard to politics' (Elwell, 2006, ¶ 2). Also, the decision to divert aid flows to strategically important countries raised questions about the U.S. government's priorities and commitment to humanitarian development. To qualify for U.S. aid funding, aid organisations such as NGOs are now required

to certify in their grant applications that proposed grant implementing partners, beneficiaries, and they themselves are not affiliated with terrorist organizations. Support to terrorist organizations or work in embargoed countries can result in sanction, liability, freezing assets, or termination of USG grant agreements. (Elwell, 2006, ¶ 3)

In 2005, USAID spent about \$887.5 million in 'counter-terrorism' projects; this number represented 'a nearly seven-fold increase over 2004' (Jones & Nikinson, 2006, Conflict, Security and Development in US Foreign Assistance section). Redirecting U.S. aid flow toward counter-terrorism projects effectively undermined the country's commitment to reduction of global poverty. Increased U.S. military spending on the counter-terrorism campaign 'can divert scarce financial resources and trained personnel from projects that could create wealth and benefit the poor' (Hillier, 2006, The Opportunity Cost of Arms Sales section). U.S. assistance to Iraq postwar reconstruction is considered the largest aid campaign since the Marshall Plan was introduced by the federal government during post-World War II. Part of U.S. aid to Afghanistan in 2004 was spent on the reconstruction of roads, water and power supply, and public infrastructures such as health facilities and government buildings, most of which had been destroyed by U.S. bombs in 2001 (Padilla & Tomlinson, 2006). Unequal global aid provision and distribution means that the United States as a donor country must re-examine its priorities in the provision and distribution of aid to ensure that other poor countries in need of aid, such as Nepal, are not left out.

Despite the technical advances and logistic improvements that have been made in the humanitarian sector, aid organisations are often hindered by political constraints. Because of the close connection between aid and politics, we cannot ignore the political aspect of the provision and distribution of humanitarian aid. Whereas charitable organisations have limited resources, state-financed development programmes have larger budgets. Issues of water and food shortages are often addressed by NGOs. Private donors are gaining less leverage in the development market as competition between states in development projects increases (Brunel, 2001). Seen in this light, the politicising of aid prevents the progress of human development.

The U.S. government's decision to cut back on aid funding has important implications for development programmes such as education, water supply, and sanitation in aid recipient countries such as Nepal (Woods, 2005). The ongoing competition and clash of donors' priorities endanger the provision and distribution of aid among recipient countries. Consequently, the international community is relegating poverty issues in poor countries such as Nepal to the back burner. In 2002, U.S. President George Bush introduced a plan for directing aid to countries that could prove

‘sound economic policies and good governance’ (p. 398). This new plan posed a challenge for those recipient countries that have not met U.S. requirements and that occupy the margins within the international aid framework.

When examining cases in South Asia, and specifically Nepal, we see that the shift in geopolitical interests among donor countries and international aid agencies has contributed to the widening of global socioeconomic disparity and inequalities. Whereas sustainable development used to be the long-term goal for various aid agencies, it is increasingly undermined by international development projects that promote freedom and security. The renewed interest in security established a new pattern of aid provision and distribution in which the majority of aid funding is being redirected to strategically important countries.

## 6. Nepal and Development Aid

Despite the rises in living standards that we have seen elsewhere in the region, Nepal is the only country in South Asia that has not seen any significant improvement in people’s living standards (South Asia Alliance for Poverty Education [SAAPE], 2003, 2006). Until the 1970s, Nepal was ‘a food exporting country. However, the situation began to change in early 1980s with a decline in food production relative the population growth’ (SAAPE, 2003, p. 137). In addition to the decline in food production, foreign aid to Nepal also dropped over the years. Consequently, a trend of poverty has emerged in the country. Approximately 40% of Nepal’s population experienced a drastic decrease in their total income over the last twenty years (SAAPE, 2003, 2006). The poverty rate is ‘much higher in rural areas (44%), where 90% of the population lives. In urban areas, the incidence [of poverty] is 23 percent’ (SAAPE, 2003, p. 131). As in other South Asian countries, poverty issues in Nepal are complex and multilayered. The widespread incidence of poverty in Nepal is connected to gender, socioeconomic, ethnic, and caste inequalities (SAAPE, 2003, 2006). In Nepal,

the *Dalits* who constitute around 16 percent of the total population do not have a single position of policy making status in the bureaucracy, army or police. . . . The only group that enjoys a position of privilege and power besides *Brahmin* and *Chhetris* is *Newar*, constituting around six percent of the total population. The *Newars* are predominantly the residents of Kathmandu valley. (SAAPE, 2003, p. 122)

Nepalese Dalits are often considered to be the poorest of the poor. The continued insurgency in Nepal has led to the destruction of the country’s infrastructures: roads, communications, schools, and hospitals (SAAPE, 2003, 2006). With an average life expectancy of 62 years, low literacy rates, and limited access to healthcare and food security, Nepal is considered one of the poorest countries in the world. Since the signing of the Colombo Plan in 1952, Nepal’s economy relied heavily on foreign aid resources. Over the years, foreign aid became an integral aspect of Nepal’s political and social landscapes, to the extent that ‘elections cannot be held without it, [and] the media depends on development agencies for sponsored awareness raising and advertising’ (SAAPE, 2003, p. 128).

Under these conditions, any cut to aid funding in Nepal has significant impacts on the lives of many Nepalese. The country’s former finance minister, Devendra Raj Pandey, argues that

the main agenda of the [Nepalese] government leaders is foreign aid, their doctrine . . . is foreign aid, and their daily activities are overwhelmed with foreign aid. . . . A bigger mystery is that none of us seem to know what to do with or without these foreign hands. To have to bear with all this is not development. (quoted in SAAPE, 2003, p. 128)

Pandey’s statement highlights the important roles that international aid plays in Nepal’s political development. Increased poverty ‘has robbed Nepal of its self-esteem and helped to create a general sense of helplessness’ (SAAPE, 2003, p. 131). Foreign aid is also seen as contributing to Nepal’s foreign debt; ‘it is estimated that more than half of the annual government revenue goes to foreign debt servicing today and each citizen, on average is calculated to owe more than US \$100 to foreign creditors’ (SAAPE, 2003, p. 128). The decision of Nepal’s government to divert foreign aid to debt repayment has thus exacerbated the widespread poverty throughout the country. In 2000, the country was considered

the recipient of the highest amount of foreign aid, as a percentage of gross national income (GNI) in South Asia. While other countries in the region have made significant progress towards reduction in dependency ratio to foreign assistance, Nepal has not. (SAAPE, 2003, p. 128)

Given the complexities involved in aid provision and distribution, it is not surprising that the Nepalese government’s efforts to generate employment and reduce poverty so far have failed.

Because trade accounts for a very small portion of Nepal’s GDP, donors do not regard the country as an important geopolitical strategic area. Increased instabilities in the country have further contributed to the decline in foreign aid (SAAPE, 2003, 2006). The UK Department for International Development (DFID), has cut its aid to Nepal from 47 million pounds in 2004 to less than 32 million pounds in 2006 (Timsina, 2006). DFID also threatened that it would cut more aid funding if there were ‘no sign of peace and democracy’ in Nepal soon (¶ 3). This action would accelerate the poverty rate in Nepal, thereby putting many lives at risk.

Since the 1950s, Nepal has been ruled by a series of political successions. The military coup led by King Mahadra in 1960 led to ‘a partyless Panchayat system that lasted till 1990’ (Siwakoti & Shrestha, 2006, ¶ 1). Despite the political changes, the Nepali government still fails ‘to implement progressive land reform and to eliminate class and caste-based discrimination’ (¶ 2). Since the 1990s, the increase in internal political conflict in Nepal led to the loss of many Nepalese lives and destruction to much of the country’s infrastructure (SAAPE, 2003, 2006). Recent reports of political corruption and human rights violations committed by Nepal’s Royal Army have become a major source of concern. For example, in 2002, the Nepalese government introduced the Terrorist and Disruptive Activities Act, which gave ‘security forces the power to arrest without a warrant and detain suspects in police custody for up to 90 days’ (SAAPE, 2006). According to Siwakoti and Shrestha (2006),

the Royal Army is interested in purchasing more and more arms and will not give away their hold on the army even after peace. [The Royal Army] have also become so corrupt that even the government officials have to pay them for special security from the Maoists. (Security Sector Reform in Nepal section)

As the conflict intensified, the majority of rural residents were forced to flee from the violence. Increased flows of migration, particularly from the countryside, led to a decrease in agricultural production (SAAPE, 2003, 2006). The mass movement from rural to urban areas thus reflects an increase in poverty rates among Nepalese.

During the 1980s, most U.S. aid development projects failed to ‘deliver development’ (Siwakoti & Shrestha, 2006, Military Aid to Nepal section). In response to the growing political influences of the Nepal Communist Party in the 1990s, ‘the US, the UK, Belgium, India and even China began to supply arms to the Royal Nepal Army (RNA) in the name of suppressing the Maoists’ (¶ 3). King Gyanendra, who came to power in 2003,

dissolved the elected government in October 4, 2004 with the support of the army. He assumed all executive power in February 1, 2005 and is now running the country despite the Supreme Court’s decision in February 13, 2006 that his rule is unconstitutional. . . . The US is supporting the Royal military openly and has condemned the agreements between the political parties and the Maoists for peaceful settlement of the existing crisis. (Siwakoti & Shrestha, 2006, ¶ 3)

The U.S. government also signed an agreement with Nepal in 2003, ‘for the establishment of an anti-terrorist assistance program and to further expand the intelligence network’ (Siwakoti & Shrestha, 2006, Military Aid to Nepal section). In the following year, the United States provided \$20 million in military aid to the government in an attempt to discourage peace negotiations between the government and the Nepali Communist Party, also known as the Maoists.

Critics of the provision of U.S. military aid in Nepal argue that ‘even if all the Maoists were killed, the basic problems of poverty elimination, democratization and social security will continue’ (Siwakoti & Shrestha, 2006, Military Aid to Nepal section). Furthermore, ‘pouring money for consultants and advocacy groups on conflict does not make any sense unless the Maoist-Government conflict is understood in Nepal’s social, cultural and political contexts and rather than treating it as terrorism’ (Misappropriation of Funds section). The U.S. ambassador, James F. Moriarty, criticised the establishment of the coalition between the seven-party alliance and the Maoists; he also

urged the King to urgently reach out to political parties, and asked the seven-party alliance to withdraw from its agreement with the Maoist rebels. . . . As a result of this US diatribe, the King has become even more brutal. His ministers are calling the political parties allied with the Maoists as terrorists (Siwakoti & Shrestha, 2006, Shift in International Concerns section).

Viewed within this context, the provision of U.S. arms and financial aid to Nepal contributed to the spread of sporadic violence throughout the country and thereby posed a major obstacle to restoring peace and security.

Unlike U.S. aid, Japan’s aid provision to Nepal has been concentrated mainly on

profit-making infrastructure projects. The main purposes of Japanese aid have been to pay for high-cost consultancy, to sell expensive equipment, and the return of most of its aid money through these schemes. Japan is less interested in actual poverty reduction strategies and programs. (Siwakoti & Shrestha, 2006, Military Aid to Nepal section).

Similarly, China and India gear their aid toward infrastructure projects. In addition, China and India provide arms aid to Nepal:

Although India’s support for the Royal military regime was reduced after the February 1 coup [in 2005], it has not stopped the arms supply even when there are protests from within and outside Nepal. . . .

[China] called for peace at the earliest. At the same time, however, China has been selling arms to Nepal and providing military assistance directly despite concerns from India and other countries. It was only in January 2006 when China for the first time expressed its serious concerns over recent political developments in Nepal. (Siwakoti & Shrestha, 2006, Nepal’s Immediate Neighbors section)

Research demonstrates that arm purchases have important effects on economic development in developing countries. The selling of arms to developing countries like Nepal was prevalent in the 1970s, when

arms sales to the developing world were financed by low-interest loans. When global interest rates rose in the 1970s and 1980s, a mountain of debt impoverished many developing countries. By 1994, it was estimated that one-fifth of the developing world's debt was due to arms imports. (Hillier, 2006, The Opportunity Cost of Arms Sales section)

Increased spending on arms reflects arms race escalations among developing countries:

Arms races in the context of developing countries can have severe consequences for government spending. Once locked into an arms race, arms purchases will not just be one-off occurrences: increasing national and regional government resources are poured into importing arms, resources that could have been spent in addressing critical development needs. (Hillier, 2006, The Opportunity Cost of Arms Sales section)

In recent years, increased provision of arms assistance by the United States and other donor countries to Nepal's Royal Army has fueled tensions among different political factions. Multilateral aid to Nepal from donor countries such as Britain, Finland, and Denmark has seen the biggest cut since 2001 (Timsina, 2006). Denmark, one of Nepal's top five bilateral donor countries, 'suspended preparation for a new integrated environment program of approximately US \$ 40 million' (Timsina, 2006, ¶ 8). In addition,

the Finnish Embassy in Kathmandu said it has frozen two rural water supply and sanitation projects worth 22 million euros. The funds for the project . . . have been diverted to the Office of the High Commissioner for Human Rights and the National Human Rights Commission, following escalation of human rights violations. (Timsina, 2006, ¶ 11)

Thus donors's competing interests resulted in failure to secure the basic necessities (such as food and shelter) for many Nepalese. Most often, donors fail to address the basic needs of the people that they intend to help.

Nepal's poverty rate from 1977 to 1996 has steadily increased at a rate of more than 3% annually (SAAPE, 2003). Recent decisions to reduce aid to Nepal effectively endanger food security for the majority of Nepalese. This situation calls for immediate interventions from the international community (see Table 1).

Former World Bank economist William Easterly criticised the recent decisions by donors to alter their aid spending (Dunning, 2004). Multilateral aid to Nepal from donor countries such as Britain, Finland, and Denmark has seen the biggest cuts since 2001 (Timsina, 2006). These donors defend their decision to cut aid to Nepal on the grounds that the Nepalese government is violating human rights. The decision to cut aid to Nepal clearly demonstrates how the provision of aid is mostly based on geopolitical selectivity. Failure to effectively address global poverty issues is in itself a violation of human rights. Poverty strips people of their dignity and self-worth and denies them opportunities for advancement (SAAPE, 2003, 2006).

## 7. Conclusion

As this paper demonstrates, current debates on global poverty reduction have renewed scholarly interest in foreign aid. The shifting geopolitical relations between North and South countries throughout the twentieth century reflect the realignment of Cold War and post-Cold War politics and ideologies. To comply with their political agendas, major aid donors (such as USAID, CIDA, and the EU) have clearly shifted their focus from humanitarian aid to political selectivity in the provision and distribution of aid. Recent concerns over national and global security have prompted donors and aid agencies to redirect aid funding to countries of strategic political interest. This shift needs to be challenged in order to address North-South inequalities and highlight the widening disparities among Southern countries. The shift in donors' commitments raises important questions about the purposes and effectiveness of aid provision and distribution in developing countries.

Through aid, donors need to demonstrate that it is in their states' interests to promote economic growth and sustainability in developing countries. The goal of development must be to improve and promote a sustainable and prospering economy and a healthy population. Unequal aid provision and distribution among Third World countries has contributed to regional instabilities, displacement of people, and widespread poverty.

The decline of aid to Nepal has contributed significantly to the widespread poverty in the country. This paper demonstrates that the provision of aid in Nepal has been and continues to be fraught with political corruption and inequalities. Therefore, any discussion of aid provision in Nepal must take into account the political dimension at the local, national, and global levels. This approach will add further complexities to the analysis of geopolitical decisions involved in the provision and distribution of aid in Nepal within the context of the global aid system.

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Table 1. Aid provision in South Asia

	Total Overseas Development Aid (Millions of US dollars)		
	1980	1990	2001
Bangladesh	1282	2103	1023.9
India	2147	1586	1705.4
Nepal	163	429	388.1
Pakistan	1130	1152	1938.2
Sri Lanka	390	665	330.2

Adapted from "Aid, Governance and Ownership," by R. Sobhan, 2004, *South Asian Journal* (4) [Online] Available: [http://www.southasianmedia.net/Magazine/Journal/aid\\_ownership.htm](http://www.southasianmedia.net/Magazine/Journal/aid_ownership.htm) (September 14, 2008), Table 1.



## Greenhouse Effect International Cooperation: Rethink Kyoto Protocol

Longlong Guo

Department of Biotechnology, Chemistry and Environmental Engineering

Sohngaardsholmsvej 57, 9000 Aalborg, Denmark

Tel: 0045-2992-3337 E-mail: guo@bio.aau.dk, harry99211@gmail.com

Hongbo Ma

Tangshan Kailuan Oriental Power Co. Ltd

A-601, ShiJi HuaTing, XinHuaDao, Tangshan city, Hebei, China

Tel: 86-315-325-2787 E-mail: mahongbo777@hotmail.com

### Abstract

The greenhouse gas emission has the closed relation with the economic growth in the every country, therefore reducing the greenhouse gas emission level or decreasing its increasing speed affect the national economic growth. If developed countries take the unconcern of the developing countries as the reason, they didn't adopt any measurements. If developing countries think the developed countries must be responsible for the climate change, they reject any action, also including Kyoto protocol. Every country governments lack national support so that the promise can't be realized in the international negotiates. Whether Kyoto Protocol finally can formally become effective depends on the economy and sustainable development.

**Keywords:** Kyoto Protocol, Nation Framework Convention on Climate Change(UNFCCC), Sulfur oxides, Nitrogen oxides, Hydrocarbons, Carbon monoxide, Clean Development Mechanism(CDM), Montreal Protocol, Semi-governmental organization, Non-government organizations(NGOs)

### 1. Introduction

Environmental issues emerged in the late twentieth century as a major focus of international concern and activity. Understanding the causes and impacts of global environmental change is an urgent task(Owen Green, 2005). Since industrial revolution, in the production of industry and agriculture the greenhouse gas emission from human activities has already led on the greenhouse gas concentration increased rapidly, the greenhouse effect causes serious outcome to the littoral and ecosystem. Global warming or the greenhouse effect is the prototype of the global commons issue. All nations are affected by the earth's climate system, and broad international cooperation is required to mitigate the threat of global warming(Gareth Porter, Janet Welsh Brown and Pamela S. Chasek, 2000). In order to 21st century's earth eliminating the threatens of the climate change, in the December 1997, the United Nation Framework Convention on Climate Change (UNFCCC) was held in Tokyo in Japan and generated Kyoto Protocol which restricts the greenhouse gas discharge from developed countries and restrains the global warming.

### 2. China Case Study

In China human activity is the main roots of the air pollution. Such as intensive population, city dimension expanded, city-industry distribution irrationality, and low efficiency environment management, etc; these factors increase a great deal of unstable component into the air. In contrast to the natural sources of air pollution, which is like carbon monoxide from the breakdown of methane; hydrocarbons in the form of terpenes from pipe trees, and hydrogen sulfide and methane from the anaerobic decomposition of organic matter, human activities sources are like total suspended particulates, sulfur oxides, nitrogen oxides, hydrocarbons and carbon monoxide. The use of fossil fuels is the dominative factor of the air pollution for heating and cooling, for transportation, for industry, and for energy conversion, and the incineration of the various forms of industrial, municipal, and private waste all contribute to the pollution of the atmosphere, so do the handling and processing operations of various and sundry industries. The sources of these pollutants are so numerous and they have been categorizing into four main groups. Mobile transportation is like motor vehicles, aircraft, railroads, ships and the handling or evaporation of gasoline; stationary combustion is like residential, commercial and industrial power and heating, including stream-powered electric power plants; industrial processes is like chemical, metallurgical and pulp-paper industries and petroleum refineries; and solid waste disposal is like

household and commercial refuse, coal refuse, and agriculture burning.

China's air pollution is the coom type. Northward situations overweigh southward; middle-small cities' pollution tendency is more than big cities; coal production area is higher than without coal production area; winter situations exceed summer; morning and evening overweigh midday. At present coal is the dominative energy consumption, amounting to 75% of its total energy consumption. Coal combustion, in which mass pollutants of dust, carbon dioxide, etc are produced, is the main cause to trend to the increasingly serous air pollution in China. For example climate change is spreading and threatens China and circumjacent countries. At present China takes economic development as its top priority of the short and medium term, in order to reduce the greenhouse gas emissions, China has encouraged the energy saving, the use of clean energy and supporting the development of energy efficiency and renewable energy. China has played an important role and takes a proactive attitude towards the global efforts for climate changed control. However it reiterates that as a developing country, it should focus on economic development and reducing the number of people living in poverty and not be subject to binding emission reduction obligations under world climate change framework(Hohne Niklas and Dian Pylipsen and Simone Ullrich and Kornelis Blok, 2005). How to keep the balance between reducing the greenhouse gas emission and protecting environment towards the sustainable development? How to implement Kyoto Protocol? How to cooperate with developed countries? ... These questions are the present challenge to China.

### **3. International society feedback**

At the core of the 1997 Kyoto Protocol are legal binding commitments b developed countries to limit greenhouse gas emissions. The EU, USA, and Japan respectively committed themselves to reduce their annual greenhouse gas emissions by December 2008 to 8. 7. and 6 percent less than 1990 levels. Prospective EU members such as Poland adopted EU targets; while Russian, Ukraine, and New Zealand agreed to stabilize their emissions at 1990 levels and Australia, Iceland, and Norway managed to negotiate limited increased in their permitted emissions. These commitments refer to net emissions, so that greenhouse gas emissions may be offset by absorption of such gases in sinks such as afforestation projects. Overall these commitments would imply a 5 percent reduction in greenhouse gas emissions in industrialized countries.

According to the Kyoto Protocol, the developed countries must provide the financial support, and cooperate with the aspects of science and technology. It also allows the developed countries to exchange part of their national emission allowances and establish the Clean Development Mechanism (CDM) that allows developed countries to obtain emission credits for financing approved climate friendly projects in developing countries. This kind of plan requests to set up the discharge quantity in a country. These countries that didn't use up the quantity can sale a part to the other countries. Therefore the countries with the discharge surplus must reduce the discharge quantity; the countries with enough quantity can get some benefit in the financial aspect. In the Kyoto Protocol, the set quantity has set to the developed countries, namely equal the reducing discharge promise. This is based on the cost benefit to decrease the greenhouse discharge quantity.

From the international political point, Kyoto Protocol is one of the most complicated multilateral negotiate in the present international social. For example, EU want to strive for the 15% of reducing discharge goal, but USA just only keep the stable discharge from 2008 to 2012. Whereas the point of departure is different, each country achieves the agreement with a certain law sanction.

From the economic point, Kyoto Protocol focus on the cost benefit, but the price of implementing Kyoto Protocol is quite expensive. Clinton government estimates GDP would be increased by 0.5% per year. The research from the scientist states implementing Kyoto Protocol can decrease the 0.2% to 2% of GDP to USA, EU and Japan. Through a great of discharge trade, the loss is 0.1% to 0.3%(Michael Grubb et al, 1998). This numeric is negligible, but the economists warn: from 2008 to 2012 if USA reduces 35% of the discharge quantities of carbon dioxide, the world economy will turbulence(Donald A. Carr and Willian I. Thomas, 1998).

Kyoto Protocol announced the country includes the 55% discharge quantity of the total greenhouse gas; the country can become effective by 55 countries authorized. China in May 1998 subscribed the Kyoto Protocol and approved the protocol in the August 2002. EU as well as member country approved the Kyoto Protocol in 31st May 2002. Till to the November 2004, 127 countries has approved the Kyoto Protocol, unfortunately USA that occupies the 25% discharge quantity of total greenhouse gas approved it in the November 1998, but Bush Government rejects the authorize because reducing discharge quantity would affect the USA economy and developing countries also would bear the reducing discharge incumbency. Due to the USA toughness attitude, Kyoto Protocol is approved filling with difficult and can't become effective.

### **4. Greenhouse discharge and climate change**

It has the closed relation between greenhouse gas discharge quantity and economic growth in a country. In terms of stipulated range, reducing greenhouse gas discharge or catabatic its increased speed will affect the GDP rising.

#### *4.1 Political balk*

The studies of environmental dynamics and politics of environmental regulation can't be understood without approaching both the physical and the social discursive dimensions of environmental problems, their origin, definitions and the responses decided (Jesper Holm). The political problem is the main balk to approve Kyoto Protocol. From the related political problems looking, Kyoto Protocol was approved by the 55 countries and became effective after 90 days. These 55 countries at least discharged the 55% carbon dioxide discharge of total greenhouse gas compared with 1990. It said Kyoto Protocol that becomes effective must get the reorganization by majority countries. From the past reporting, the process is difficult. To the 04-05-1999, 84 countries had subscribed Kyoto Protocol, but only 8 countries approved the protocol. Almost countries put up acute attitude. Such as EU as a whole, wouldn't approve it before USA and Japan approved it. Furthermore USA senate also wouldn't pass it, unless pivotal developing countries would take the worth valuable action. These pivotal developing countries are Argentina, China, Brazil and India. Though USA subscribed Kyoto Protocol after Argentina and Kazakhstan announced they will bear the incumbency, approving it is very difficult in the future.

Western developed countries are based on the standpoint of worth valuable action from developing countries to consider whether approve Kyoto Protocol or not. The reason is very simple: from past 10 years experience, developing countries lack the strong implementation mechanism from the self country, the result is the government just owns the nominal power, referring to the environmental problem is also like this. Therefore government expresses the willing to carry out the protocol, the country can't be realized any agreements without enough system framework.

The developing countries think the developed countries must take the action firstly, shouldn't force some unreasonable incumbency to the developing countries. This notion can be understood. Forcing developing countries to bear incumbency of volunteer characteristics not only can't achieve the forecast purpose, but also destroy the foreign relations. But then developing countries need consider the long term outcome of preventing strategies. Forecast statement, the greenhouse gas discharge from developing countries will last enhancement, and easily receive the harm of climate change compared with developed countries (IPPC, 1998). According to the background how do the developing countries put the problems of development and which price development into the agenda? In addition it needs the public predication to solve these problems.

Maybe oppugn mentioned, can't the political balk be overstep? Some governments think it optimism. Clinton emphasized we can't take the action after the protocol was approved. If the industry accepts the sign to start to invest new technology; if EU can encourage constituting the strategy of reducing greenhouse gas discharge, in the few years later, Kyoto Protocol will be approved completely.

#### *4.2 Emission trade*

In the essential discharge trade can't realize the reducing greenhouse discharge. It is difference with the supervision and verified check. It was decided by scientist and policy makers through innovation methods to distribute the discharge quantity to each country and permit they can trade each other. These problems are very complex. Kyoto Protocol attempts to distribute the right in the developed countries, and it is very outrage to the developing countries. Cooper in 1998 forecasted this is a long term problem. Distributing the discharge quantity is a method to solve the problems, but according to the Kyoto Protocol promise, it can't be implemented because of the distribution right. (Richard N. Cooper, 1998) In 1993 Bodansky stated on the one hand, if the purpose considering GDP per capital or per unit put in the global discharge level, like USA with high per capital must reduce the discharge greatly, and affects the economic growth. This kind of purpose can't be realized in the political aspect. On the another hand, if the discharge purpose can be accepted by USA, low discharge countries will also rise the discharge quantity equal to the USA level. The result is global discharge rising greatly (Bodansky, 1993).

#### *4.3 Public participation*

The worsening trend for a long term has increased the public participation environmental awareness. Government departments have realized that environmental pollution can't be solved by relying only on laws and administrative interventions. When its economic strength and science and technology still remained at a low level, active public participation in environmental protection could be more effective at a lower cost (Zhanglei, 2001). The participation is like individuals, student group, social groups, and semi-governmental organization. Particularly in the recent years, various public media about the individual action and social organization action has been increasing. Under the advancing environmental awareness, the domestic environmental Non-government organizations (NGOs) play a limited role, but the mass media have increasingly treated the environmental issues with the approval of the central government. Public participation has gained the significant success, but intervention limitation reduces the public participation efficiency. Efficiency organized the public participation groups is the one of the important tools to solve the environmental problems. At the same time, the government should not only cooperate with them, but support the finance assistance and give the right to them.

If the concern from the region is so limited, the national policy is like nominal, and foreign relations are flatulent. Within Europe whether the measurement of reducing discharge can be accepted or not by public. Negotiate official from Europe, USA, Japan think to the deep influence reducing discharge measurement they just get a limitation support from the self country 21. The early researches show in the majority developing countries, the problem of climate change at all isn't being lined in the national agenda. In some islet countries the climate change has lined in the national agenda, but they almost can't reduce the few discharge.

Fortunately, it has worry, but also has active activity. Some industry is taking action to reduce the discharge. General motors developed a natural gas shift plan to reduce discharge. The academia people are researching to bring forward mode and approach with perfecting climate change management system. NGOs also take part in this activity.

## 5. Conclusion

Kyoto Protocol becoming effect has difficulty, but we can believe whether Kyoto Protocol finally can be approved or not, it depends on the relation between economic growth and sustainable development. If present or future USA president can insure to approve Kyoto Protocol, or EU approves it and obtains a great public support, other developed countries and developing countries also do it like this. Whatever happens, Montreal Protocol (16-09-1987) on Substances that deplete the ozone layer and the on-going negotiations for preparing the framework convention on climate change, the subscription process is like this. If the measurement is right, protecting climate is profit, benefit and high quality life standard.

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## Sustainable Forest Management and West Malaysian Sawntimber Supply Analysis

Abdul Rahim Abdul Samad

Department of Economics, Faculty of Economics & Management  
Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia  
Tel: 60-3-8946-7630 E-mail: abrahim@econ.upm.edu.my

Mohd Shahwahid Hj. Othman

Department of Hospitality & Recreation, Faculty of Economics & Management  
Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia  
Tel: 60-3-8946-7630 E-mail: msho@econ.upm.edu.my

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### Abstract

This paper examines the dynamic effects of sustainable forest management (SFM) on the West Malaysian sawntimber supply. Both short-run and long-run effects on sawntimber supply are studied using a multivariate cointegration analysis. The proxy of SFM variable is permanent forest reserve. It is expected as an exogenous negative shock in the sawntimber supply. In general, given the fact that West Malaysian sawntimber supply is decreasing since 1990s, the results show that sawntimber supply is statistically influenced by SFM practices. Furthermore, reducing of harvested area of forest has significant effect on sawntimber supply decreases. While in the short-run, the results suggest that there are negative impacts of SFM practices on sawntimber supply at 10 percent significant level, in the long-run, the result is significant at 1 percent level. This may to some extent pull down the West Malaysian sawntimber supply together by bringing the forest harvests to sustainable level.

**Keywords:** Sustainable forest management, Sawntimber supply, Cointegration analysis

### 1. Introduction

The calculation of the allowable cut was an important element of forest management. It is expressed in term of forest area of wood volume to be harvested. The goal was to obtain a sustainable yield of the best possible yield. Mohd Shahwahid & Awang Noor (2002) revealed that the annual coupe was lower than the official approved annual coupe by 34%. In fact, in Peninsular Malaysia, annual coupes have been steadily declining and this is part of the conservation strategy to ensure sustainable timber production. Hence, the sustainable yield has been one of the basic views of forest management for a considerable length of time. Initially, the only goal or at least the main goal in mind of forester was usually wood production.

Recently, the forest conservation in West Malaysia was evaluated (with respect to quality as well as quantity) from a biological point of view, and a substantial increase in area of forest reserve was recommended (Salahuddin, 1996). This does not have just negative impacts to supply of logs but also to the wood-based products in particularly is sawntimber. Based on the Forest Department Peninsular Malaysia (FDPM) Statistics (2005), the supply of logs increased gradually with a slight fluctuation from 6.5 million m<sup>3</sup> in 1970 to 13.0 million m<sup>3</sup> in 1992 with an average growth rate of 4.5 percent per year and then decreased to 4.4 million m<sup>3</sup> in 2005 with an average reduction rate of -5.1 percent per year. This decline in log production was mainly due to the reduction of annual coupes resulting from the Rio Convention and Malaysia's need to achieve ITTO objectives 2000 and international certification standard in attaining SFM (Lim, 2002). In the case of sawntimber supply from natural forest, almost the same pattern is indicated as well as log production. The supply of sawntimber has increased from 2.3 million m<sup>3</sup> in 1970 to 6.2 million m<sup>3</sup> in 1990 with an average rate of

growth annually of 8.5 percent and then gradually decreased to 3.2 million m<sup>3</sup> in 2005 with an average reduction rate of -3.2 percent per year. In general, we can say that, timber and timber products particularly sawntimber have faced the same impact of decreasing its productions since 1990s.

There exist a large number of studies on costs connected to forest conservation, but only a few studies address consequences on the timber and forest products markets. Perez-Garzcia (1993), Sedjo *et al.*, (1994), Sohngen *et al.*, (1999) are among the exceptions in this regards. At the national level, Barbier *et al.*, (1995) analysed economic effects of imposing sustainable forest management in Indonesia using simulation approach. The econometric analysis of forest conservation on timber price and harvest level were examined empirically by Linden & Uusivuori (2002), based on historical data from Finland. In addition, local studied done by Mohd Shahwahid (1995), concluded that, in the event of reduce logging hectarage (due to strict conservation measures), price should provide an adequate incentive to encourage further extraction of log. The incentive should be enough to cover the marginal cost of extraction, transportation and royalty payment. Another study concludes that in Finland, annual timber-selling income was unchanged after the increased of conservation since the decreased harvest and increased price were of the same relative magnitude. Finally, Leppanen *et al.*, (2005) study the market impacts of increased forest conservation in Finland using a dynamic econometric model. The results confirm that conservation increases timber prices and decreases the harvest, but the impact on forest industrial output and timber imports were projected to be less than the *a priori* expectation (Leppanen *et al.*, 2005).

There are several studies have used the cointegration method to analysed their studies. For example, Silvapulle & Jayasuriya (1994) analysed the Philippines rice market integration by using multiple cointegration approach. Kugler & Lenz (1993) used multivariate cointegration analysis to test the long run validity of purchasing power parity and Bahmani-Oskoose & Mohsen (1986) used the same method to analysed the international trade flows in developing countries.

Hence, the purpose of this paper is to analyse the economic consequences on sawntimber supply from natural forest in term of domestic price, import price, area open for harvest and specifically on the different extents of permanent forest reserve in West Malaysia.

## 2. Methodology and Data

### 2.1 Production of Sawntimber Model

$$\text{LnSTSS}_t^s = \beta_0 + \beta_1 \text{LnSTDP}_t + \beta_2 \text{LnSTMP}_t + \beta_3 \text{LnHA}_t + \beta_4 \text{LnPRF}_t + \mu_t$$

$$\beta_1 > 0, \quad \beta_2 > 0, \quad \beta_3 < 0 \text{ and } \beta_4 < 0$$

where LnSTSS is the quantity of sawntimber production, LnSTDP is domestic prices of sawntimber, LnSTMP is import price of sawntimber, LnHA is the annual harvested area and LnPRF is the permanent reserve forest,  $\mu$  is error term, and superscript *s* refers to supply and *t* for periods annually of that endogenous and exogenous variables. All the variables are log-transformed. The coefficient of domestic prices of sawntimber,  $\beta_1$ , is expected to be positive and it is also expected that the import price of sawntimber is positive sign because as domestic supply of sawntimber decrease, local industry will find substitute for sawntimber products from import market, annual harvest area is positively related to sawntimber supply; an increase in harvest area would spur the supply for Malaysian sawntimber and vice versa. Taking into consideration of the permanent reserve forest as proxy of SFM is generally expected to be negative. This would slightly diminish the sawntimber supply when the permanent reserve forest area is increases to be in line with the objective of SFM.

### 2.2 Unit Root Tests

In the long-run, unit root tests in autoregressive time-series models have received considerable attention in the econometric literature. The unit roots test is testing for the order of integration. The basic idea is that, the order of integration of a series is given by the number of time a series must be differentiated in order to produce stationary series. If a non-stationarity was detected in a series it is eliminated by differentiating the series until stationarity is obtained. In time series jargon, a non-stationary series which can be transformed to a stationary series by differentiating *d* times is said to be integrated of order *d* denoted by I~(*d*). If the first differentiated variable achieves stationarity, that variable is integrated of order one, I~(1). On the other hand, if the level of a variable is already stationary, that variable is integrated of order zero, I~(0). This stationarity can be verified by finding out if the time series contains a unit-root, that is, a non-stationary situation.

### 2.3 Johansen and Juselius (JJ) maximum likelihood test

Johansen & Juselius (1992) procedure posses several advantages over Engle and Granger method in testing for cointegration:

- i. No prior assumption regarding the number of cointegrating vector;

- ii. Assumes all variables as endogenous;
- iii. Provides a unified framework for estimating and testing cointegration relations within the vector error correction model (VECM) formulation; and
- iv. Unlike EG cointegration test, which use bivariate framework, ARDL bounds test allows a multivariate framework that enable us to include other relevant variables to avoid simultaneity and specification problems.

The procedure developed by Johansen which involves the identification of rank of the  $m$  by  $m$  matrix  $\Pi$  in the specification is given below:

$$\Delta Y_t = \delta + \Pi Y_{t-k} + \sum_{i=1}^{k-1} \Gamma_i \Delta Y_{t-k} + v_t$$

where  $X_t$  is a column vector of the  $m$  variables,  $\Pi$  and  $\Gamma$  are coefficient matrices,  $\Delta$  is difference operator,  $k$  denotes the lag length, and  $\delta$  is a constant. There are two tests provided, namely trace and maximal eigenvalue tests. The main importance of these two tests is that both tests have no standard distributions under the null hypothesis, although approximate critical values are tabulated by Osterwald-Lenum (1992). Nevertheless, Johansen & Juselius (1990) suggest that the maximal eigenvalue test is more powerful than the trace test.

Trace test:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^n \ln(1 - \hat{\lambda}_i)$$

Maximal eigenvalue test:

$$\lambda_{max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1})$$

where  $r$  is the number of cointegrating vector,  $\hat{\lambda}$  is the estimate values of the characteristics roots obtain from the estimated  $\Pi$  matrix,  $T$  is the number of usable observations.

#### 2.4 Vector Error Correction Model (VECM)

Vector autoregression (VAR) has been used primarily in macroeconomics. Early in their development, it was argued by some authors (i.e. Sim, 1980) that VARs would forecast better than the sort of structural equation models. One could argue that as long as the error term ( $\mu$ ) includes the current observations on the (truly) relevant exogenous variables, the VAR is simply an overfit reduced form of some simultaneous equations model (Hamilton, 1994). One of the virtues of the VAR is that it obviates a decision to what contemporaneous variables are exogenous; it has only lagged (predetermined) variables on the right-hand side, and all variables are endogenous. In addition to forecasting, VARs have been used for two primary functions, testing Granger causality and studying the effects of policy through impulse response characteristics (Engle & Granger, 1987).

#### 2.5 The Data

This study was used the secondary data which represented the whole Peninsular Malaysia. All data were compiled from published sources of Malaysian Government publications, namely from the Annual Reports of the Forestry Department of Peninsular Malaysia, the Ministry of Primary Industries, the Malaysian Timber Industry Board and various issues related to all the publication by Malaysian Forestry Department. All of the data are time series annual basis from 1970 to 2005 and are in absolute value. These values are expressed in terms of Ringgit Malaysia (RM), meter cubic ( $m^3$ ) and hectare (ha). The data set consists of four variables. The variables are production of sawntimber, domestic price of sawntimber, import price of sawntimber, annual harvest area and permanent forest area. All of the variables in the data set are transformed into natural logarithms for usual statistical reasons.

### 3. Results

This part presents and discusses the empirical analysis on the relationship between sawntimber supply and the several of independent variables including PRF the main factor that need to be analysed. PRF is a proxy of a factor of SFM practices. The complete analysis involves unit root test and Johansen & Juselius (1990) multivariate cointegration procedures. Regression analysis based on time series data implicitly assumes that the underlying time series are stationary. This analysis can be checked by finding out if the time series contain a unit root. The Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) tests can be used for this purpose.

#### 3.1 Unit Root Test

Table 1 shows the result of ADF and PP tests at level and first different. All of the independent and dependent variables are integrated of first order  $I(1)$ . Given that all time series are stationary in first differentiate, we proceed to test for cointegration between sawntimber supply and other independent variables in examining the long run relationship between both of them.

### 3.2 Multivariate Cointegration Test

The results of the cointegration tests are presented in Table 2. The traced statistics indicate long-run relationship among the variables, where the null hypothesis of no cointegration at  $r = 0$ ,  $r \leq 1$  and  $r \leq 2$  are rejected at 5 percent level where it is indicated that at least three (3) cointegrating equation(s) occurred. The maximum Eigen value statistics, on the other hand, indicate only one (1) cointegrating vectors where it is significant at 5 percent level. Since both the trace and maximum eigen value statistics reject the null hypothesis of no cointegration at  $r=0$  and another two (2) null hypothesis in the trace statistic, we in this study, therefore assume that there exists at least one (1) and not less than three (3) cointegrating vector. We shall use this relationship to analyse the long-run behavior of the sawntimber supply.

The result of long-run analysis reveals that the domestic price of sawntimber, the import price of sawntimber and the permanent forest reserve are significant at 5 percent level in determining the sawntimber supply. While the annual harvested area shows that there is an empirically insignificant impact on sawntimber supply. From this result, it is clear that the West Malaysian sawntimber supply has negatively significant impact from the implementation of SFM practices. It is consistent as mentioned earlier that the sawntimber supply reveals the decreasing rate since 1990s at -3.2 percent annually until 2005 (FDPM, 2005).

The behaviour of the sawntimber supply is examined by estimating the vector error-correction model (VECM). Two (2) lags are chosen as it is sufficient to achieve white noise in the error term. The results of VECM showing the short-run dynamics of the sawntimber supply equation and the diagnostic tests are given in Table 3. The diagnostic tests indicate that the VECM is adequately specified. The Jarque-Bera statistic (JB) suggests that the residuals are normality distributed, the Breusch-Godfrey LM statistics indicate that there is no autocorrelation in the residuals by two (2) lags. The value  $R^2$  of 0.7464 indicates that about 74.64 percent of the variation in the sawntimber supply is explained by all the independent variables. Furthermore, Chow's forecast test suggests that there was no structural break during the period of study.

Table 4 shows most of variables could not affect the sawntimber supply, except HA and PRF which are significant at 5 and 10 percent level respectively. The ECT in the model was also negatively significant which is good for the model. In the domestic price of sawntimber equation, none of the variables could affect the price of sawntimber and the ECT in the model was positively significant. In the import price of sawntimber equation, only domestic price is significant. In the annual harvested forest equation, none of the variables were influenced. Finally, the only significant variable in permanent forest reserve equation is annual harvested area at 1 percent level while the rest are not significant including error correction term.

### 4. Conclusion

In this study, we have examined the long-run and short-run relationships between the West Malaysian sawntimber supply with the domestic price of sawntimber, import price of sawntimber, annual harvested area and permanent forest reserve as a proxy of SFM practices. A cointegration analysis is carried out to identify the long-run relationship among the variables. The results show that by complying with SFM criteria, there is a disruption in the sawntimber supply. Furthermore, in the long-run, an increase in domestic price of sawntimber would help to compensate for lost volumes these days. On the other hand, the short-run dynamics of sawntimber supply is by referring to the ECT. The VECM results show that a substantial portion of the adjustment to the long-run equilibrium takes place and there are insignificant impacts on sawntimber supply in the short run except by the annual harvested area. Furthermore, the results obtained in Granger causality tests indicate that the domestic price of sawntimber and import price of sawntimber do not stand as an important determinants of sawntimber supply in the short-run except annual harvested area and permanent forest reserve. Hence, we can conclude that, West Malaysian sawntimber supply has been affected in the short-run as well as in the long-run as a result of complying with the sustainable forest management policy.

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Table 1. Results of Unit Root Test

Variable	Level (trend & intercept)		First difference (trend & intercept)	
	ADF	PP	ADF	PP
LnSTSS	-2.2558	-2.2693	-5.7010***	-5.6998***
LnSTDP	-1.2715	-1.4104	-4.7401***	-4.7457***
LnSTMP	-2.3257	-2.2350	-7.6161***	-7.7133***
LnHA	-1.9574	-2.0701	-6.3378***	-6.4078***
LnPRF	-1.6415	-1.7942	-2.9323*	-2.9097*

Notes: \*\*\*Significant at 1 percent: Critical value = -3.6394, \*\*Significant at 5 percent: Critical value = -2.9511, \*Significant at 10 percent: Critical value = -2.6143, LnSTSS (Production of Sawntimber), LnSTDP (Domestic Price of Sawntimber), LnSTMP (Import price of Sawntimber), LnHA (Annual harvested area) and LnPRF (Permanent Reserve Forest).

Table 2. Johansen's Test for the Number of Cointegrating Vectors (VAR with 2 Lags)

Null	Trace		Maximal Eigen value	
	Statistic	5% critical value	Statistic	5% critical value
R = 0	87.57**	69.82	35.79**	33.89
R ≤ 1	51.78**	47.86	21.45	27.58
R ≤ 2	30.33**	29.80	19.12	21.13
R ≤ 3	11.21	15.49	10.01	14.26
R ≤ 4	1.20	3.84	1.20	3.84

Co-integration Equation:

$$\text{LnSTSS} = 52.37 + 2.138 \text{ LnSTDP} - 0.8340 \text{ LnSTMP} + 0.7529 \text{ LnHA} - 3.5250 \text{ LnPRF}$$

[3.120]\*\*
[2.2143]\*\*
[1.5384]
[3.9961]\*\*

Notes: \*\* significant at 5 percent level,  
The values in the parentheses [] are the t-values

Table 3. VECM Results; Dependent Variable is Production of Sawntimber

Lags	ECT <sup>a</sup>	ΔSTSS <sup>a</sup>	ΔSTDP <sup>a</sup>	ΔSTMP <sup>a</sup>	ΔHA <sup>a</sup>	ΔPRF <sup>a</sup>	C <sup>a</sup>
1	-0.1099* [-2.0022]	-0.1012 (-0.5589)	0.2219 (0.9951)	-0.0536 (-1.1415)	0.2615 (3.0913)**	0.6401 (0.8595)	-0.0143 (-0.4545)
2		-0.1616 (-0.9685)	-0.2078 (-1.0463)	0.0758 (1.5753)	-0.2277* (-2.0271)	0.8687 (1.2083)	

Diagnostics tests

R<sup>2</sup> = 0.7464, Normality test: JB ~ χ<sup>2</sup> = 0.25(0.8825), CHOW test: Prob. F(7,20) = 0.1590, Breush-Godfrey LM test: Prob. F(1,28) = 0.9236

Notes: <sup>a</sup> The values in parentheses are *t*-statistics

\*\*significant at 5 percent level, \* significant at 10 percent level

STSS (Production of Sawntimber), STDP (Domestic Price of Sawntimber), STMP (Import price of Sawntimber), HA (Annual harvested area), PRF (Permanent Reserve Forest), ECT (Error Correction Term), C (intercept)

Table 4. Granger Causality Tests

Wald Statistics	$\Delta$ STSS <sup>a</sup>	$\Delta$ STDP <sup>a</sup>	$\Delta$ STMP <sup>a</sup>	$\Delta$ HA <sup>a</sup>	$\Delta$ PRF <sup>a</sup>	ECT <sup>b</sup>
$\Delta$ STSS	-	1.2619 (0.5321)	1.3030 (0.2537)	8.3189** (0.0156)	5.5757* (0.0616)	-0.1099* [-2.0022]
$\Delta$ STDP	0.8699 (0.6473)	-	2.9315 (0.2412)	0.2174 (0.8970)	0.8817 (0.6435)	0.1267** [2.3115]
$\Delta$ STMP	0.2920 (0.8641)	5.0925* (0.0784)	-	0.7043 (0.7032)	4.2489 (0.1195)	-0.2008 [-1.5425]
$\Delta$ HA	3.4559 (0.4711)	0.4548 (0.7066)	0.0658 (0.9676)	-	0.3687 (0.8316)	-0.1703 [-0.7798]
$\Delta$ PRF	2.2415 (0.3260)	0.2749 (0.8716)	2.2017 (0.3326)	9.7979*** (0.0075)	-	0.0138 [0.9644]

Notes: <sup>a</sup>The values in parentheses are the probabilities,

<sup>b</sup>The values in parentheses () and [] are the *p*-value and *t*-statistics respectively.

\*\*\*Significant at 1 percent level, \*\*Significant at 5 percent level and \* Significant at 10 percent level

STSS (Production of Sawntimber), STDP (Domestic Price of Sawntimber), STMP (Import price of Sawntimber), HA (Annual harvested area), PRF (Permanent Reserve Forest), ECT (Error Correction Term)



## An Empirical Study on the Relationship between China's Economic Development and Environmental Quality-----Testing China's Environmental Kuznets Curve

Gendi Wen

School of International Business, Beijing Foreign Studies University, Beijing 100089, China

E-mail: wengendi@gmail.com

Zhe Cao

Oriental College of Science & technology, Hunan Agricultural University, Changsha 410128, China

E-mail: caozhe@gmail.com

### Abstract

Since the reform and opening-up policy, China's economy has achieved a sustainable and fast growth. However, the traditional economic growth mode with high investments, high consumption, and high emissions causes a growing contradiction between China's economic growth and environment. How to select an economic growth way with the harmonious development of society, economy, ecology, and environment with the restriction of environment is meaningful in theory and practice. Whether there is a reverse U-shape relationship between the national income per capita and the environmental pressure affects the policy choice of economic growth mode. If there is a reverse U-shape relationship between the national income per capita and the environmental pressure, the government can only implement measures driving the economic growth. Once economy grows to certain degree, environmental pressure will decline naturally. However, there is not a reverse U-shape relationship between them, or although there is a reverse U-shape relationship, the national income per capita at the turning point is hard to realize, the development mode adopted by many developing countries that emphasizes on economic growth, polluting first, then improving, will do nothing but worsen the environment. The government should take action to change the economic growth mode, decreasing the pressure on environment caused by economic growth. Only by this way, can it realize the sustainable development of economy. This paper firstly analyzes and comments the empirical studies of Environmental Kuznets Curve (EKC), then makes regression on the national income per capita for years and the main pollutants indexes, analyzing the relationship between China's national income per capita and environmental pressure. An empirical study shows that the relationship between China's emission of main pollutants and the national income per capita does not follow a typical EKC.

**Keywords:** Economic growth, Resources and environment, Environmental Kuznets Curve (EKC)

### 1. Introduction

Since the industrial revolution, along with the fast growth of global economy, human has consumed considerable natural resources. Environment quality is worsening seriously. Macro economic theories begin to care about economic growth and environment. After the publication of *The Limits to Growth* by Mesdows in 1971, the relationship between economic growth and environment gained more and more attentions from people.

To study the relationship between economic growth and environment has extremely important policy meanings. If there is a contradictory relationship between economic growth and environmental pollution, the rational choice for human is to restrict the economic growth and protect the ecological environment in which human live. If there is a mutually promoting harmonious relationship between economic growth and environmental quality, the rational choice for human is to accelerate economic growth, because fast economic growth will directly lead to the improvement of environmental quality. If there is a reverse U-shape relationship between economic growth and environment, it means environmental degradation associates with economic development stage. Economic growth will benefit the improvement of environmental quality finally.

What's the relationship between China's economic growth and environmental quality? Whether the "development-first, treatment-second" mode is an irreplaceable way for developing countries? Is there alternative for China's development? After making an empirical analysis of the evolvement of the relationship between China's environment and economy in 20 years, this paper tries to give answers to these questions.

This paper firstly analyzes and comments the Environmental Kuznets Curve's (EKC) empirical studies. Then, this paper makes regression on China's national income per capita and main pollutants indexes, analyzing and researching the relationship between China's national income per capita and environmental pressure.

## 2. Literature review of EKC empirical studies

### 2.1 The mode's basic form and study result

In recent ten years, lots of domestic and foreign scholars make considerable empirical studies on changes of environmental quality in economic growing process. These studies have the prominent commonness that all data are parallel data measured at different time points in different countries and they adopt the following mode to make regression on the relationship between environmental pressure  $E$  and national income per capita  $Y$ .

$$E_{it} = \alpha + \beta_1 Y_{it} + \beta_2 Y_{it}^2 + \beta_3 Y_{it}^3 + \beta_4 t + \beta_5 Z_{it} + e_{it} \quad \text{Formula (1)}$$

Here,  $E_{it}$  means the environmental pressure of country  $i$  at the time  $t$ .  $Y_{it}$  is the national income per capita in country  $i$  at the time  $t$ .  $\alpha$  is the intercept of abscissas.  $\beta$  is the parameter in estimation.  $Z_{it}$  means other factor affecting environmental pressure except the income.  $e_{it}$  is the random error in normal distribution. According to different regression results, Model (1) can reflect seven kinds of environment-income relationship as follow in Figure 1.

- (1)  $\beta_1 > 0, \beta_2 = \beta_3 = 0$ : linear shape, monotone increasing, as the income rises, environmental pressure is increasing.
- (2)  $\beta_1 < 0, \beta_2 = \beta_3 = 0$ : linear shape, monotone decreasing, as the income rises, environmental pressure is decreasing.
- (3)  $\beta_1 > 0, \beta_2 < 0, \beta_3 = 0$ : reverse U-shape, as the income reaches certain value, environmental pressure decreases as the income rises.
- (4)  $\beta_1 < 0, \beta_2 > 0, \beta_3 = 0$ : U-shape
- (5)  $\beta_1 > 0, \beta_2 < 0, \beta_3 > 0$ : N-shape, similar to the U-shape. But as the income rises further, environmental pressure increases again.
- (6)  $\beta_1 < 0, \beta_2 < 0, \beta_3 > 0$ : reverse N-shape, environmental pressure decreases firstly, then increases, and finally decreases.
- (7)  $\beta_1 = \beta_2 = \beta_3 = 0$ : horizontal line, the income does not affect environmental pressure.

Therefore, the reverse U-shape EKC is only one of seven results from the regression of Model (1).

Popular environmental quality indexes include  $\text{SO}_2$ , suspended particulate, dust, CO,  $\text{CO}_2$ , COD, pathogenic bacteria, and heavy metal. The study model usually adopts a quantity decreasing form, abstracting the influencing factors of environmental quality into the income. Some environmental quality indexes use the emission method, and some the environmental degradation index. As for the income, people may use the PPP method or the market rate. Besides, due to the different data used in studies, the empirical studies on EKC hypothesis result in different conclusions. Specific studies are shown in Table 1.

Here, the main studies are as follow:

#### (1) $\text{SO}_2$

Grossmna and Krueger (1995) analyze the relationship between city air pollution and GNP per capita based on data of  $\text{SO}_2$  in 42 countries from 1977 to 1993, which are tested by the Global Environmental Monitoring System (GEMS) that is designed by World Health Organization and the United Nations Environment Programme. They find that the relationship between them is not in a reverse U-shape but N-shape. At the first and the second peak, the income per capita is respectively 4,100 US dollars and 14,000 US dollars. However, Panayotou (1993), Shafik (1992), Selden and Song (1995) think there is a reverse U-shape relationship between the two. In their studies, at the peaks, the income per capita is respectively 10,700 US dollars, 3,700 US dollars, and 5,900 US dollars.

#### (2) City air suspended particulate

According to studies of Grossmna and Krueger (1995), Selden and Song (1995), and Panayotou (1993), there is a reverse U-shape relationship between city air suspended particulate and income per capita. They calculate that the peak (income per capita) of the curve is respectively 16,000 US dollars, 9,800 US dollars, and 9,600 US dollars.

#### (3) Dust

Grossmna and Kurgeer (1995) agree that the dust-income per capita curve is in N-shape. Based on data of air suspended

particulate in 37 countries, they calculate the income per capita at the first and the second peak is respectively 6,200 US dollars and 10,000 US dollars. Based on data from America, the number is respectively 4,700 US dollars and 10,000 US dollars.

(4) NO<sub>x</sub>

Grossmna (1995) thinks that NO<sub>x</sub> has a reverse U-shape relationship with the income per capita. At the peak, the income per capita is 18,500 US dollars. Selden and Song (1995) and Panayotou (1994) also agree this idea. In their calculation, the income per capita at the peak is respectively 12,000 US dollars, and 5,500 US dollars. Khanna (2002) thinks it is a U-shape relationship.

(5) CO

Grossmna (1995), Selden and Song (1995) find that CO-income per capita relationship curve is in reverse U-shape. In their calculation, the income per capita at the peak is respectively 22,800 US dollars and 6,200 US dollars.

(5) CO<sub>2</sub>

Shafik (1994) thinks that there is not a reverse U-shape relationship between CO<sub>2</sub> and the income per capita. Holtz-Kani (1992) thinks that there is a reverse U-shape relationship between the two. By calculating the emission of CO<sub>2</sub> per capita and the income per capita, he gets the income per capita at the peak is 35,400 US dollars. Based on the emission of per unit capital and the income per capita, the income per capita at the peak is 8,000,000 US dollars. Khanna (2002) thinks that there is linear relationship between the two.

(7) Dissolved oxygen in water

Grossmna (1993) thinks that there is a reverse U-shape relationship between the two. The value at the peak is 8500 US dollars. Shafik (1994) thinks there is not a reverse U-shape relationship between the two. Along with the rise of income, the dissolved oxygen in water will increase continuously.

(8) Quantity of pathogenic bacteria in water

Shafik (1994) thinks there is an N-shape relationship between them. The value at the first and second peak is respectively 1,400 US dollars and 11,400 US dollars. Grossmna and Krueger (1995) think that there is a reverse U-shape relationship between them. The value at the peak is 8,000 US dollars.

(9) Total quantity of bacteria in water

Grossmna and Krueger (1995) think that there is an N-shape relationship between them. The value at the first and the second peak is respectively 3,034 US dollars and 8,000 US dollars.

## 2.2 Comments on empirical studies of EKC hypothesis

From analyses above, we know that most EKC empirical studies focus on air quality indexes and water environment indexes in some cities. These environment indexes tend to worsen firstly and then improve along with economic growth in general. Most pollutants have a reverse U-shape relationship with the income per capita. But in different studies, the value at the peak is far different. Meanwhile, the pollutants that have a reverse U-shape relationship with the income per capita can be degraded in environment naturally. Besides, most are local pollutants. These pollutants associate directly with local residents' health and welfare. So, it is easy for these pollutants being treated properly. As for the global environmental problem or the environmental problem that polluters are far from victims in space and time, the economic growth does not exert a significant effect on the improvement of environment. For example, the emission of greenhouse gas, the loss of water and oil in upstream area increasing the possibility of flooding in downstream area, contemporary people destroying environmental resources threatens the sustainable development. In addition, empirical studies show that some pollutants have a N-shape relationship with the income per capita. To sum up, EKC empirical studies result in different conclusions. The author thinks that reasons for the differences of conclusions include these aspects as follow.

Firstly, as selecting environmental pressure indexes, some researchers take the concentration of pollutants as indexes, but others take the emission as indexes. Even for the same pollutant, due to the different way reflecting environmental pressure, it will cause different results in research.

Secondly, in researching and making regression, whether the explanatory variables increase or not, and to add different indexes will lead to different results.

Thirdly, due to the shortage of materials, present research samples have more limits. Western scholars usually use the cross-section data from developed countries and developing countries to make analysis in researching EKC. The selection and scope of samples affect the research results directly. Besides, samples cover a narrow area and short time period.

Fourthly, the calculation of income per capita is different. Trans-national cross-section data associates with the

exchange rate. Different countries may use different indexes to calculate the GDP per capita, such as current price or the price at certain fixed year, which will lead to different results.

Fifthly, presently most empirical studies focus on one single pollutant index, without researching the general condition of environmental quality. Along with the development of economy, the material base for economic activity will change. Environmental pollution may turn into other kind of pollution from one pollutant. Therefore, although some pollutant indexes decrease, the general environmental quality is not improved. For example, Mc-Gilivrya (1993) studies 22 OECD countries by comprehensive environmental indexes based on 12 environmental indexes and finds that there is not a significant correlation between income and environmental quality.

Sixthly, at present, the income per capita at the turning point of EKC is mostly the social average income. Because the distribution of social income is not equal in practice, more people locate under the average than that above the average. Therefore, in analyzing the relationship between the growth and environment, to choose the average income as an index is unreasonable. The income median is a more reasonable index. But seldom it is used in studies at present.

### 3. Empirical test on China's environmental EKC

Whether there is a reverse U-shape relationship between China's income per capita and environmental pressure? If there is, what is the value at the turning point? In this part, we will use the EKC model to make a regression analysis of China's income per capita and main pollutants.

#### 3.1 Data selection

In order to compare with present researches, we can select SO<sub>2</sub>, waste water, waste gas, and solid waste as environmental pressure indexes. Each pollutant has two kinds of data, namely emission and concentration. Data of emission is calculated by practical energy consumption multiplying emission coefficient. Data of concentration is from practical measure. Although data of concentration is exacter data of emission, it is improper to use concentration data to analyze the relationship between environmental pressure and the GDP per capita. Firstly, concentration data merely reflects the pollution at the monitoring spots, which mostly locate in large cities, where the income per capita is usually different from the GDP per capita. Secondly, people pay more attention to cities' environmental quality. Many polluting industries move toward some undeveloped areas around cities. This industrial transfer in one country will affect the concentration of pollutants at the monitoring spot but not the GDP per capita. Besides, changes of climate have effects on the data of concentration. For example, rain can shorten the moving distance of pollutants in air. At the year with more rain, cities exporting pollutants have higher concentration of pollutants, while cities importing pollutants have lower concentration of pollutants. These changes have nothing to do with the income per capita apparently. So, in order to make the regression more precise, we choose the emission data to make regression on EKC. Sample data are in Table 2 as follow.

#### 3.2 Standard model estimation and result analysis

In order to test the relationship between China's pollution emission and economic growth, we build an econometric testing model as follow:

$$\ln P_x = a_0 + a_1 \ln INC + a_2 (\ln INC)^2 + \varepsilon_0 \quad \text{Formula (2)}$$

$$\ln(P_x / N) = a_0 + a_1 \ln INC + a_2 (\ln INC)^2 + \varepsilon_0 \quad \text{Formula (3)}$$

Here, INC is the national income per capita. P<sub>x</sub> is the emission of pollutant. N is the number of population. Table 3 is a result of making regression on the time sequence data by the regression model in SPSS.

From the Table 3, we know that the determination coefficients of the four indexes, namely emission of waste water, waste water emission per capita, emission of waste gas, and waste gas emission per capita, are all above 0.8, which indicates a relatively positive fitting effect. The determination coefficient R<sup>2</sup> of emission of SO<sub>2</sub>, SO<sub>2</sub> emission per capita, emission of solid waste, and solid waste emission of per capita, are relatively smaller. Especially the determination coefficients of emission of SO<sub>2</sub> and SO<sub>2</sub> emission per capita are lower than 0.5, which means the fitting effect is unsatisfying.

From the Table 3, we find that the eight indexes have the characteristics of U-shape curve, which is not in accordance with EKC. Although the determination coefficients of four indexes, namely emission of SO<sub>2</sub>, SO<sub>2</sub> emission per capita, emission of solid waste, and solid waste emission per capita, are smaller. Especially the determination coefficients of SO<sub>2</sub> emission per capita and emission of SO<sub>2</sub> are lower than 0.5, and the fitting effect is not satisfying. Their practical curves are in a mess. In a short term, we could not identify their real tendency. They should be researched in a longer time period. In general, the fitting effects show that the relationship between China's main pollutants emission and changes of GDP per capita has no typical characteristics of EKC changes.

### 4. Conclusion

According to the EKC hypothesis, environmental degradation is only a stage phenomenon in the process of economic

growth. As economy grows to certain degree, environmental pressure will be released gradually. Economic growth can reduce environmental pressure naturally. But this study indicates that although the rise of main pollutants emission tends to be slow, the emission of main pollutants has no typical characteristics of EKC. The emission of many pollutants keeps in rising along with the economic development. Due to the increasing demand for energies in developing China's heavy industry, emission of SO<sub>2</sub> and other pollutants is rising. Maybe as the time sequence is longer, a turning point in EKC will appear. But at present, the relationship between China's economic growth and resources and environmental pressure is not in accordance with the EKC hypothesis. Therefore, to apply the EKC theory to China's economic growth simply may cause serious consequences and cost a lot.

At present, many developing countries are making choices between economic development and environmental protection. China is not an exception. Therefore, it is impossible to solve the environmental issue originated from economic growth completely by economic growth itself. To solve the environmental pressure in economic growth, the government must choose the right path for economic growth. If without understanding this point, it is hard for China's future economic growth decreasing the environmental pressure, and the economic growth path will not turn toward the direction of sustainable development naturally. In this sense, China has more to do on the sustainable development way.

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Table 1. Empirical studies of the relationship between the income per capita and environmental quality

Pollutant	Researcher	Curve	Value at the first peak (US dollar)	Value at the second peak (US dollar)
SO <sub>2</sub>	Grossman and Krueger (1991)	N-shape	4,100	14,000
	Sharflik (1994)	Reverse U-shape	3,700	
	Grossman (1993)	Cubic equation	4,100	
	Grossman and Krueger(1995)	N-shape	13,400	14,000
	Selden and Song (1994)	Reverse U-shape	8,900	
	Panayaotou (1993)	Reverse U-shape	10,700	
Suspended particulate	Grossman and Krueger (1991)	Linear equation, growing downward		
	Sharflik (1994)	Reverse U-shape	3,300	
	Grossman (1993)	Reverse U-shape	16,000	
	Grossman and Krueger (1995)			
	Selden and Song (1994)	Reverse U-shape	9,800	
	Panayaotou (1993)	Reverse U-shape	9,600	
Dust	Grossman and Krueger (1991)	N-shape	5,000	10,000
	Grossman (1993)	N-shape	4,700	10,000
	Grossman and Krueger (1995)	N-shape	6,200	10,000
NO <sub>x</sub>	Grossman(1993)	Reverse U-shape	18,500	
	Selden and Song (1994)	Reverse U-shape	12,000	
	Panayaotou (1993)	Reverse U-shape	5,500	
	Khanna (2002)	U-shape		
CO	Grossman (1993)	Reverse U-shape	22,800	
	Selden and Song (1994)	Reverse U-shape	6,200	
CO <sub>2</sub>	Sharflik (1994)	Linear equation, growing upward		
	Holtz-Eakin and Selden (1995)			
	Emission per capita	Reverse U-shape	35,400	
	Emission per unit capital	Reverse U-shape	8,000,000	
	Khanna (2002)	Linear equation, growing upward		
Dissolved oxygen in water	Sharflik (1994)	Linear equation, growing upward		
	Grossman (1993)	Reverse U-shape	8,500	
	Grossman and Krueger (1995)	Reverse U-shape	2,703	
Quantity of pathogenic bacteria in water	Sharflik (1994)	N-shape	1,400	11,400
	Grossman (1993)	Reverse U-shape	8,500	
	Grossman and Krueger (1995)	Reverse U-shape	8,000	
Total quantity of bacteria in water	Grossman (1993)	Cubic equation		
	Grossman and Krueger (1995)	N-shape	3,034	8,000

Table 2. Relevant data estimated by China's EKC

Year	Emission of industrial waste water (10,000 ton)	Emission of waste gas (100 million cubic meter)	Emission of industrial CO <sub>2</sub> (10,000 ton)	Emission of solid waste (10,000 ton)	National income per capita (RMB/capita)
1989	2574009	73970	1100	10000	1160.5
1990	2602380	69679	1250	13283	1354.1
1991	2637531	77275	1412	8719	1508.4
1992	2683886	82380	1523	8545	1637.2
1993	2520945	83065	1565	5265	1884.4
1994	2486861	85380	1494	4767	2299
1995	2356608	101415	1165	3376	2975.1
1996	2338534	104787	1323	2587	4014
1997	2194919	109604	1292.5	919	4938.1
1998	2155111	97463	1341.42	1932	5731.3
1999	2218943	123407	1405.02	2242	6281.3
2000	2058881	111196	1363.57	1690	6654.7
2001	1883296	113375	1362.63	1549	7011
2002	2006331	121203	1593.02	7048	7732.2
2003	1973036	126807	1460.09	3880	8467.5
2004	1942405	138145	1615.32	3186	9271.5
2005	2026282	160863	1566	2894	10460.2
2006	2071885	175257	1561.98	2635.21	12349.3
2007	2122527	198906	1791.56	1940.91	14068.6
2008	2211425	237696	1891.4	1761.95	15477.3

Table 3. The conic model estimation results of national income per capita and pollutants emission

$LnP_x$ or $Ln(P_x / N)$	$a_0$	$a_1$	$a_2$	$R^2$	F test
Emission of waste water	18.3388 (12.511)	-0.8117 (-2.199)	0.0432 (1.876)	0.830	41.414
Waste water emission per capita	7.5666 (5.320)	-0.9625 (-2.688)	0.0478 (2.140)	0.932	115.694
Emission of waste gas	18.4518 (5.021)	-2.1057 (-2.276)	0.1543 (2.674)	0.881	62.660
Waste gas emission per capita	7.6796 (2.189)	-2.2565 (-2.555)	0.1589 (2.885)	0.840	44.685
Emission of SO <sub>2</sub>	11.0788 (3.610)	-1.0680 (-1.382)	0.0731 (1.516)	0.477	7.762
SO <sub>2</sub> emission per capita	0.3066 (0.103)	-1.2187 (-1.623)	0.0777 (1.659)	0.176	1.816
Emission of solid waste	51.9280 (3.695)	-10.4379 (-2.950)	0.6153 (2.788)	0.622	13.999
Solid waste emission per capita	41.1558 (2.929)	-10.5887 (02.994)	0.6199 (2.810)	0.666	16.920

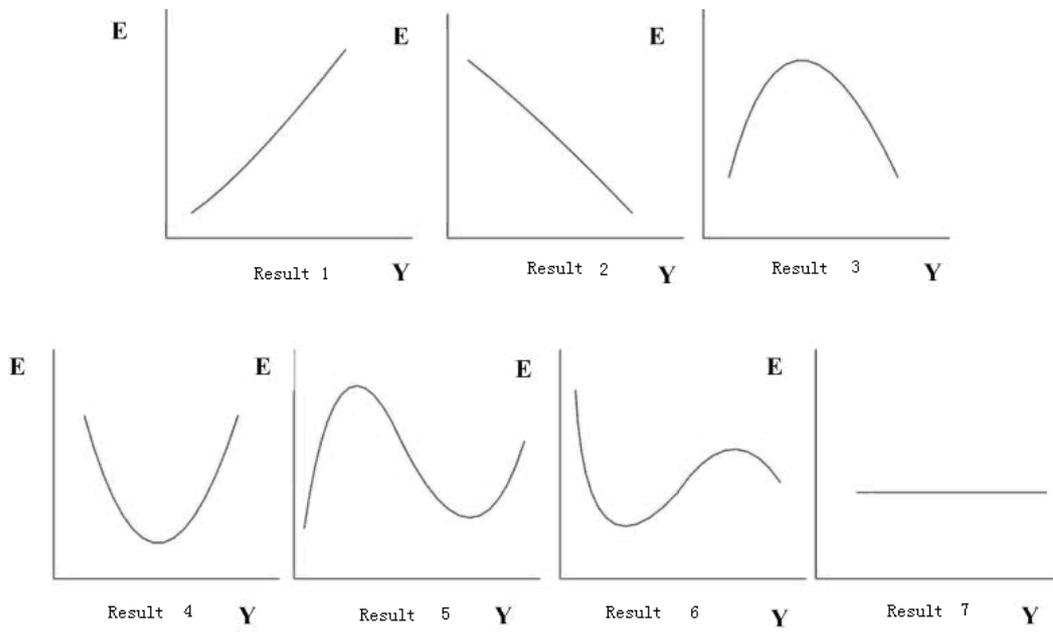


Figure 1. The Different Relationship between Environmental Pressure and National Income per Capita



## Resort Potentials as a Strategy for Sustainable Tourism Development in Plateau State, Nigeria

Aniah, Eugene J.

Department of Geography and Regional Planning, University of Calabar

Calabar – Nigeria

E-mail: geneaniah@yahoo.com

Eja, E. I.

Department of Geography and Regional Planning, University of Calabar

Calabar – Nigeria

E-mail: ejako2007@yahoo.com

Otu, Judith E.

Department of Sociology, University of Calabar, Calabar – Nigeria

E-mail: judithesame@yahoo.co.uk

Ushie M. A.

Department of Sociology, University of Calabar, Calabar – Nigeria

E-mail: ushiemike@yahoo.com

### Abstract

The unique climate conditions of Plateau State and the numerous tourism attraction and spots has made Plateau State the home of peace and tourism and also tourist haven of Nigeria. This paper is centered on five resorts in Plateau State such as National Museum, Jos Wildlife Park, ASSOP Falls, Pandom Wildlife Park and Solomon Lar Amusement Park. Data for resort patronage were provided only in National Museum, Jos Wildlife Park and ASSOP Falls. The critical issue of concerned was on domestic and international patronage of tourist resort between 1996-2008 and the recreational facilities provided in each of the resort centres. Data were collected base on questionnaires, directly field observation and interviews. The data collected were analyzed using ANOVA and the results obtained shows that there is a significance variation in the patronage of the different resorts centres used for this study. However, the viability of tourism potentials can only strive effective in Plateau State if there is full participation of the various stakeholders in decision making process.

**Keywords:** Resort, Tourism, Destination, Patronage, Sustainable

### 1. Introduction

Almost all nations are in recent times recognizing the importance of tourism and embracing it. No wonder the world tourism organization/WTO 2000, claimed that tourism is among the fastest growing industry in the world. Tourism development had unquantifiable benefits ranging from social physical to economic gains. Socially, it promotes world peace and exposes people to new “worlds or environments thus making participant to learn about new environments. In Nigeria, the vast tourism potentials such as table mountains beautiful landscapes, colourful folks, overwhelming serenity wildlife, waterfalls and other rich festivals, architecture, and craft has necessitated towards the existing tourism drive in the country. Today Plateau State is blessed with abundant tourism potentials, such as beaches, spectacular rock formations, hydrological bodies, wildlife and waterfall and other rich festival, architecture, and craft which has necessitated towards the existing tourism drive in the State. However, the rich tourism attractions of the State have earned her the slogan “Home of peace and tourism”. A part from this, most of the tourism potential have been converted

into tourism resorts while others are still left to fallow without any conscious effort by the government and private individual towards its development.

Beside numerous factors has hindered patronage of tourist resort in Plateau State. These factors ranged from age, gender, occupation income social class amongst others. Regretfully most of the tourist resort lack the basic facilities such as accommodation, catering, entertainment, electricity, water which are of essential to tourist and hence making them less attractive in any given location. In this regard it should be asked if resort development is of economic important in Plateau State, what role does resort play in Plateau State? Is resort development an appropriate tool for sustainable local socio-economic development. This study addressed some of the critical issues on resort potentials, particularly as it relate to patronage and facilities provided in the various resort centres. However two hypothesis were stated in this study, thus:

**Ho:** There is no significant variation in the patronage of the selected resorts.

**Hi:** There is significant variation in the patronage of the selected resorts.

## 2. Study Area

Plateau is one of the 36 States of Nigeria. It is located in the central part of the country. It covers an area of about 3,000 square miles, at a general level of about 4,200 feet above sea level and is surrounded by high plains with altitudes ranging from 2,000 to 3,000 feet above sea level. Apart from the southern margin which is both very steep and rather regular in outline, the Plateau is bordered by an irregular margin with gentle slopes. This study only covered some selected tourism resort in Plateau State.

## 3. Material and Method

Five tourist resorts were used in this study. There are, Jos wildlife park, Jos National Museum, Solomon Lar Amusement park, ASSOP waterfalls and Pandom wildlife park. Data were collected using questionnaires and Participatory Research Method (PRM). Four hundred and seventy one (471) copies of questionnaires were administered to occupants living within the resort center using systematic sampling technique. This was to ascertain the recreational activities undertaken by visitors in each tourist resort. While Participatory Research Method (PRM) was employed to obtain data based on domestic and international patronage in National museum, Jos wildlife park and ASSOP falls and facilities provided to tourist in each resort center. However, three hundred and twenty (320) household were used for this study. While two hundred and fifty (250) respondent were drawn from the (320) household sample for this study. The (250) respondent represent the sample size for this research work. Analysis of variance (ANOVA) was adopted for testing the stated hypothesis. It was used to compare the variation within and variation between groups of the resorts. Data on the level of patronage in Pandom wildlife park and Solomon Lar Amusement park were not made available.

## 4. Literature Review

### 4.1 Sustainable Tourism Development

Sustainability is one of the key-words of the 1990s. sustainability and sustainable development were given impetus and made popular by the Brundland report (world commission on environment and development 1987). It define sustainable development as “development that meet the needs of the present without compromising the ability of future generations to meet their own needs”. Both an equity dimension (intergenerational and intergenerational) and a social/psychological dimension are clearly outline by this definition the Brundland report also highlighted the “essential needs of the world’s poor, to which overriding priority should be given”, and “the idea of limitations imposed by the state of technology and social organization on the environment’s ability to meet present and future needs” means that such development must be ecologically bearable in life long term, as well as economically viable, and ethically and socially equitable for local communities.

The principle of sustainable tourism was proposed as early as 1988 by the World Tourism Organization, with sustainable tourism envisaged as leading to management of all resources in such a way that economic, social and aesthetic needs can be fulfilled while maintaining cultural integrity, essential ecological processes, biological diversity and life support system. Recalling previous declarations on tourism, such as the Manila Declaration on world tourism, the Hague Declaration and the Tourism Bill of rights and tourist Code, the charter for sustainable tourism approved during the World Conference on sustainable tourism, held in Lanzarote in 1995, underlined the need to develop a kind of tourism that meets both economic expectations and environmental requirements, and respects not only the social and physical structure of its destination, but also the local population.

The concept of sustainability has a twin valence: on one hand there is the ecological aspect, that is the conservation of the natural equilibrium of all the components of the natural environment (flora, fauna, water resources, etc); on the other hand there is the anthropological aspect, which could be expressed by the persistence of enjoyment of this environment in spite of growing tourist flows.

It is obvious, at least for the economist, that there is a strong relationship between the two characteristics (ecological and anthropological) of sustainability in tourist enterprise. In fact, the degradation of weaker components of the natural environment, especially if it is irreversible, provokes, first of all, a slow down in the development of tourist activity, with substantial consequences at a social and economic level. Such a situation of backwardness and impoverishment will subsequently result in a loss of interest in conservation and good use of natural and environmental resources, which are of great interest to tourists. Added to this there is also a substantial loss even in the financial profitability of the different commercial activities concerned. According to him, internet may represent one opportunity for making and selling the product.

#### *4.2 The Role of the Private Sector in Tourism Development*

Scheyvens (2002) in analyzing the role of private sector in tourism development opines that corporate businesses can assist by providing markets, capacity building, monitoring and micro-financing support for small, medium and micro-enterprises. Swarbrooke (1999) agreeing with Scheyvens pointed out that the private sector seems to recognize the issues of sustainability, and to recognize the importance of the community as a stakeholder in the paradigm of successful tourism, with the more aware operators and investors understanding something about the needs and requirements of the community. The private sector is more sensitive to the market than any other stakeholder; this is of course not surprising as private sector stakeholders are interested in financial stability, remuneration and economic sustainability (UNWTO, 2005). According to Loannides (2002) smaller enterprises may, naturally, have the ability, interest and spatial positioning to be more sensitive to community needs and objectives.

Godwin (2001) in assessing the role of private sector in tourism development opines that the private sector can contribute to local economic development and poverty reduction by changing the way it does business and through philanthropic activities.

He further emphasized that there are strong commercial motivations for private sector engagement in local economic development and poverty reduction, principally the creation of an enhanced product range, which adds market advantage and of a better business environment, which fosters of favourable staff attitudes and morale. Potter (2006) agreeing with the works of Goodwin further stress that private sector can foster local socio-economic development by recruiting and training local people, procuring goods and services local and shaping local infrastructure development to include benefit for the poor. Private sector can also encourage tourists to purchase products that are complementing to the core holiday, such as handicrafts, art, local food and beverages and services such as guide services, music and dance (UNWTO, 2005).

Singh and Dowling (2003) in their study of private sector involvement in tourism development discovered that private sector is capable to undertake joint marketing and promotion, to liberation trade in travel and tourism, to enhance cooperation in raising the quality and sustainability of tourism in any region and to ensure tourist safety and security and human resources development.

#### *4.3 Tourism and Economic Development*

Hall (2003) in his study on the socio-economic impact of tourism discovered that tourism has become a significant source of foreign exchange revenue for many countries of the world. According to him tourism activities in Maldives contributed 66.6 per cent of the country's Gross Domestic Product (GDP) and accounted for 65.9 per cent of its exports, Roe and Godwin (2002) supported the works of Hall, according to their analyses, tourism industry in Vanuatu has contributed 47.0 per cent of the country's GDP and 73.7 per cent of its total export earnings. They went further to emphasized that thirteen (13) developed countries in Asia (Cambodia, Lao people's Democratic Republic and Neps), tourism accounted for more than 15 per cent of export earnings.

Hall (1999) opines in his study of economic impact of tourism opinion that this industry has contributed to GDP as seen in the Island states of Fiji, Tonga and Vanuatu.

He further stress that tourism alone contributed 43.5 per cent of the total export earnings of Fiji and one third of its GDP. Other small Islands such as Tonga and Vanuatu are dependent on tourism for half or more of their export earnings. Prentice (2007) in his study opines that tourism in China has provided a substantial contribution to its GDP amounting to 13.7 per cent in 2006. Taking full advantage of the potential of their natural and culture tourist resources, countries in the greater Mekong sub-region are benefiting from the tourism industry. He went further to stress that in 2006, tourism in Cambodia and the Lao people's Democratic Republic accounted respectively for 22.3 and 21.4 per cent of their total export earnings and contributed 19.6 and 9.3 per cent respectively of their GDP.

According to UNWTO (2004) tourism industry contributes significantly to the creation of employment both directly and indirectly. According to UNWTO the industry in the Asian and Pacific region provide jobs for about 140 million people representing an average of 8.9 per cent of total employment. It also emphasized that tourism employment in North-East Asia is estimated at 86 million jobs, or 10.1 per cent of total employment. This situation is attributed main to China, where 1 out of 10 persons works in a tourism-related industry. In support of UNWTO's argument, Sharpley and

Stelfer (2002) following empirical findings, indicated as part of his illustration, that in Oceania, the workforce in the tourism sector accounted for 14.5 per cent of total employment, or 1 in every 6.9 jobs. The importance of tourism becomes more significant when the structure of the workforce in selected Pacific Island economies is analyzed. For instance in 2003, 1 in every 3.2 persons was employed in the tourism sector, while in Vanuatu the ratio was 1 in every 2.4 jobs.

Richards and Hall (2003) opines that tourism industry has become a significant provider of employment in countries of the Asian and Pacific region, thereby improving the economic situation of the people of those countries. In addition, revenue generated from tourism has enabled Governments to allocate financial resources for improving education and health in these countries. They further stress that in Maldives, where tourism activity is the economic mainstay, almost 100 per cent of the population is now literate, while the infant mortality rate has improved from 121 per 1,000 in 1977 to 38 per 1,000 in 2002 and over the same period, the average life expectancy at birth increased from 47 years to 67 years.

## 5. Research Findings

Table 1 gives the summary of some of the recreational activities which the tourist engaged in at the various resorts sampled.

The Table 1 reveals that majority of the visitors are engaged in relaxation/drinking a value 27% compare to other variables with values rock climbing 7% swimming 13% game viewing 21% horse riding 9% and sight seeing 22% respectively.

Table 2 shows the level of domestic and international tourist of the national museum resort between 1996 to 2008. The data obtained indicate a high level of domestic tourist patronized in the National Museum compared with international tourist.

The highest level of patronage of the resorts were recorded in 2003, while 2001 recorded the lowest patronage. The national museum resort witnessed a drastic fluctuation in terms of domestic and international patronage.

Furthermore, levels of patronage of domestic and international tourist in Jos wild life park resort were obtained.

Table 3 represent annual increase in the patronage of Jos wild life park. International tourist were fewer than domestic tourist. Table 3 reveals that there is a fluctuation in terms of domestic and international tourist arrival to Jos wildlife between 1998 – 2003. This could be due to the religious crisis which almost engulfed the entire Plateau State. With regards to ASSOP falls resort. Table 4 shows the level of patronage of domestic and international tourists to ASSOP falls resort.

Comparatively, ASSOP falls recorded the least patronage over the thirteen years period covered in this study. The annual totals are relatively low. The domestic patronage shows a steady increase from over eight thousand in 1996 to over twenty five thousand in 2003. Conversely, the number of international tourists dwindled over the years, but interestingly reached the peak of over four thousand in 2001 when the domestic tourists dropped to the least (3,407) in the same 2001, due to religious crises. However, in order to verify the data collected in the field, the stated hypothesis which was stated as there is no variation in the patronage of the selected resorts was tested and the calculated value of 99.49 was obtained. This result shows that there is significant variation in the level of patronage of the different resorts: Nevertheless, Table 5 shows the facilities provided by respective resorts in the study area.

Table 5 shows that patronage of any resort is a function of facilities provided. It also reveals that accommodation is the major facilities provided by the National museum and Pandam Wildlife Parks with values 67 and 45 respectively.

## 6. Conclusion

This case study shows that Plateau State is endowed with great tourism potential which can be developed to ensure sustainability and socio-economic empowerment of the local people. Consequently, there is a high percentage of patronage by domestic tourist as compared to international tourist over the years. Therefore, if tourism is to contribute to sustainable economic development in Plateau State, a strategy centered on expansion of local empowerment and self employment, development of partnership amongst public and private sectors, improving social and cultural impacts, increasing local access to infrastructure and services provided for tourist must be advocated.

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Table 1. Recreational activities undertaken by the visitors at the resort

Activity(S)	No of Patrons	Percentage
Rock climbing	40	7
Sight seeing	54	9
Swimming	76	13
Game viewing	123	21
Horse riding	52	9
Relaxation/drinking	126	22
<b>Total</b>	<b>471</b>	

**Field work 2008**

Table 2. Levels of patronage of domestic and international tourists in national museum resort (1996 - 2008)

Year	Tourists		Total
	Domestic	International	
1996	75,323	2,546	77,869
1997	76,767	2,979	79,772
1998	67,000	4,0378	71,038
1999	50,213	3,139	537,551
2000	131,457	6,100	137,551
2001	7,082	7,032	14,114
2002	202,727	5,382	208,109
2003	275,809	5,124	280,933
2004	273,012	3,397	276,409
2005	241,871	3,544	245,415
2006	3,691	417	3,244
2007	3938	551	3,391
2008	4085	653	3,493

**Source: Management of the resort (2008)**

Table 3. Levels of patronage of domestic and international tourists to Jos wildlife park resort (1996 - 2008)

Year	Tourists		Total
	Domestic	International	
1996	22,340	767	23,107
1997	28,701	811	29,512
1998	32,589	672	33,260
1999	101,094	806	101,900
2000	65,242	581	65,823
2001	83,917	737	84,654
2002	58,327	409	58,736
2003	90,371	607	90,978
2004	103,923	1,164	10,5087
2005	104,977	2,204	10,718
2006	3,691	417	3,244
2007	3938	551	3,391
2008	4085	653	3,493

**Source: Management of the resort (2008)**

Table 4. Levels of patronage of domestic and international tourist to ASSOP falls resort (1996 - 2008)

Year	Tourists		Total
	Domestic	International	
1996	8,245	1,086	10,417
1997	8,413	1,679	10,092
1998	7,903	2,158	1,006
1999	9,587	1,741	11,328
2000	10,898	1,051	11,949
2001	3,490	4,980	8,470
2002	20,853	216	21,069
2003	23,966	101	24,067
2004	21,982	213	22,191
2005	25,050	315	25,365
2006	3,691	417	3,244
2007	3938	551	3,391
2008	4085	653	3,493

Source: Management of the resort (2008)

Table 5. Facilities provided at the resorts

Facilities	National	Jos	ASSOP	Pandam	Solomon Lar
Library	1	-	-	-	-
Auditorium/hall	1	-	-	1	1
Parking space	3	1	1	8	1
Restaurant/bar	2	-	1	-	1
Conference room	1	-	-	1	-
Open air theater	1	-	1	-	-
Children playing ground	1	-	1	-	1
Accommodation	67	-	-	45	7
Water supply	7	1	1	-	-
Public convenient	6	-	-	4	-
Picnic area	-	-	1	5	-
Canoe	-	-	-	4	-
Nature museum/museum	1	1	-	1	3
Café	-	-	-	-	-
Shopping mail	-	-	-	-	4
Swimming pool	-	-	-	-	1
Lawn tennis court	-	-	-	-	1
Artificial lake	-	-	-	1	1

Source: Field work (2008)



## Studies on Sustainable Development of Ecological Sports Tourism Resources and Its Industry

Pengfei Zhu (Corresponding author)

Beihai College of Beihang University, Beihai, Guangxi 536000, China

E-mail: bhuzhu@126.com

### Abstract

Through the analysis of ecological sports tourism resources and its characteristics, we investigated the key ecological sports tourism resources from the angle of regional planning, industrialization programming, design and so on in the present paper and put forward novel countermeasure for sustainable development.

**Keywords:** Ecological sports tourism, Tourism industry, Sustainable development

### 1. Introduction

Modern Chinese physical education is the combination of western and traditional Chinese sports. From the angel of historical development, whether western or Chinese sports deriving from natural sports, are all the products of human production and survival development. Modern sports civilization is the human civilization of industrial revolution and cultural development, and similar to the environmental issues imposed by industrial revolution, also bring many new issues. Along with the enhancing cognition and investigation level of human being on resources and environment, the combination of ecological and social science make people consider the return of modern sports to nature and the construction of new sports ecological environment. Therefore, sports ecology has been a new research area promptly developing in and out of China at present. Research directions developed currently mainly includes: composition of sports ecological system, basic characteristics and development law, sports and environment, green Olympics, leisure sports and so on. All these fail to form a systematic and complete theory and method system for sports ecology. Some research areas on sports ecological resources, such as systematic investigation, scientific analysis, sustainable development utilization and so on, have not attracted great attention, and especially, research on sustainable development utilization have not been systematically and comprehensively developed.

With abundant ecological resources, protection and utilization of ecological resources have been paid more and more attention during the process of ecology construction by Chinese government. In china, resource base is profound for the investigation and development of multi-ethnic ecological sports, ecological tourism is required by more and more people of the whole society, and attention have been paid to investment and development of high-grade ecological tourism industry. All these resource dominance afford a wider development space for ecological sports tourism industrialization. Spontaneous mass sports activities have always been developed well, which offers an excellent mass basis for the investigation of sports ecology and industrialization construction. On such condition of resources, environment and market demand, by using theory and technology of ecology, in combination with industrial development requirement, investigation and study of ecological sports tourism resources is systematically undertaken in order to seek countermeasures for sustainable development of ecological sports tourism industry, offer novel insight into sports development, pave a new space for the comprehensive development of society and economy in China and protection and utilization of ecological environment, and promote coordinated development of society, economy and ecology. Therefore, ecological sports tourism industry will bring favorable benefits of society, economy and ecology(Zhu, 2001, PP. 13-15).

### 2. Resource analysis of ecological sports tourism industry

Ecological sports tourism industry resources mainly include: ecological sports tourism resources, ecological tourism resources and tourism industry resources.

Ecological sports tourism resources are ecological sports items resources which meet with the demand of increasing healthy consumption of human society with respect to sports, including traditional, ethnic sports items and so on, and historical and traditional culture resources covered by those items, with obvious ethnic characteristics and personality(Wang, 2005, PP. 29-31). Chinese traditional and ethnic sports items, with distinctive characteristics, are the non-negligible high quality historical and cultural heritage in the inheritance of Chinese history and culture. Cross-synthesis of subjects, such as ethnology, sports science, tourism science, ecology and so on, are essential for understanding the values of its resources.

Through investigation on such resources and combination with Chinese reality, characteristic resource evaluation and development system of Chinese history and culture could be developed, followed by product or production of industrialization(Zheng, 2005, PP. 43-46).

Ecological tourism resources are the general designation of all resources with respect to natural ecological environment in tourism resources, and the natural environment and its historical cultural background tourists learn, taste and enjoy, namely natural ecological, social and historical cultural resources. All these resources possess natural attributes, such as distinctive regionality, seasonality and so on, and social culture attribute. Such resources could be independently developed into ecological resource industry, but in combination with ecological tourism resources could get mutual benefits and form a novel industrial feature.

Tourism industry resources are summation of industrialization resource, tourism and item management with respect to tourism. Different from the two resources mentioned above, it could not only rely on the basis of natural ecological, ecological sports, tourism resources and so on, but also be independent on those resources. It is a kind of soft management and industrialization resource, implementation security of socialization, economization and ecology for tourism items, products and industry, and hence possesses indispensable values similar to the above-mentioned resources.

### **3. Regional planning of ecological sports tourism key resources**

Scientific comprehensive investigation and study on ecological sports resources has not been undertaken at present. The question how to recognize and understand scientifically and comprehensively the characteristics and dominance of regional ecological sports resources, appears to be a mainly obstacle to industrialization development of ecological sports resources. Through the application of modern technological means of 3S(Remote sensing, geography information systems and global positioning systems) and mathematical statistics, in combination with requirement survey of ecological sports tourism resources, environmental capacity, carrying capacity, etc., sorts, quantity, scale, characteristic and so on of regional key resources was ascertained. Based on this, further in combination with theory and method of regional planning, advisable regional planning was undertaken in order to offer scientific basis for the development of ecological sports tourism industry and government decision making, which could not only guarantee the scientific development of ecological sports, but also avoid the waste and destruction of ecological sports resources during the process of development, gradually pave a sustainable way for ecological sports industry and thus promote harmonious development of regional society, economy, culture and ecology and bring forward good social, economic and ecological benefits(Zhao, 2006, PP. 90-94).

In order to implement sustainable development of ecological sports tourism industry, latest achievements in subjects, such as ecological science, sports science, tourism management science, etc., should be applied in this area, and an investigation system including resource investigation, resource evaluation and analysis, resource utilization planning and resource management should be established. Based on this, resource dominance of industrial management should be exerted well to achieve the values of resources under performance of integration and actualization. Due to vast territory, lots of nationalities and abundant historical cultural heritage in China, it is tough to ascertain the policy and strategies for sustainable development. In the first stage, a comprehensive survey should be undertaken about Chinese ecological sports tourism resources. On the basis of the survey, basic and key resources of regional ecological sports tourism were ascertained through scientific analysis, and regional industrial development planning should be undertaken on such resources(Song, 2005, PP. 75-78).

Regional development planning of ecological sports tourism industry mainly includes: ① basic constitute, distribution charts and protection and utilization general planning of basic resources; ② Characteristics, distribution charts and regional planning of key resources; ③ General planning of industrialization development; ④ Design and planning of regional industrialization item.

Establishing supporting industrial policy according to the requirement of resources and planning, is essential for ensuring healthy sustainable development of industry. Industrial policy includes: ① Protection and utilization policy of basic resources; ② Protection, utilization and special management policy of key resources; ③ Supporting and preferential policy of industrialization sustainable development; ④ Strengthening the cognition of resource value, science popularization and correlated policy of resource management.

### **4. Planning and design of ecological sports tourism industry**

Any industrialization developments all carry out through specific project design and implementation, and hence scientific and normative industrialization project design and implementation management become important content and guarantee for sustainable development. Because industrial development require strong and powerful economic guarantee, industrialization planning and design sometimes have many contradictions. Actually, relationship among economic, ecological and social benefits is complementary to each other. Scientific planning and design could attenuate such contradictions. Therefore, it becomes paramount for the prospective of planning and design, science of project planning and design and concrete embodiment of technical progress achievement. Studies on subjects, such as ecological science, sports science, tourism

management science, industrial economics and so on, should be successfully undertaken to realize its sustainability by planning and its enforceability and validity by planning and design.

Principles of planning and design: economic benefits priority, unification of economic and social benefits; Adaption to local conditions; Protection and reasonable exploitation of resource; Unified planning, highlighting key points and implementing step by step.

Objective and index system: Objective is to establish an ecological sports tourism item with good economic benefits, meanwhile pay attention to ecological and social benefits; Corresponding index system includes economic indices(ratio of output to input, progressive increment capability of economic benefits and so on); Ecological indices(green cover percentage, ecological recovery ability, suitable degree of resource protection and utilization, environmental quality, pollution control rate and so on); Social indices(healthy tour and healthy body and mind, public environmental awareness and resource consciousness, universal education of ecological environment protection science and so on ).

Objective feasibility analysis: such analysis is kind of technical feasibility assess in terms of planning and design of ecological sports tourism item industrialization development, including environmental evaluation, population evolution law analysis, ecological recovery ability, resource optimization, item optimization setup and construction and so on, and offer technical support and guarantee for industrial planning and design.

Item functional planning and design: according to the investigation, analysis and evaluation of ecological sports tourism resources, all kinds of resources are undertaken conceptual and functional planning with function optimization in light of the requirement of tourism item development, with attempts to enhance resource protection, decrease resource destruction, sufficiently exert resource values and offer insight into the subsequent specific item design.

Item design: according to functional planning, industrialization specific items are designed, including item design of key ecological sports tourism resources, optimal combination design of basic resource item, tourism function guarantee design, special item design for health, tour and leisure, novel item design such as science popularization, environmental protection education, etc. All these items become industrial chain and cluster after integrated development.

Guarantee measures for industrial development and item construction: it mainly includes establishing and perfecting management system guaranteed for industrial development and item construction; Industrial planning brought into social economy development planning and yearly development plan by local government, accomplishing fund input for supporting early construction, widening capital channels, inducing further input of social fund, guarantee input of development fund, taking macro-control; Strengthening environmental protection and unified supervision; Exerting effects of media and education to promote awareness of public participation; Relying on scientific and technological progress, protecting and guaranteeing for industrial development; Drawing supporting policies and regulations, management regulations and detailed rules for implementation for the practice of ecological sports tourism industry in terms of national law, regulations and rules; Intensifying international exchange and cooperation and so on.

## **5. Countermeasure for sustainable development of ecological sports tourism industry**

Sustainable development theory and method system have been developed for many years, and formed into certain mode. Such mode promotes social development, but at the same time, not always satisfies the development requirement of specific industry and item. Therefore, novel insight into sustainable development of ecological sports tourism industry is essential, and this update embodies specific innovated thinking and countermeasure in development countermeasure. Previous studies conformed that, and hence the following several key innovations are used as main content of sustainable development countermeasure to construct and develop.

Novel protection and utilization of ecological sports tourism resources is essential according to the characteristics of ecological sports tourism industry. Innovation in this area is based on the investigation, analysis and evaluation of ecological sports tourism industry, facilitates understanding the heterogeneity and value generality of natural ecological resources, sports ecological resources, tourism resources and historical cultural resources, and constituting measures of resource protection and strategy of resource exploitation and utilization(Liu, 2005, PP. 17-19).

Ecological sports tourism industry contains subjects, such as ecology, sports, tourism, sociology, culture and so on, and refers to ecological industry, sports industry, tourism industry, etc. Due to segmentation of trap and block resulted from professional research and industrial development, it is tough to form a systematic research and development, which becomes a limiting factor significantly affecting sustainable development of this industry. Consequently, sustainable development of the industry should break traditional limitations, under the guidance of local government, organize and develop cooperations of trans-subject and industry units and talents, integrate multi-subjects theory and technology application achievement to guarantee smooth progress of industrialization.

The formation and development of an industry relies on the progress of science and technology. In light of the requirement of industrial development, ecological sports tourism science and its related frontier and interdisciplinary subjects should be established and developed. Only in this case, innovative development has its stamina.

Due to vast territory, irregular distribution of resources, notable discrepancy in economy between eastern and western regions, as well as main ecological sports tourism resources distributed in central and western regions and minority areas where development of economy, science and technology is relatively backward, and talent resources is scarce, diversification of developing modes should be mainly adapt to the requirement of industrial development, and moreover, government, investors, talents and so on should be provided with novel idea and sustainable development notion, and cooperate with innovation planning and science construction to achieve sustainable development.

Taken together, ecological sports tourism industry already possesses a qualification for healthy industrial development. During the period of industrial development, it can be anticipated that it could result in the progress of science and technology and grandness of excellent professional talent team, and based on those, promote economy development, social progress and human ecological civilization, and exhibit a profound prospect for the industrial sustainable development.

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## Operational Characteristics of Diesel Engine Run by Ester of Sunflower Oil and Compare with Diesel Fuel Operation

Murugu Mohan Kumar Kandasamy & Mohanraj Thangavelu

School of Mechanical Engineering, SASTRA University

Thanjavur 613402, Tamilnadu, India

E-mail: kmohan2001@rediffmail.com

Rajamohan Ganesan

School of Engineering and Science, Curtin University Technology

Sarawak Campus 98009, Miri, Malaysia

### Abstract

A single cylinder direct injection diesel engine was first run with diesel fuel and then with Ester of sunflower oil. The operational characteristics of the engine run with both the fuel have been compared and the results obtained are shown in this paper. From the results obtained, it is understood that the thermal efficiency is slightly less and the specific fuel consumption is slightly higher with Ester of sunflower oil when compared with Diesel. This is due to the lower calorific value of the Ester of sunflower oil. All other parameters are also clearly discussed in this paper and finally it is concluded that the Ester of sunflower oil can be used as alternative fuel in the Diesel engine without any engine modifications.

**Keywords:** Diesel engine, Sunflower oil, Bio diesel, Operational characteristics and Engine performance

### 1. Introduction

The world is presently confronted with the twin crisis of fossil fuel depletion and environmental degradation. Indiscriminate extraction and lavish consumption of fossil fuels have led to reduction in underground-based carbon resources. The search for an alternative fuel, which promises a harmonious correlation with sustainable development, energy conservation management, efficiency and environmental preservation, has become highly pronounced in the present context.

Diesel fuel play an important role in transport sector and their demand is constantly increasing. Due to stringent environmental regulations, the refiners need to practice increased degree of refining to produce clean diesel fuels having lesser quantities of aromatics. This results in lowering of lubricity of diesel fuels leading to malfunctioning of fuel pumps, wear of nozzles and injector parts. The lubricity of diesel fuels can be improved by the use of additives or blending fatty acid methyl/ethyl esters (ASAE, 1996). Ester of sunflower oil is obtained by chemically modifying the neat vegetable oil, a process known as transesterification. In this process ethanol or methanol is reacted with neat vegetable oil in the presence of a catalyst to produce fatty acid esters and glycerol. This process changes the properties of the vegetable oil in to a diesel like fuel (Chang, 1997).

In the modern and fast moving world, petroleum based fuels have become important for a country's development. Products derived from crude oil continue to be the major and critical sources of energy for fuelling vehicles all over the world. However, petroleum reserves are limited and are non renewable. At the current and projected rates of consumption of crude, it is estimated that these reserves will be badly depleted in due course and it may become impossible to meet requirements. Oil availability from sources within India increased from 0.25 million tones in 1947 to about 34.56 million tones in 1989-90. This met 66% of the total demand in 1989-90. The demand for petroleum products in 1990-91 was estimated as 58.87 million tones and it was approximately 100 million tones in 2000. It is expected to reach 175 million tones in 2006-2007. Diesel is mainly consumed in the transport, industrial and agricultural sectors. The cost of transportation affects the economics of all other consumables that reach common people in a developing country like India. A country's development is strongly linked to availability of fuels for transportation and power generation.

Thus, India faces the major challenge of meeting the high demand of oil to meet the growing energy needs. It is therefore, important to have a long-term plan for development of alternative energy sources in a balanced manner by making optimal use of available land and manpower resources. It is important to explore the feasibility of substitution

of diesel with an alternative fuel, which can be produced with in the country on a massive scale for commercial utilization. Vegetable oils are considered as good alternatives to diesel as their properties are close to diesel (Duke, 1982).

Vegetable oils are renewable in nature and can be directly used as fuels in diesel engines. However, their high viscosity and poor volatility lead to reduced thermal efficiency and increased hydrocarbon, carbon monoxide and smoke emissions (Barsic, 1981; Ali, 1995 and St.Joseph, 1982). Transesterification is one of the methods by which viscosity could be drastically reduced and the fuel could be adopted for use in diesel engine. The transesterification process involves reacting vegetable oils with alcohols such as methanol or ethanol in the presence of a catalyst (usually sodium hydroxide) at about 70°C to give the ester and the by product, glycerin (Korbitz, 1995). This esterified vegetable oil is popularly known as Bio-diesel and that is commercially available in the developed countries due to its distinct advantage over the conventional diesel. In our work, Sunflower oil has been converted into Bio diesel by the Transesterification method and the viscosity has been reduced to 4.8 centistokes from 21.4 centistokes. The Free fatty acids (FFA) present in the sun flower oil have got the greater influence in the process of converting it into the Bio diesel. This has been observed during the time of producing the Bio diesel in the laboratory level and that has been clearly explained in this paper (Van, 2004).

## 2. Experimental Investigation and Test

The engine is coupled with an eddy current dynamometer. Ester of Sunflower oil was injected in to the engine through the existing conventional injection system. However, two separate fuel tanks were used, one for diesel fuel and other for Ester of Sunflower oil. Both the fuels were injected at the room temperature only. A fuel changing arrangement was provided to change one fuel mode to another fuel. Since the test rig is a computerized engine test rig, all the observations were carried out by the respective sensors, i.e., the engine speed was measured by the crank angle encoder, the cylinder pressure and fuel injection pressure were measured by the piezo electric sensors. The signals that were obtained from various sensors are fed to the engine indicator for storing the data and interfacing with computer.

### Specification of the Engine

Make a Model	:	COMET
No of Cylinder	:	One
Orientation	:	Vertical
Cycle	:	4 Strokes
Ignition System	:	Compression Ignition
Bore and stroke	:	80 mm × 110 mm
Arrangement of valves	:	Overhead
Rated power	:	3.5 kW @ 1500 rpm
Cooling Medium	:	Water cooled
Combustion Chamber	:	Open Chamber (Direct Injection)
Compression ratio	:	18:1
Displacement volume	:	553 cc

## 3. Engine Performance Characteristics

### 3.1 Thermal Efficiency

The Thermal efficiency of the engine run by Ester of sunflower oil has been compared with Diesel fuel operation and it is shown in the figure 1. It is observed that the thermal efficiencies are close to each other. But however there is a slight decrease in the thermal efficiency of the Ester of sunflower oil. This is probably due to high density of Ester of sunflower oil (0.88g/cc) than Diesel (0.86g/cc) and that affects mixture formation of the fuel thus leads slow combustion. The maximum thermal efficiency of the ester of sunflower oil 31.86, where as in the case of Diesel it is 34.5%.

However there is no drop in the maximum power with the Ester of sunflower oil.

### 3.2 Specific Fuel Consumption

The specific fuel consumption of Ester of sunflower oil and Diesel fuel are compared at various load is shown in figure 2. The Ester of sunflower oil has maintained similar trend as that of Diesel in the entire load range. However the SFC in the case of Ester of sunflower oil is higher as compared to Diesel. This is because of the lower calorific value of Ester of sunflower oil and that has led to more discharge of fuel for the same displacement of the plunger in the fuel injection pump. Therefore there is an increase in the SFC. At full load, the SFC of Ester of sunflower oil is 0.29 (kg/kW-hr) and

for Diesel, it is 0.25 (kg/kW-hr).

### 3.3 Exhaust Gas Temperature

The figure 3 shows that there is no much variation in the Exhaust Gas Temperature when compare Ester of sunflower oil with Diesel fuel. The maximum temperature of exhaust gas at maximum load is 371.09 K for Ester of sunflower oil and 361.33 K for Diesel. This is because of less heating value of Ester of sunflower oil, i.e., the less heating value leads to less dissipation of heat for the same quantity of fuel burnt when compare to the Diesel fuel.

### 3.4 Volumetric Efficiency

The actual volume of air which is inducted for the combustion of Ester of sunflower oil is less with respect to stoichiometric A/F ratio of 38:1 but in the case of Diesel it is 16:1 and therefore the volumetric efficiency of the engine is decreased when Ester of sunflower oil is used as fuel and it is shown in figure 4 at different load.

## 4. Engine Combustion Characteristics

### 4.1 Delay Period

The figure 5 shows the delay period curves at different load. The delay period is the time lapse (in terms of °CA) between the start of injection and the start of combustion. It is lower for Ester of sunflower oil when compare with diesel fuel. In general, the delay period in the case of C.I. engine depends on various parameters. Among all the characteristic of fuel, degrees of atomization are considered as the important factors. The decrease in fuel viscosity leads to better atomization and small sizes of fuel droplets. The smaller size of droplet requires less time for the start of combustion and hence the delay period is decreased. In our case, the viscosity of the Ester of sunflower oil is 4.8Cst. Hence atomization is slightly more and that leads to minimizing the time for start of combustion and hence there is a decrease in the delay period for Ester of sunflower oil.

### 4.2 Peak Pressure

The peak pressure depends on the amount of fuel taking part in the uncontrolled combustion phase, which is governed by the delay period and spray envelope of the injected fuel. There is a little difference between the Peak Pressure of the Ester of sunflower oil and the Diesel. In the case of Ester of sunflower oil, the delay period is less, the fuel taking part in the uncontrolled combustion phase is less and hence the Peak Pressure is slightly lesser than the diesel fuel for all the load operation is shown in figure 6.

### 4.3 Rate of Pressure Rise

The Rate of pressure rise is concerned, it is generally higher for Diesel fuel and it is probably due to the domination effects of the premixed phase of combustion and for Ester of sunflower oil it is slightly lower than Diesel fuel. This is shown in the figure 7.

### 4.4 Mean Gas Temperature

The figure 8 shows the mean gas temperature is more for ester of sunflower oil and less for diesel fuel. This is because of effective burning of ester of oil in the engine. Effective burning is made possible by the very small droplets in sizes when compare.

## 5. Conclusions

The comparison of result shows very clearly that the performance and the combustion characteristics of C.I engine using Ester of sun flower oil as a fuel are almost matching with the diesel mode of operation. This justifies that the attempt made to use Ester of sun flower oil as a fuel in the C.I engine is very effective and can be used as an alternative fuel without modifying the engine. However due to the lower calorific value of the Ester of sun flower oil, it is found that the thermal efficiency of the engine is found to be slightly lesser and the specific fuel consumption is higher with Ester of sunflower oil when compared to Diesel fuel.

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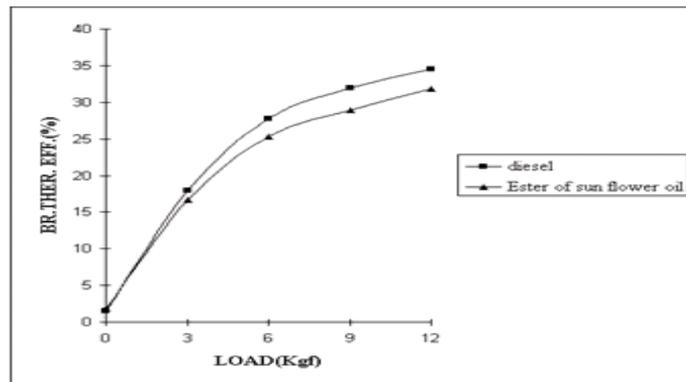


Figure 1. Load versus Brake thermal efficiency

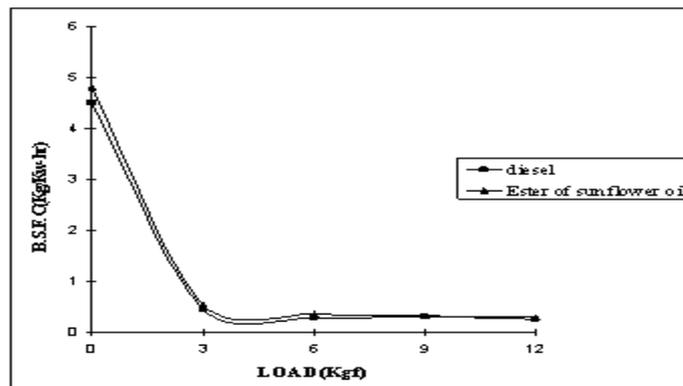


Figure 2. Load versus Brake specific fuel consumption

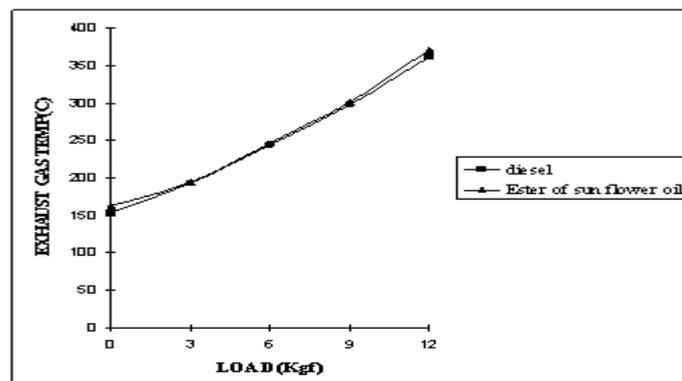


Figure 3. Load versus Exhaust gas temperature

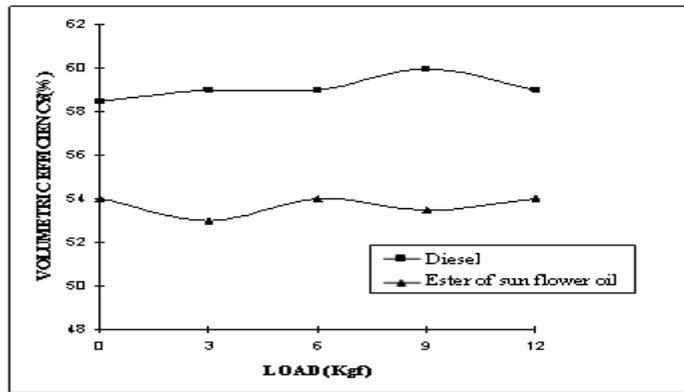


Figure 4. Load versus Volumetric efficiency

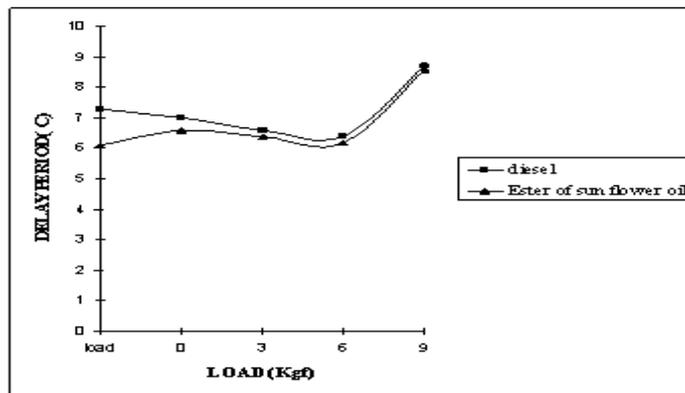


Figure 5. Load versus Delay period

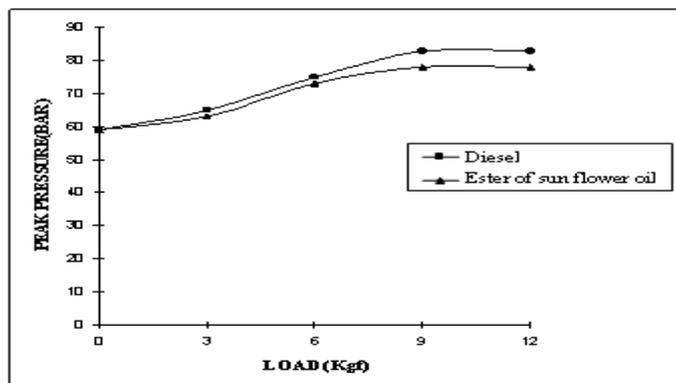


Figure 6. Load versus Peak pressure

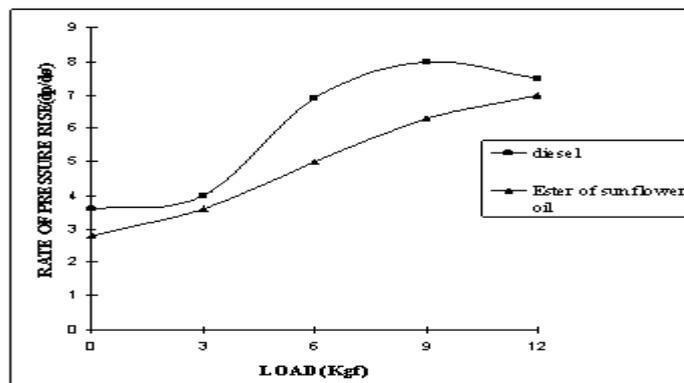


Figure 7. Load versus Rate of pressure rise

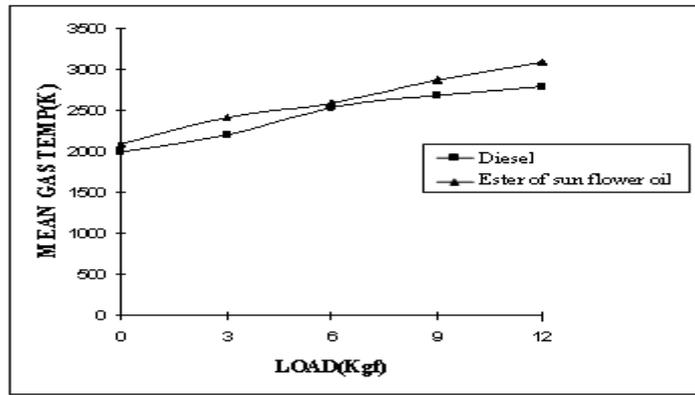


Figure 8. Load versus Mean gas temperature



## The Effect of *BACILLUS SUBTILIS SY1* and *PSEUDOMONAS FLURESCENS W1* in the Ecological Remediation of the Soil

Xin Liu (Corresponding author)

School of Chemical Engineering, Tianjin University of Science and Technology

Mailbox 526 Tianjin University of Science and Technology

1038 Dagunan Road, Hexi district, Tianjin, 300222, China

Tel: 50-6-453-3535 E-mail: v089i@unb.ca

Jinzhao Pang

School of Chemical Engineering, Tianjin University of Science and Technology

1038 Dagunan Road, Tianjin, 300222, China

Tel: 86-22-6027-3577 E-mail: jzpang@sina.com

Zongzheng Yang

School of Chemical Engineering, Tianjin University of Science and Technology

1038 Dagunan Road, Tianjin, 300222, China

Tel: 86-22-6027-3577 E-mail: yzz3520@hotmail.com

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### Abstract

As years of unreasonable farming practices in agriculture soil damaged seriously. The soil-borne disease and the chemical residue are two serious problems of soil pollution which affect the yield and quality of agricultural products. Ecological remediation of soil is an effective way to resolve these problems and maintain the sustainable development of agriculture. In this paper the agents *Bacillus subtilis SY1* and *Pseudomonas flurescens W1* were used to improve the ecosystem function and reduce the disease occurrence.

**Keywords:** Soil pathogens, Pesticide residue, Ecological remediation, Sustainable development

### 1. Introduction

Due to the excessive use and misuse of chemical pesticides, chemical fertilizers and unreasonable farming practices in modern agriculture, many serious soil environmental problems emerge, especially in facility agriculture, such as soil fertility deterioration, organic chlorine pesticide residue and plant fungal pathogens. To overcome these problems, biological remediation has recently been developed and beneficial agents, such as *Bacillus subtilis* (Shinji Mizumoto et al, 2007; Wang J et al, 2007; Marc Ongena et al, 2005), and *Pseudomonas flurescens* (ZHANG et al, 2007; D.C. Naseby et al, 2001, 1998) are widely used.

In the paper *Bacillus subtilis SY1* and *Pseudomonas flurescens W1* were used in the experiments to determine their bioremediation effect in soil. The eggplant planting experiments indicated that *Bacillus subtilis SY1* could improved the function of rhizosphere ecosystems in soil and promote the plant growth and increase stress tolerance. The American ginseng planting experiments showed that the organic chlorine pesticide residue in soil and American ginseng reduced, meanwhile, the functions of rhizosphere ecosystems of soil improved and the growth of American ginseng accelerated accordingly.

### 2. Materials and method

#### 2.1 Microbial agents

The *Bacillus subtilis SY1* used through this work was preserved in the laboratory. The *Pseudomonas flurescens W1* was separated from soil in American ginseng planting base. Four fungi plant pathogens are provided by Vegetable Research Institute, Tianjin Academy of Agriculture Sciences.

## 2.2 Experimental method

### 2.2.1 Eggplant pot experiment

Eggplant seeds were disinfected with 70% ethanol-water ratio solution and then with 0.5% sodium hypochlorite. After rinsing six times with sterile water, the seeds were soaked in the water to pregermination. After three days, eggplant seeds were selected and sown into the pots. The plants were irrigated with water every other day. After 3 and 16 days sowing, 3 mL *Bacillus subtilis SY1* suspension was added as drench to the roots of the plant except the controls (which was only watered with 3 mL sterilized saline).

After 20 days, the growth situation and antioxygen enzyme of eggplant seedling were determined. After 40 days, the species and population of microorganisms in the soil of inoculated and control were determined by spread-plate method.

In vitro antagonistic examination the antifungal activity of *Bacillus subtilis SY1* was tested against the four typical soil-borne pathogen diseases on the PDA media. Spore suspensions with different fungi (5 days old cultures, the concentration was more than 106 cfu / mL) have been prepared in 0.85% sterilized saline. The melted solid wateragar medium was put on the plates, the sterile stainless steel columns were put on the frozen solid agar. When the melted semisolid PDA media cooled to 40-50°C, 1 mL of spore suspensions of each fungus was put in and well-mixed with PDA media. The mixture was then put onto the wateragar medium plates using transfer pipet. When the agar was frozen solid, the stainless steel columns were taken away and 50 µL transformation was put into the hole except the controls (put into 50 µL sterilized saline). Every treatment repeated three times. The plates have been incubated at 28±1°C for 7 days to detect the diameter of fungal inhibition around.

### 2.2.2 American ginseng field experiment

The field experiment of inoculated and control were did in the American ginseng planting base. The inoculated and the control were did simultaneously and were both repeated for three times. After disinfecting the ginseng roots were regularly arranged on the land which surface soil was removed in advance. After covering the soil onto ginsengs again 5 mL *Pseudomonas fluorescens W1* suspension was added as drench to the roots of the American ginseng. Three times of inoculation were did in the first three month after sowing. The ginsengs and the soil around their roots were dug out after 12 month to be analyzed.

## 2.3 Analysis method

Chlorophyll content—By means of ethanol extraction

Superoxide dismutase (SOD)—By means of nitroblue tetrazolium photoreduction

Catalase (CAT) —By means of ultraviolet absorption

Peroxidase (POD) —By means of guaiacol method (Wu et al, 2006)

Total saponins —By means of thin layer chromatography

BHC and DDT —By means of gas chromatography/microelectron capture detector (µ-ECD)

## 3. Results and discussion

### 3.1 Eggplant pot experiment

#### 3.1.1 The microecosystem changes in the soil

The species and population of microorganisms in the soil of inoculated and control were determined by spread-plate method (Li et al, 2000) and the statistics were showed in Table 1. From the table we can find that after inoculating the number of Bacterium and Actinomycetes all increased and the Fungi decreased. The rate of Actinomycetes to Fungi of inoculated was 2.7, whereas the control was only 0.49. The higher Actinomycetes / Fungi ratio demonstrate the better soil fertility.

#### 3.1.2 The growth situation and antioxygen enzyme of eggplant seedling

After 20 days' growth, eggplantseedlings selected in random order were dug out and cleaned with sterile water, plant height, dry weigh, chlorophyll content, antioxidant enzyme such as SOD, CAT and POD were determined. The results showed in Table 2.

From Table 2 we could see clearly that the growth of seedling and the antioxidant enzyme activities in the plant all improved after inoculating the *Bacillus subtilis SY1*. The Plant height and the dry weight of the seedling increased 56.61 % and 33.55 % respectively. The improvement of chlorophyll content and antioxidant enzyme activities stands for the increase of plant metabolism and stress tolerance. The chlorophyll content is closely related with photosynthesis which provide energy to the plant. SOD is a common enzyme that exists throughout the animal and plant kingdoms, it could remove the superoxide radical. The activity of CAT has a great impact on plant resistance to cold and disease.

POD is a highly activity enzyme that also common exists in the plant which is close related to the respiration, photosynthesis and degrade reaction of growth hormone.

### 3.1.3 The antifungal effect of *Bacillus subtilis SY1*

The antifungal activity of *Bacillus subtilis SY1* was tested against the four typical soil-borne pathogen diseases *Pythium aphanidermatum*, *Fusarium oxysporum f.sp.lycopersici*, *Botrytis cinerea* Pers and *Alternaria solani* on the PDA media. The diameter of fungal inhibition ring demonstrates the inhibitory activity.

From Table 3 and Fig 1 we can see that *Bacillus subtilis SY1* has antifungal activity to all these four pathogens to a certain extent, especially *Alternaria solani* the diameter of fungal inhibition ring attained 43.6 mm. *Alternaria solani* is the most common and harmful soil-borne pathogen fungi in agriculture which cause decline of plant yield and quality every year. Bioremediation of inoculating beneficial bacteria *Bacillus subtilis SY1* is an effective method to decrease the pathogen fungi amount. The lower quantity and activity of soil-borne pathogen fungi could decrease the disease occurrence so as to guarantee a bumper harvest.

## 3.2 American ginseng field experiment

### 3.2.1 The residue of BHC and DDT in the soil and American ginseng

The separated agent *Pseudomonas fluorescens W1* was expanded cultured and inoculated into the soil of American ginseng planting base. After one year of growth the American ginseng and the soil in the planting base were dug out to be analyzed. American ginsengs selected in random order were dug out and cleaned with sterile water, the BHC and DDT content in them were analysed with gas chromatography/microelectron capture detector. The soil in the American ginseng planting base were collected and analysed with gas chromatography/microelectron capture detector also.

Table 4 showed that the content of BHC and DDT which are two main composition of organic chlorine pesticide in soil decreased 42.50 % and 38.66 % respectively after inoculating of *fluorescens W1* into soil. From table 5 we can see that the content of BHC and DDT in the American ginseng also decreased 26.08 % and 27.87 % accordingly compared with the control. The less pesticide residue is the quality control of Chinese medicinal materials.

### 3.2.2 The growth situation and effective components of American ginseng

The plant height, leaf area and the total saponins of American ginsengs were determined also. The results are showed in Table 6. Fig 2 is a photo of the inoculated and the control American ginsengs.

From Table 6 we can see that the improvement of the soil after inoculating *Pseudomonas fluorescens W1* was significantly. The leaf area, plant height and the emergence rate of American ginseng all increased. The detection of total saponins showed that the effective components in the American ginseng increased 18.96 %. In Fig 2 we can also found the number of ginseng fibrous roots of inoculated, which plays an important role on nutrient uptake, were significantly more than the control.

## 4. Conclusions

This two beneficial agents *Bacillus subtilis SY1* and *Pseudomonas fluorescens W1* used in this experiment improved soil physical and chemical properties and fertility, promote soil nutrient sound cycle and accelerate the plant growth.

In the eggplant planting experiment the *Bacillus subtilis SY1* has great antifungal effect on pathogens and the growth and stress resistance of the seedlings in the inoculated soil increased. After inoculating, the plant height, dry weight and chlorophyll content increased 56.61 %, 33.55 % and 40.1 % respectively. The antioxidant enzymes SOD, CAT and POD improved significantly of 103.2 %, 127.3% and 81.5 %.

In the American ginseng planting experiment the content of BHC and DDT in the plant and soil decreased 26.08 %, 27.87 %, 42.50 % and 38.66 % after inoculating with the *Pseudomonas fluorescens W1* in soil. Meanwhile, in inoculated soil the American ginseng grow better and the total saponins in the American ginseng increased 18.96 % accordingly.

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Table 1. Species and population of microorganisms in inoculated and control soil

Treatment	Bacterium ( $\times 10^7$ cfu·g <sup>-1</sup> )	Actinomycetes ( $\times 10^6$ cfu·g <sup>-1</sup> )	Fungi ( $\times 10^3$ cfu·g <sup>-1</sup> )	Actinomycetes / Fungi
Inoculated	62.8	24.8	9.2	2.7
Control	47.6	11.6	23.6	0.49

Table 2. The growth situation and antioxidant enzyme activities of eggplant seedling after 20 days

Treatment	Plant height (cm)	Dry weight (mg)	Chlorophyll Content (mg·L <sup>-1</sup> )	SOD (U·g <sup>-1</sup> )(FW)	CAT (U·g <sup>-1</sup> )(FW)	POD (U·g <sup>-1</sup> )(FW)
Control	7.912±0.169	4.717±0.173	0.536±0.134	86.210±0.210	21.075±0.208	35.883±0.100
Inoculated	12.390±0.103	6.300±0.009	0.751±0.125	175.150±0.195	47.906±0.106	65.122±0.251
Increasing rate (%)	56.61	33.55	40.1	103.2	127.3	81.5

Table 3. Inhibitory activities of *Bacillus subtilis* SY1 to four typical pathogens

	Pathogenic bacteria	Diameter of fungal inhibition ring (mm)
A	<i>Pythium aphanidermatum</i>	22.4
B	<i>Fusarium oxysporum f.sp.lycopersici</i>	20.2
C	<i>Botrytis cinerea</i> Pers.	16.5
D	<i>Alternaria solani</i> (Ell.et Mart.)	33.6

Table 4. The pesticide residue decreasing effect of BHC and DDT in soil

BHC in soil			DDT in soil		
Control (mg/kg)	Inoculated (mg/kg)	Degradation rate (%)	Control (mg/kg)	Inoculated (mg/kg)	Degradation rate (%)
6.204±0.150	3.567±0.143	42.50	11.946±0.109	7.328±0.055	38.66

Table 5. The pesticide residue decreasing effect of BHC and DDT in American ginseng

BHC in American ginseng			DDT in American ginseng		
Control (mg/kg)	Inoculated (mg/kg)	Degradation rate (%)	Control (mg/kg)	Inoculated (mg/kg)	Degradation rate (%)
47.439±0.177	35.065±0.124	26.08	60.915±0.122	43.937±0.054	27.87

Table 6. the growth situation and total saponins of the American ginseng

Treatment	Leaf area(g)	Pant height(mm)	Emergence rate	Total saponins(mg)
Control	61.060±0.357	12.300±0.142	71.385%	5.8%
Inoculated	62.735±0.108	12.526±0.189	77.586%	6.9%
Increasing rate (%)	2.67	1.6	8.5	18.96

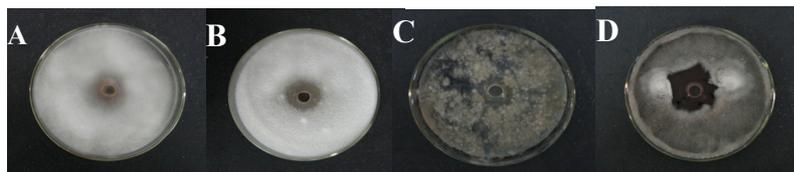


Figure 1. Inhibitory activities figures of *Bacillus subtilis SY1* to four typical pathogens

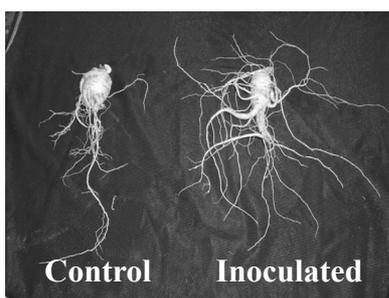


Figure 2. The photo of American ginseng



## A Contingent Valuation Study of Marine Parks Ecotourism: The Case of Pulau Payar and Pulau Redang in Malaysia

Mohd Rusli Yacob (Corresponding Author)

Department of Hospitality and Recreation, Faculty of Economics and Management

Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

Tel: 60-3-8946-7709 E-mail: mroy@econ.upm.edu.my

Alias Radam

Department of Management and Marketing, Faculty of Economics and Management

Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

Tel: 60-3-8946-7775 E-mail: alias@econ.upm.edu.my

Ahmad Shuib

Department of Economics, Faculty of Economics and Business, Universiti Malaysia Sarawak

Kota Samarahan, Sarawak, Malaysia

Tel: 82-58-2428 E-mail: sahmada@feb.unimas.edu.my

### Abstract

The present paper has applied dichotomous choice survey design-contingent valuation method (CVM) to investigate empirically the willingness to pay (WTP) of the visitors for ecotourism resources in two selected marine parks in Peninsular Malaysia. Hence, the purpose of this research is to estimate the value of ecotourism resources by using environmental economic tools which focuses on contingent valuation method of WTP. It uses Logit and Probit models to estimate the visitor's WTP responses for conservation the marine parks for ecotourism. The studies are based on a sample of 215 respondents in Pulau Redang and 153 respondents in Pulau Payar that were randomly interviewed for data collection for both islands in April-July 2007. The results in Pulau Redang indicate that visitors are willing to pay for conservation about RM7.8 and RM10.6 per year for local and international visitors. Meanwhile, in Pulau Payar, the result has shown that local and international visitors are willing to pay about RM7.30 and RM8 respectively. The findings may provide guideline to marine parks and to help develop management policies that enhance ecotourism contribution to sustainable development and conservation in marine parks in Malaysia.

**Keywords:** Contingent valuation method, Marine park, Ecotourism, Conservation, Willingness to pay, Pulau Payar, Pulau Redang

### 1. Introduction

Apart from the objectives related to the conservation of biodiversity, the establishment of marine parks tends naturally to have a positive effect on the enjoyment and appreciation of natural resources by the public. Marine parks encourage the development of tourism and ecotourism. These benefits can be observed in the contribution to income at national or state level due to the arrival of tourists, the generation of direct and indirect employment, and an increase in social and cultural development (Mohd Rusli et al., 2007). Marine parks are often suitable as recreational areas or picnic sites as a result of their inherent beauty. The coral reefs, fish, mangroves, coastal vegetation, beautiful beaches and clear blue waters, together with the peaceful and harmonious condition of the islands, combine to offer an area for human enjoyment. This combination is the main attraction to tourists, and might be of particular benefit to those who live in urban areas.

The current management practice for an entrance fee system in marine parks is called "Conservation Fee". Since January 1999, a conservation fee has been imposed on visitors to marine parks. The conservation fee charged for adults is RM5.00 (US\$1.32) per person and half price for students, retirees and children. No price differential is made between domestic and international visitors. However, this charge does not include the domestic residents living inside the marine parks. The money from the entrance fee is put into a Marine Park Trust Fund, which is managed under the Department of Marine Parks, and used for maintenance, management and building infrastructure in marine parks.

The establishment of marine parks as protected areas in the country aims at protecting special biological and environment values. However, because of open access to marine park resources and failure of the market system in restricting their use, over-use and environmental degradation have resulted. The degradation of marine parks might affect the sustainability of ecotourism in future. In addition, the market failure is associated with users not paying the full costs of using the natural resources in the marine parks. Thus it is possible that the park may be subject to excessive use, overcrowding and biological degradation. The high level of usage may result in conflicts between users, the social and biological carrying capacity, limits of acceptable change and potential environmental degradation.

Conflicts between ecotourism uses and conservation needs arise when nature-based tourism industries rely on access and use of the resources in the protected areas. Marine parks as ecotourism sites (protected area) have considerable economic importance to the tourism industry and to local fisheries communities. The marine parks' ecotourism activities such as scuba-diving, snorkeling etc., may have potential negative effects on their ecotourism resources. Besides, beyond certain use levels, human contact with the natural resources reduces the quality of the recreational experience that can be derived from the resources.

Sustainable development of the tourism and ecotourism resources implies taking courses of action that do not jeopardize the long-term stability of the ecological systems or the survival of the key features of the cultural landscapes and marine habitat. To ensure sustainable development for the future of the ecotourism destinations in marine parks, the management approach must take into consideration the ecological, economic, social, and cultural parameters. Thus, the ecotourism development must prepare to balance the needs and preferences of visitors, contribute benefits to local people and at the same time sustain the role of conservation of marine biodiversity.

In this respect, the purpose of this research is to estimate the value of ecotourism development in marine parks in Malaysia by using environmental economic tools, a dichotomous choice CVM. The remainder of the paper is organized as follows. Section 2 describes the location of study sites, Pulau Redang and Pulau Payar Marine Parks. The third section describes the application of CVM. The fourth section outlines the methodology used, including the survey design and estimated model. The fifth section provides a discussion of the study results and the final section concludes with the summary and policy implications.

## **2. Location of the Study Site**

### *2.1 Pulau Redang Marine Park (PRMP)*

The Pulau Redang Marine Park (PRMP) is located in the north-eastern corner of Peninsular Malaysia, off Terengganu's coastline. They consist of 11 islands with a fast-growing popularity for tourism and ecotourism. The PRMPs can be further sub-divided into five groups, all of which have been declared as marine parks. These groups are known as Pulau Redang Marine Park (PRMP), Perhentian Island Marine Park (PPMP), Lang Tengah Island Marine Park (LTIMP), Kapas Island Marine Park (KIMP) and Tenggol Island Marine Park (TIMP).

The establishment of PRMP has helped to sustain the marine environment for its use as an ecotourism destination, besides providing an excellent opportunity for visitors to appreciate the beauty of coral, marine life and nature. The existence of the marine park centre at Pinang Island in PRMP gives an opportunity for those who visit the centre to gather relevant information about what is available to see and do within the park. They also gain the knowledge and information required to understand and observe the rules and regulations governing the park. The educational programmes also are conducted to create awareness about the protection and conservation of marine resources and their habitats. Most of the programmes involve government agencies, students, and local people continuously throughout the year to educate people about the marine park.

Nowadays, PRMP itself is becoming an increasingly important ecotourism destination in Malaysia. For example, whilst in 1995 PRMP was visited about 22,725 visitors has increased on a yearly basis, and in 2005 it received more than 123,000 visitors (Table 1). This overwhelming increase in visitor numbers now poses a serious challenge to the Parks Management, who must cater for the needs of the tourists whilst ensuring that economic concerns, environmental awareness, marine ecosystem protection and conservation are maintained, (Mohd Rusli et al., 2008).

Insert Table 1 about here

### *2.2 Pulau Payar Marine Park (PPMP)*

The Pulau Payar Marine Park is situated off Kedah, between Pulau Langkawi and Penang. The marine park consists of a group of four islands i.e. Pulau Payar, Pulau Kaca, Pulau Lembu and Pulau Segantang. Pulau Payar is the largest of the islands with an approximate length of 1.75 km (Aikanathan and Wong, 1994). The Island is made of predominantly rock and characterised by steep cliffs and wave-cut gullies. Pulau Payar has limited strips of beach coast. Only four sandy beaches can be found in Pulau Payar with approximately 100 m to 150 m long each. The entire island is covered by dense vegetation.

The Pulau Payar group of islands constitutes one of the few coral reef areas found off the west coast of Peninsular

Malaysia. The type of coral reefs in Pulau Payar Marine Park is fringing reef. The coral fringes off the islands are shelter to a vast diversity of marine flora and fauna. Major coral genera include Acropora, Octocorals, Porites, Platygyra, Goniopora, Sponges, Corallimorph, Diploastrea and Plerogyra (Aikanathan and Wong, 1994; Harborne et al., 2000). Fish observed underwater include barracuda, giant grouper, rabbit fish, triggerfish, damsel fish and sharks (Harborne et al., 2000).

The Pulau Payar Marine Park Centre was open to public in 1989, with restriction as fisheries prohibited area. This island was gazetted as marine park in 1994. The gazettement of this island as a marine park is the first step to conserve marine resources from future impact of tourism on the island itself. Nowadays PPMP is receiving pressure from influx of visitors. The total number of visitors to PPMP has been increased in every year (Table 2).

Insert Table 2 about here

### **3. The Application of Contingent Valuation Method**

The development of environmental valuation in Malaysia is very slow compared to other developing countries in Asia, Latin America and Africa. It began in the late 1980s and early 90s; Kumari (1995) provides some estimates about the medicinal plants from Malaysian forests; Mohd Shahwahid and Awang Noor (1999) estimates the non-timber value of Rattan from forests. The earlier stage uses of environmental valuation in Malaysia focus on the valuation of non-timber forest products. These products can be classified into two main categories, namely goods and services. Examples of goods include rattan, bamboo, medicinal plants and wildlife. Services refer to soil protection, carbon sequestration, biodiversity conservation and recreational opportunities.

Nowadays, the development of environmental valuation in Malaysia has been rapid and it is increasingly used. Furthermore, supported by academic interests and financial support, the environmental valuation methods in Malaysia are increasingly used, not only focusing on forest and recreational benefits but also on other sectors such as waste management (Jamal, 2002) and wetland benefits (Jamal and Redzuan, 1998; Alias et al., 2008). Methodological approaches for estimating the monetary value of environmental resources, including ecotourism sites, can be broadly classified into two main value elicitation groups; non-market stated preference methods and market based revealed preference methods. The revealed preference approach has the advantage of being based on the actual choices made by individuals. However, the valuation is conditional on current and previous levels of the non-market good and the impossibility of measuring non-use values. Thus, research in the area of valuation of non-market goods has seen an increased interest in another branch, the stated preference method.

Stated preference method assesses the value of non-market goods by using individual stated behaviour in a hypothetical setting. The methods include choice modeling and contingent valuation methods. In most applications, CVM has been the most commonly used approach, directly asking respondents' whether or not they would be willing to pay a certain amount of money for realizing the level of the non-market good described (Bateman and Willis, 1999).

CVM is widely used all over the world in areas of economics such as in health economics (O'Shea et al., 2008; Borghi and Jan, 2008), cultural economics (Kim et al., 2007), and transportation safety and economics (Md Nor and Mohd Yusoff, 2003) as well as in environmental economics. It is a simple, straightforward and flexible method, which has recently been widely used in environmental valuation. This method has been used intensively in environmental economics, especially for non-market valuation techniques for the last 30 years.

CVM is an approach developed by economists to value non-marketed public goods and particularly to estimate the value of improvements or damage to environmental amenities (Garrod and Willis, 1992). In contrast to private goods, public goods are not traded directly in any market and thus do not command a market price. Furthermore, the absence of markets means that the quantity desired by consumers or their preferences cannot be directly observed.

Historically, the CVM was originally proposed by Ciriacy-Wantrup (1947) who was of the opinion that analyzing the benefits of measures to prevent soil erosion generates some extra market benefits that are public goods in nature, and one possible way of estimating these benefits is to elicit the individual's willingness to pay for these benefits through a survey method (Hanemann, 1994). However, Davis (1963) was the first to use the CV method empirically when he estimated the benefits of goose hunting through a survey among the goose hunters. Afterwards, this method gained popularity and has been used around the world, including in developing countries like Malaysia. The strength and advantage of this method is its capability for estimating the use and non-use value of environmental economics. In addition, in an environmental economics valuation, CVM is the only method which can capture non-use value.

In Malaysia cases, the earliest used CVM was by Nik Mustapha (1993); valuing outdoor recreational resources in urban parks; Willis et al., (1996) studies on Forest Recreation Amenities services; Jamal and Redzuan (1998) and Alias et al., (2008) studies on wetland benefits; Dayang Affizah et al., (2007) and Zaiton (2008) conservation benefits in National Parks; Puan Chong et al., (2005) on recreational benefits in Highland Forest. However, most of them studied the economic value of recreational benefits based on forest resources except Yeo (2004) in their studies of Marine Parks. Thus, the application of CVM in this study was introduced and through this initiative, produces a great contribution in

terms of variety in methodological approaches; payment vehicles and elicitation format used. In addition, lack of research conducted in marine parks environment perhaps will contribute to empirical knowledge in terms of variety of values, which is good in validity and reliability of the results for the policy purposes in future.

Nik Mustapha (1993) was carried out at Tasik Perdana recreational area in Kuala Lumpur using the dichotomous choice contingent valuation method incorporating the logit and probit models. The mean willingness-to-pay ranged from RM84 to RM106 from both models while the median WTP ranged from –RM109 to RM36. Median WTP measures was argued to be more robust than the mean WTP, and in this study he concluded that the median WTP figure for the outdoor recreational resources in Tasik Perdana recreational resources in Tasik Perdana was about RM36.

Alias et al., (2002) conducted a study of willingness of Local Tourists to Pay for Conservation of Tourism Sports in the Damai District Sarawak. The study applied the dichotomous choice of Contingent Valuation Method (CVM) to visitors sampled randomly. Results using the logit model indicated a per person median value of RM11.64 WTP for the preservation of Damai.

Alias and Ruhana (2003) apply the dichotomous choice CVM to the outdoor-recreational resources of the Malaysian Agricultural Park, Bukit Cahaya Sri Alam, Selangor. The WTP figure derived from the model shows that visitors are willing to pay higher fees than the present fees charged. Jamal and Shahariah (2003) applied the Dichotomous-Choice Contingent Valuation Method on Paya Indah wetlands in Kuala Langat, Selangor to estimate the non-marketed benefits of conserving the wetland from the perspective of non-users, in particular among urban households in Selangor. Results indicate that the mean willingness to pay (equivalent surplus), which reflects the non-use values of Paya Indah wetlands, accrued to urban non-user households in Selangor ranges from RM28 – RM31 annually. From all studies mentioned above, it is revealed that the large sum of monetary value that visitors are willing to pay indicates that the magnitude of social benefits that society obtains from conserving nature is highly valued by the general public.

#### **4. Methodology**

##### *4.1 CVM Theoretical Framework*

This study attempts to measure conservation benefits from visitors perspective (use values). The contingent valuation method (CV) is used to derive willingness to pay (WTP) of users in PRMP and PPMP for conservation of marine ecotourism resources. From this value, the aggregate monetary benefits of conserving marine parks are estimated. In estimating this value, the CV with close-ended WTP elicitation format was employed.

Contingent valuation is defined as ‘any approach to valuation of a commodity that relies upon individual responses to contingent circumstances posited in an artificially structured market’ (Seller et. al., 1985). In the studies for marine parks, individuals were asked directly to reveal how much they were willing to pay to avoid some assumed levels of decline in the provision of a group of services representing a certain quality of marine parks resources as a marine ecotourism destination.

The theoretical basis of CV used in this study is the equivalent surplus (ES) measure of welfare, which measures the amount a person is willing to pay or accept to place him on a better utility or welfare level if changes in quality of goods in question do not occur.

##### *4.2 Questionnaire Design*

The survey questionnaire is a survey instrument that sets out a number of questions to elicit the monetary value of a change in a non-market good. Hence, it should be designed to get respondents to think seriously about the topic of interest, to provide the necessary information for them to be able to make informed decision and to encourage them to identify and reveal their monetary valuations.

Contingent valuation method (CVM) uses survey question to elicit the society’s preference for public goods by creating a hypothetical market. CVM questionnaires can be designed to elicit willingness to pay (WTP) or willingness to accept (WTA) estimates for a change in the level of provision of a public good. Eventually, the decision to use WTP or WTA depends on the property rights of the good. However, WTA estimates are often biased upwards; therefore most of CV studies are designed to elicit WTP estimates (Mitchell and Carson, 1989).

Questionnaire for this research has been designed to gather primary information such as socio demographic profile, attitude, and visitors’ willingness to pay for ecotourism resources in marine parks. The questionnaires consist of structure question that divided into two forms: dichotomous choice and multiple categories question. Generally, the questionnaire will divided into four categories; (a) characteristic of visitors and society, (b) attitude of visitors in relation to sustainability of ecotourism resources, (c) visitor’s perception about ecotourism resources, and (d) willingness to pay of visitor for marine parks conservation fee (bid price presented).

A dichotomous choice question offers just two answer choice, yes or no. Meanwhile, the multiple categories question has more than two answers. Dichotomous choice is a single, “take it or leave it (TIOLI)” bid offer presented to each respondent. This technique is simple and inexpensive to administer by mail. However, the information derived from

the responses must be transformed into WTP or WTA estimates based upon a utility theoretic method which predicts the probability of a yes response.

For the purpose of this study, primary data from 153 visitors were collected in PPMP and 215 visitors in PRMP through interviews by mean of questionnaires. Information on socio-economic characteristics of respondents obtained included race, place of origin, age, marital status, education, size of family members, occupation, and monthly and supplementary gross income. The personal interviews were conducted on visitors at both marine parks by filling the questionnaires at the chosen location. Each of the respondents was told regarding the details on the purpose of preservation of island, facilities available and format used in Contingent Value techniques. Respondents were asked the following question and required to respond either 'Yes' or 'No':

'If the conservation fees are increased by RM x, would you willing to pay so that you could continue to use this ecotourism site?'

Where x ranged from RM6 to RM10, representing a 'reasonable' additional amount of conservation fee to many privately managed marine parks in Malaysia.

#### 4.3 Willingness to Pay Estimation

Following recommendations from environmental literature (Arrow et al., 1993), the closed-ended (CE) WTP approach to estimate the benefits from the conservation and preservation the marine parks was used. The Visitors were asked as whether they would pay specific additional fees amount for a given commodity, with possible responses being "YES" and "NO". The bid amount is varied across respondents and the only information obtained from each individual is whether his/her maximum WTP is above or below the bid offered.

Logistic regression technique was used to estimate WTP (Hanemann, 1994). Using this approach the probability of saying "YES" to a bid at different level of the independent variable is estimated as

$$P = (1 - e^{-x})^{-1} \quad (1)$$

Here, x is the "bid amount" (price), and P is the probability of accepting the price. Mean WTP is estimated as the area under this probability function. This area shows the proportion of the population who would consume the good at each price level, and their associated utility. The area under the curve is estimated by integration techniques and can be expressed as;

$$E(WTP) = \int_L^U (1 + e^{a + bPRICE})^{-1} dPRICE \quad (2)$$

where  $(1 + e^{a + bPRICE})^{-1}$ , are the probability of saying "YES" and U and L the upper and lower limits of the integration respectively.

Estimating mean WTP within this framework relies on making some assumption about upper and lower limits of the integral, i.e. knowing the price amounts at which probability saying "NO" is zero and probability saying "YES" is one. Applying this to marine parks, and assuming that individuals will not pay if they receive a disutility from it, negative WTP can be ruled out and zero is used as the lower limit. Bishop and Heberlein (1979) and Sellar *et al.* (1986) used the upper range for the integration of their price amounts as the upper limit for the integration. Hanemann (1994) argued that such an approach makes a certain assumption about the probability distribution for the unknown WTP in the sample. He argued that the upper limit should be infinity and that using the highest offered amount may be a poor approximation of the mean utility estimated when integrating between zero and infinity. In this study, zero was chosen as the lower limit of the integral and the maximum value as the upper limit. Confidence interval of WTP also calculated using the variance-covariance matrix and a technique adopted for dichotomous CVM by Park *et al.* (1991).

The ability to seek willingness to pay is represented by the dichotomous variable of WTP with values of 1 for those willing to pay the additional amount of conservation fee and 0 is otherwise. An OLS regression of the above relationship with WTP as the dummy variable is beset by several problems namely: (1) non-normality of the error term, (2) heteroscedasticity, and (3) the possibility of the estimated probabilities lying outside the 0-1 boundary (Gujarati, 1988). Since the dummy WTP is actually a proxy of the actual propensity or ability of willingness to pay, the probit and logit models guarantee that the estimated probabilities lie in the 0-1 range and that there are nonlinearly related to the explanatory variables. The differences between these two approaches are mainly in the distribution of the regression error terms. The logit approach assumes that the cumulative distribution of the error term is logistic while probit assumes that is normal.

## 5. Results

### 5.1 Sample Characteristics

The socio-economic characteristics of respondents for both islands are shown in Table 3. The trends of sample demographic for these areas are similar. Majority of the respondents were in their mid-twenties to mid-thirties, college and university graduates and work with private sectors. However, majority of respondent's income levels for PRMP was higher than income level in PPMP. People in this age category with this level of education attainment and higher in income level are likely to be aware of conservation and environmental issues. However, with demographic variables, there seems to be no consensus on the economic literatures as to the sign and important of income on conservation and environmental concern.

Insert Table 3 about here

### 5.2 Contingent Valuation Method Estimates

Table 4 shows only PRICE, INCOME and LOCAL TOURIST among demographic variables had significant impact on WTP for conservation of marine ecotourism in Redang Island Marine Park. Meanwhile, in Pualau Payar marine Park, PRICE and INCOME variables only had significant. Other socio-demographics variables such as age, gender, employment, educational levels are not significant for both models. However, in this case, both results show consistent with findings in the economic literature where the influence of these variables on WTP environmental services is not conclusive.

Insert Table 4 about here

Income is a significant variable and positive relationship in the analysis for both models (logit and probit) for PRMP and PPMP which consistent with some of previous studies in marine parks. Normally, high-income respondents put a premium on environmental conservation compared with their lower income.

Table 5 shows the results of estimating of mean WTP for PRMP and PPMP. Estimating the logit model at the sample mean predicted respondent WTP value equal RM7.84 for local tourist and RM10.63 for international tourist for PRMP. It is worth noting that the mean WTP value quoted by local respondent below the mean WTP value international respondents. This disparity in WTP given the higher income of foreign tourist and their better ability to pay compared domestic tourists in PRMP.

Insert Table 5 about here

However, estimated respondent mean WTP for PPMP much lower than PRMP (Table 5). The respondent mean WTP was RM7.26 for local tourist and RM7.96 for international tourists. Estimating the mean value for this island had not much different among local and international tourists. The relatively lower estimated in this study could be due to a number of factors. First, there does not appear to be any significant difference between domestic and international tourists although the latter tend to have significantly higher income in profile. Secondly, this small disparity in WTP values among local and international tourists perhaps related to ecotourism resources and recreational activities available in PPMP. Some of the international tourists quoted the lower value on their WTP might be they are unwilling to pay more due to spoiled with un attractive of coral, lack of facilities etc. Infact, they are already spend more of their expenses on package price to visits the island.

To compute the aggregate benefit of conservation in both study sites, we used the estimated WTP from Table 6. The numbers of parks visitors of 11 years (1995-2005) were used; resulting in a figure of 0.71 mil visitors to PRMP and 1.13 mil visitors to PPMP over the period. By using the mean WTP for logit and probits models, gives the average benefits estimate of RM 0.064 mil per year for PRMP (Table 6) and RM0.103 mil for PPMP (Table 7).

Insert Table 6 & 7 about here

To translate these annual benefits into the total present values of the conservation of ecotourism, we discounted the benefits accruing using an estimate of the sicoal discount rate. A social discount rates is appropriate here because the parks is a public good and should be lower than Malaysia market interest rate. An estimate of 3% of discount rate eas used in this calculation. Using this rate, the estimated present value of conservation benefits in PRMP is estimated to be between RM4.25 mil to RM4.7 mil. Meanwhile, the estimated present value of conservation benefits for PPMP between RM6.2 mil and RM7.0 mil.

## 6. Conclusion and Policy Implications

The aim of this study was to estimate the WTP for conservation benefits and economic benefits of ecotourism in PRMP and PPMP. Given concerns about increasing coral reef damage in marine parks and lack of awareness among visitors on marine beauty resources, the results of the study could be useful to park management in setting appropriate conservation fee.

In PRMP, the results indicate that visitors are willing to pay about RM7.80 to RM10.60 per annum for conservation, resulting in total benefits of between RM4.25 mil to RM4.7 mil. Meanwhile in PPMP the visitors are willing to pay about RM7.26 to RM7.95 per annum, resulting in total benefits of between RM6.2 mil and RM7.0 mil, using a social discount rate of 3%.

The estimated conservation fee or entrance fee in this study is very low compared to other related study. A closely related study was that conducted by Yeo (2004) on estimating the recreational benefits of the coral reefs in Pulau Payar Marine Park. She found that the mean WTP for entrance fee was RM16. In her study, the payment card elicitation format used which produced higher estimates of WTP compared to this study. In addition, different environment, quality of site, quality of facilities and services and characteristics of visitors definitely contributed to higher in WTP. All these suggest a higher WTP value for PPMP in previous studied by Yeo (2004) compared to the WTP value derived in this study.

The implication of this study is important as a guideline to assist the park management or decision-makers in terms of welfare measures such as ecotourism and conservation benefits especially considering the importance of our natural resources in order to meet developmental needs and other economic activities. The result of this study may also be incorporated in the economic analysis for determining the viability of conserving the marine ecosystem in the long run. Furthermore, the estimated benefits obtained from this study (source) may be transferred to other similar marine parks for the purpose of policy or management decisions affecting the target resource.

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Table 1. Number of Visitors to Pulau Redang Marine Park

Year	Domestic		International		Total
	Visitors	%	Visitors	%	
1995	18,690	82.2	4,035	17.8	22,725
1996	26,988	77.7	7,755	22.3	34,743
1997	30,258	83.6	5,940	16.4	36,198
1998	26,922	78.1	7,544	21.9	34,466
1999	39,449	83.9	7,559	16.1	47,008
2000	43,390	82.4	9,244	17.6	52,634
2001	65,539	89.1	8,041	10.9	73,580
2002	56,263	88.2	7,563	11.8	63,826
2003	71,654	94.0	4,565	6.0	76,219
2004	111,225	78.1	31,251	21.9	142,476
2005	98,863	80.3	24,296	19.7	123,159

Source: Department of Marine Parks

Table 2. Number of visitors to Pulau Payar Marine Park

Year	Local Visitors	%	International Visitors	%	Total
1995	23,484	33.3	46,935	66.7	70,419
1996	25,254	28.0	65,053	72.0	90,307
1997	23,174	25.4	67,993	74.6	91,167
1998	19,869	22.8	67,423	77.2	87,292
1999	16,557	19.9	66,689	80.1	83,246
2000	19,944	18.7	86,836	81.3	106,780
2001	38,027	29.8	89,514	70.2	127,541
2002	56,269	42.1	77,516	57.9	133,785
2003	44,921	39.0	70,303	61.0	115,224
2004	36,282	26.8	98,990	73.2	135,272
2005	19,607	20.8	74,492	79.2	94,099
2006	26,043	23.1	86,605	76.9	112,648

Source: Marine Park Unit, Kedah.

Table 3. Socioeconomic Profile of Respondents in PRMP and PPMP

	PPMP (n=153)		PRMP (n=215)	
	Freq.	Percent	Freq.	Percent
<b>Gender</b>				
Male	71	46.41	125	58.14
<b>Race</b>				
Malay	17	11.11	94	43.72
Chinese	69	45.10	108	50.23
Indian	7	4.58	2	0.93
Others	60	39.22	11	5.12
<b>Education level</b>				
Primary school	2	1.31	8	3.72
Secondary school	19	12.42	57	26.51
College/institute	42	27.45	51	23.72
University	90	58.82	99	46.05
<b>Marital status</b>				
Single	81	52.94	86	40.00
Married	71	46.41	126	58.60
Widow	1	0.65	3	1.40
<b>Employment status</b>				
Student	9	5.88	13	6.05
Self-employed	23	15.03	24	11.16
Work with government	15	9.80	28	13.02
Work with private sector	104	67.97	131	60.93
Others	2	1.30	19	8.84

<b>Age</b>				
Less than 25 year	37	24.18	3	1.40
26 - 30 year	47	30.72	91	42.33
31 - 35 year	33	21.57	62	28.84
36 - 40 year	14	9.15	32	14.88
41 - 45 year	10	6.54	18	8.37
46 - 50 year	8	5.23	4	1.86
More than 50 year	4	2.61	0	0
<b>Origin of tourist</b>				
Domestic tourist	69	45.10	164	76.28
International tourist	84	54.90	51	23.72
<b>Income level</b>				
Less than RM1000	6	3.92	11	5.12
RM1001 - RM2000	19	12.42	85	39.53
RM2001 - RM3000	30	19.61	43	20.00
RM3001 - RM4000	9	5.88	22	10.23
RM4001 - RM5000	31	20.26	16	7.44
More than RM5000	58	37.91	38	17.67

Table 4. Parameter Estimates for Dichotomous Choice Model for Pulau Redang and Pulau Payar Marine Parks

	<b>Pulau Redang</b>		<b>Pulau Payar</b>	
	<b>Logit Model</b>	<b>Probit Model</b>	<b>Logit Model</b>	<b>Probit Model</b>
Intercept	3.0850 (2.9151)*	1.8914 (2.9974)*	2.702440 (2.1013)	1.649900 (2.1314)
PRICE	-0.2257 (-2.4263)*	-0.1413 (-2.4899)*	-0.303611 (-1.8405)	-0.178748 (-1.7978)
INCOME	0.00019 (2.2759)*	0.00012 (2.3360)*	0.000057 (1.9281)	0.000027 (2.0446)
LOCAL TOURIST	-1.3903 (-2.5852)*	-0.8232 (-2.7265)*	-	-
Log-likelihood	-120.7700	-120.3300	-88.9270	-89.2834
MCFADDEN R-SQUARE	0.1314	0.1346	0.0577	0.0540
% Right Prediction	66.98	66.98	69.28	69.28

Note: Figure in the parentheses is t-ratio

\* Significant at 1% level

Table 5. Estimating of Mean WTP for Pulau Redang and Pulau Payar marine Parks

<b>Model</b>	<b>Visitors Origin</b>	<b>Pulau Redang</b>	<b>Pulau Payar</b>
		<b>WTP (RM)</b>	<b>WTP (RM)</b>
Logit Model	Domestic visitors	7.84	7.26
	International visitors	10.63	7.95
Probit Model	Domestic visitors	7.11	6.73
	International visitors	9.81	6.45

Table 6. Estimated Benefits (RM) of Conservation Pulau Redang based on Logit and Probit Analysis

Year	Number of Visitors		Logistic Model			
			Logit Model		Probit Model	
	Domestic	International	Domestic WTP = 7.8	International WTP = 10.6	Domestic WTP = 7.1	International WTP = 9.8
1995	18,690	4,035	146529.6	42892.1	132885.9	39583.35
1996	26,988	7,755	211585.9	82435.7	191884.7	76076.55
1997	30,258	5,940	237222.7	63142.2	215134.4	58271.4
1998	26,922	7,544	211068.5	80192.7	191415.4	74006.64
1999	39,449	7,559	309280.2	80352.2	280482.4	74153.79
2000	43,390	9,244	340177.6	98263.7	308502.9	90683.64
2001	65,539	8,041	513825.8	85475.8	465982.3	78882.21
2002	56,263	7,563	441101.9	80394.7	400029.9	74193.03
2003	71,654	4,565	561767.4	48526.0	509459.9	44782.65
2004	111,225	31,251	872004.0	332198.1	790809.8	306572.3
2005	98,863	24,296	775085.9	258266.5	702915.9	238343.8

Table 7. Estimated Benefits (RM) of Conservation Pulau Payar based on Logit and Probit Analysis

Year	Number of Visitors		Logistic Model			
			Logit Model		Probit Model	
	Domestic	International	Domestic WTP = 7.26	International WTP = 7.95	Domestic WTP = 6.73	International WTP = 6.45
1995	46,935	23,484	70,419	186,698	315,873	151,472
1996	65,053	25,254	90,307	200,769	437,807	162,888
1997	67,993	23,174	91,167	184,233	457,593	149,472
1998	67,423	19,869	87,292	157,959	453,757	128,155
1999	66,689	16,557	83,246	131,628	448,817	106,793
2000	86,836	19,944	106,780	158,555	584,406	128,639
2001	89,514	38,027	127,541	302,315	602,429	245,274
2002	77,516	56,269	133,785	447,339	521,683	362,935
2003	70,303	44,921	115,224	357,122	473,139	289,740
2004	98,990	36,282	135,272	288,442	666,203	234,019
2005	74,492	19,607	94,099	155,876	501,331	126,465



## Study on the Relativity between Airborne Microbes and Environmental Factors in Pearl River Delta' Urban Agglomeration, Guangdong

Zhiqing Zheng

School of Geographical Sciences, Guangzhou University, Guangzhou 510006, China

E-mail: zhiqingzheng@hotmail.com

Xiaobao Xie, Yousheng Ouyang, Chunhua Wang, Haiyan Zeng & Yiben Chen

Guangdong Institute of microbiology, Guangzhou 510070, China

Taotao Chen

College of Continuing Education South China University of Technology, Guangzhou 510640, China

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### Abstract

In this paper, according to the fieldwork and statistic analysis, the issues for the relativity between airborne microbes and environmental factors in Pearl River delta' Urban Agglomeration, Guangdong are discussed using ecological method in order to research on health prevention and environment control measures in Pearl River delta' Urban.

The results show that as follow:(1) The average content of airborne microbes (fungi and bacteria) in Guangzhou and Dongguan is higher than other 6 cities in Pearl River delta' Urban; the content of bacteria is higher than fungi; outdoor content is higher than indoor content; the average content of airborne microbe in the area without greenbelt is higher than the area with greenbelt; the average content of airborne microbe are higher during spring and summer than other seasons.

(2) There are obvious relativity between the average content of airborne microbes (fungi and bacteria) and environment factors (wind speed, humidity, temperature, total suspended particulate (Tsp); Furthermore, most of those have positive or negative linear relationship.

(3) There are also obvious relativity between the average content of airborne microbes (fungi and bacteria) and the number of person flowrate, car flowrate and condition of afforestation, population density.

**Keywords:** Pearl River delta'Urban Agglomeration, Airborne microbes, Environmental factor, Relativity

### 1. Introduction

Atmosphere is the environment which human being relies for existence and the dissemination medium for proliferation of microorganism and diffusion of disease. Particulates of airborne microbes which include bacteria, fungi, virus, actinomycetes and other microorganisms are an important part of air pollution, and there are close relation between produce from microorganism and human activity. Human activity has big influence on City environment, as Human activity rebuilt ground and kinds of facilities. Human and animal' skin and hair can be attached to the small particulates surface of atmospheric Sol. Some airborne microbes can stay through a human skin and bring tremendous damage to human health; even they can also spread via fluxion of air to the farther region and bring human many contagion and disease about upper respiratory tract(Ouyang Yousheng, Xie Xiaobao, 2003). When movement of the atmosphere change, haze will form the particulates of microorganism and non-living meet together. It is possible that it will bring big healthy problem to human and serious second pollutions to the industrial products, such as electronics, the living creature system medicine, food, animal feed and cosmetics...etc, and will also bring bad influence on development of tour industry and dining industry(Wang Chun-hua, Xie Xiao-bao, Zeng Hai-yan, 2007)(J.Nicklin. K.Graeme-Cook, T.Paget & R.Killington). In addition, the content of microorganism in the atmosphere which can reflect the quality of air condition in the city is an important parameter of atmosphere pollution in the city.

Pearl River Delta covers an area of 47525.4km<sup>2</sup> which is about 26.7% of Guangdong province, including 14 cities and districts--Guangzhou, ShenZhen, Zhuhai, FoShan, JiangMen, DongGuan, ZhongShan, Huizhou, Huiyang, Huidong, Boluo, Duanzhou distric and Dinghu distric of Zhaoqing, Gaoyao and Sihui. It has a favourable geographical position which has fine natural and economic environment. With the speeding progress of civilization, the Pearl River Delta became one of the most flourishing regions in economic development. Rapid development of urban agglomeration,

expeditious inflation of population, increase of pollution source from urban agglomeration and locating in south-Asia tropical monsoon area provided a good environment for the reproducing of microorganisms in atmosphere. In recent years, the atmosphere environmental problems in Pearl River Delta become obvious.

The number of haze days in atmosphere year is up to 100 days which is obviously more than in the past. At the same time, virus of SARS and bird-flu strike human beings frequently, which threaten human beings' health and life(Ouyang Yousheng, Xie Xiaobao, 2004)(Ouyang yousheng, xie xiaobao, chen yiben., 2006)(Chen haowen. 1996). Therefore, the problems of the pollution and spread microorganisms in atmosphere, the atmosphere pollution and its protection had become desiderated.

The issues about pollution and distribution of airborne microbes were paid attention by many scholars in recent years, but the issues about the reciprocity between airborne microbes and environment are rarely researched in China, even the research report on the relativity between airborne microbes and environment in Pearl River Delta area is not present. In this paper, according to the fieldwork and statistic analysis, the issues for the relativity between airborne microbes and environmental factor in Pearl River delta Urban, Guangdong are discussed using ecological method in order to research on health prevention and environment control measures in Pearl River delta' Urban.

## 2. Method

### 2.1 Collector

Adopting JWL-IIB Air-Borne Microbial Sampling Apparatus, the samples were collected using principle of inertial impaction, according to air exhausts driving force effect. High-speed airflow comes out as the air goes through slit and eyelet, and make microorganism particulate which suspend in the air to hit the medium and to be collected. Using collected air push the dish revolves, those collected microorganism particulates are distributed equality on medium, in order to rightly measure density of particulates with bacteria in this environment.

### 2.2 Location and timing of sample collection

Air sampling and environmental factors were carried out synchronously in four functional places(key traffic route, commercial pedestrian street, residential district and industrial district) in eight each cities around Pearl River delta' Urban, Guangdong, in four different seasons during 2005 and 2007. The height of sample collected is 1.0 m. The air flux of sample is 20 L/min and testing time is around 2-5 minutes. At the same time of sample collecting, meteorological factors (such as atmosphere temperature, humidity, wind speed and intensity of illumination light) and environment factors (person flowrate, car flowrate and condition of afforestation are monitored and recorded.

### 2.3 Medium of collecting sample and method of culture

The collected bacteria in air culture agar substrate, in  $30 \pm 2$  °C , 24-48 h; the fungi culture PDA agar substrate , in  $25 \pm 2$  °C , 3-5 days; each of them were treated in twice repeat.

### 2.4 Data and statistic analysis

The formula of colony: colony cfu/ m<sup>3</sup>=[ average colony in even utensil (N) × 1000] ÷[the air flowrate(L/min) × collecting time(Min)]

Adopting the Spss software for calculation, the number of airborne microbes fungi and bacteria colony, synchronously observational data of meteorological factors which include temperature, humidity, wind speed, and simultaneous atmosphere monitor data of total suspend particulates(TSP) and inhalable particulates(PM10) were analyzed using correlative analysis, Unary Linear Regression analysis and multiple linear regression analysis. At the same time, the statistic and comparative analysis on colony number of fungi and bacteria of airborne microbes and person flowrate and afforestation condition in collected point were carry out.

## 3. Results and analysis

### 3.1 Condition of atmospheric microorganism colony numbers and the environment factors in observation point

Data statistics indicate: The compositor of density of airborne microbes, in 8 cities are Guangzhou> Dongguan> Zhongshan> Foshan> Huizhou> Shenzhen> Jiangmen> Zhuhai; (See table 1)According to the content of microorganism from each observation point, bacteria is the most in atmospheric microorganism which is 299378 cfu/m<sup>3</sup>, about 78.2% of the airborne microbes, total amount, generally 200-300% of fungi(126113 cfu/m<sup>3</sup>); (See table 1.2) See from the space distribution, compare different function area: transportation junction > industrial district > business district> residential district > green belt, there are the most content of fungi and bacteria in transportation junction.(See table3) The content of fungi and bacteria indoor(1694.76 cfu/m<sup>3</sup>) are more than outdoor's environment(1368.31 cfu/m<sup>3</sup> , ); furthermore the quantity of bacteria is much more; the content in afforestation area is less than that in non-afforestation area and the air quality is much better.(See table2) See from time distribution, compare of total average content of bacteria and fungi: Spring>summer>autumn>winter; average content of fungi: Spring> summer> winter> autumn; average content of bacteria: Spring> autumn> summer> winter.(See table 4)

The main reasons that above mentioned are relative with the variety of development of urbanization, city climate and environmental factors. Guangzhou is center city of Pearl River Delta, whose business economy is flourishing and person flowrate and materials circulation are more concentrated; Development of urbanization in Dongguan was very fast in last 20 years, whose industry is dense and population is more; therefore airborne microbes, content of both cities are higher than others in Pearl River Delta' Urban. Place Pearl River Delta which located in subtropical monsoon climate zones, there are high temperature and humidity in whole year, especially in spring and summer when the big change of temperature and humidity happen frequently, and consequently airborne microbes content in spring and summer are much higher than other two seasons. Northern Hemisphere turn warm in spring and summer, the air pressure descends (1001.3-1003.1 HPA), the temperature rise (21-29 °C) gradually, the degrees of humidity enlargement (69-81%), all of these are very benefic to the increase of fungi and bacteria. In these seasons, the variety of weather is usually vigorous, the wind speed is weak, the air circulate is not good, the city population is concentrated, the exhaust capacity of industry pollution material is great, total suspending particulates and inhalable particulates are increasable (there is respectively 182-239 mg/m<sup>3</sup>, 39.8-63.5 mg/m<sup>3</sup>) in the air, all of these are the reasons that the many content of fungi and bacteria bring about the problem that the air pollution increased. It follows that concentrated population and weak Ventilation are two important factors for the content of airborne microbes in indoor environment; Rapid development of industrialization, concentration of the person flowrate and materials circulation, high air temperature and humidity, condition of afforestation, all of these are influence factors for content of airborne microbes, in outdoors environment, particularly it is obvious in the place which is rapid development of urban industrialization and high person flowrate, in the spring and summer when the weather drastic changes.

### 3.2 Relativity with meteorological factors and atmosphere particulates

#### 3.2.1 Relativity analysis

Relativity analysis of statistical data shows that fungi, bacteria and temperature, humidity are good relativity in the majority cities of the Pearl River Delta' Urban (especially Shenzhen, Huizhou), but there are obvious relativity with wind speed only in individual cities. The relativity coefficient (R) about temperature and fungi, the total number of bacteria in four seasons is between 0.588-0.988, and the relativity coefficient (R) with humidity between 0.660-0.944 (see table 5)

In Guangzhou City, the relativity coefficient about fungi and total number of bacteria with the meteorological factors is between 0.28-0.36, which is general relativity. The relativity coefficient (R) about fungi and total number of bacteria with pressure are respectively 0.605,0.050; The relativity coefficient with sunshine hours are 0.239,0.227; The relativity coefficient with inhalable particulates are 0.525,0.081; with total suspended particulates are 0.388, -0.044, these results show that there is obvious relativity between total numbers of fungi and total pressure, inhalable particulates, however value R is bigger which may be the numerical sampling error.

#### 3.2.2 Unary Linear Regression analysis

According to the content of airborne microbes and meteorological factors is counted as variable, the regression equation was established, and the results show that:

The Unary Linear Regression equation was established base on the relationship between Fungi, bacteria and temperature is counted as variables. There respectively relativity of three seasons is obvious, and two tests (P & T value) indicated that confidence level is high. Unary Linear Regression model as follows:

**Fungi:** autumn  $y = -47.673x + 1649.177$        $p = 0.019$        $T = 0.004$

winter  $Y = 7.468x + 318.515$        $p = 0.483$ ,       $T = 0.133$

summer  $y = 129.102x + (-2922.550)$        $p = 0.440$        $T = 0.607$

**Bacteria:** spring  $y = -114.413x + 4546$        $p = 0.096$        $T = 0.18$

autumn  $y = -37.013x + 2567.420$        $p = 0.521$        $T = 0.196$

summer  $Y = -273.599x + 8786.616$        $p = 0.055$ ,       $T = 0.025$

The Unary Linear Regression equation was established base on the relationship between Fungi, bacteria and humidity is counted as variables. There relativity of three seasons for fungi and four seasons for bacteria are obvious, and confidence level is high. Unary Linear Regression model as follows:

**Fungi:** autumn  $y = -479.170x + 608.646$        $p = 0.480$        $T = 0.100$

winter  $Y = 23.035x + 420.032$        $p = 0.002$        $T = 0.001$

summer  $T = -2580.393x + 2848$        $p = 0.695$        $T = 0.30$

**Bacteria:** spring  $Y = 6033.573x + (-2466.473)$        $p = 0.065$        $T = 0.246$

winter  $Y = 66.145X + 1051.610$        $P = 0.124$        $T = 0.01$

$$\text{summer } y = -646.679x + 1659.634 \quad p = 0.776 \quad T = 0.186$$

$$\text{autumn } Y = -3456.121x + 3189.715 \quad p = 0.46 \quad T = 0.206$$

The once basic linear regression equation was established base on the relationship between Fungi, bacteria and wind speed is counted as variables. There relativity of four seasons for fungi and bacteria are obvious, and confidence level is high. Unary Linear Regression regression model as follows:

**Fungi:** spring  $Y = -201.394 + 1033.444x$   $p = 0.046$   $T = 0.001$

summer  $y = -178.655x + 1559.230$   $p = 0.508$   $T = 0.037$

autumn  $y = 33.046x + 320.220$   $p = 0.412$   $T = 0.001$

winter  $y = -134.023x + 808.465$   $p = 0.287$   $T = 0.001$

**Bacteria:** spring  $y = -2580.393x + 2848$   $p = 0.695$   $T = 0.30$

summer  $y = -97.190x + 1473.108$   $p = 0.392$   $T = 0.001$

autumn  $y = 178.644x + 1171.068$   $p = 0.521$   $T = 0.008$

winter  $y = -1119.140x + 3537.788$   $p = 0.132$   $T = 0.006$

Above Unary Linear Regression regression analysis showed that fungi, bacteria and meteorological factors such as temperature, humidity, wind speed have a significant positive or negative relativity associated linear relationship. Because temperature in summer, high humidity, which are appropriate environmental conditions for the growth of bacteria and fungi, they propagated rapidly, which resulted in increased urban air pollution, and especially there are obvious in the area with high population and heavy traffic. In autumn and winter with the weather of low temperature and dry climate, the growth of fungi and bacteria are affected by climate change, and those resulted in the relatively low content of airborne microbes. Meteorological factors such as temperature, humidity and wind speed are main factors affect on the content of airborne microbes. Temperature or humidity increase, the content of airborne microbes, will increase at the same time. Wind speed is week (0.3-1.0 m/s); the content of airborne microbes, is high, especially in summer and winter.

### 3.2.3 Multiple linear regression analysis

Base on the variable relationship between content of atmospheric fungi, bacteria in the Pearl River Delta' Urban agglomeration and meteorological factors, multiple linear regression equation were established. Statistical analysis shows that the linear relationship between airborne microbes in Pearl River Delta' Urban agglomeration and meteorological factors include temperature, humidity, wind velocity are obviously. Base on the relationship between total number of atmospheric fungi, bacteria and temperature, humidity, wind velocity, the multiple linear regression analysis is higher credibility, especially in spring, autumn and winter.

Base on the variables relationships between content of atmospheric fungi, bacteria from seven cities in the Pearl River Delta' Urban and meteorological factors, the multivariate linear regression equation is established. According to the test, confidence level is high. The multiple linear regression model as follows:

**Fungi:**

spring  $T = -14.542x + (-2085.143)y + (-21.5.416)z + 2879.994$   $p = 0.249$

autumn  $T = -48.687x + (-588.400)y + 3.2652z + 1985.586$   $p = 0.102$

winter  $T = -42.714x + 12.882y + 55.640 + 1583.276$   $p = 0.216$

**Bacteria:** spring  $T = 389.877x + 27800.688y + (-1188.866)z + (-23739.7)$   $p = 0.083$

autumn  $T = -284.34x + (-417.745)y + (-4.389)z + 11298.805$   $p = 0.220$

winter  $T = -263.802x + (-12.260)y + (-218.366)z + 8991.570$   $p = 0.086$

Base on the variables relationships between average content of atmospheric fungi, bacteria at the same day in Guangzhou and daily mean temperature, daily mean humidity, daily mean wind speed, daily mean air pressure, daily sunshine hours, inhalable particulates (PM10) and total suspended particulates (TSP), the multiple linear regression model were established. According to the test, confidence level is high. The multiple linear regression model as follows:

**Fungi:**

$$T = 26.623x + 25.176y + (-0.356)z + 39.682i + 26.563j + 11.122k + (-3.056)l + (-260471)$$

$$P = 0.385 \quad T = 0.132$$

**Bacteria:**

$$T = 196.742x + 165.346y + (-36.846)z + 186.759i + (-690.763)j + (-82.593)k + 71.682l + (-1660282)$$

$$P = 0.078 \quad T = 0.026$$

Guangzhou and the major cities in Pearl River Delta' Urban agglomeration as an example, according to test the absolute value of statistics T (or  $F = T^2$ ) in the condition that regression coefficient is whether zero or not, the importance of each variable are ranked (see Table 6. 7. 8). It showed that changes of wind speed in 7 Pearl River Delta cities in the spring and summer have the greatest impact on the air concentration content of fungi and bacteria. However, the changes of temperature in the autumn and winter have greatest impact on the air concentration content of fungi and bacteria.

The importance of environmental factors in Guangzhou City is ranked as follow: temperature > average pressure > average humidity > total suspended particulates > inhalable particulates > average wind velocity > sunshine hours. the average temperature is an important factors impact on the content of airborne microbes,

### 3.3 Relative with the environmental factors such as population, movement of vehicles and conditions of afforestation

Statistics of survey data (see Table 9) show that: the content of airborne microbes, are much more in the area such as commercial centre with heavy traffic, railway station and coach station. The main reasons for that are high car flowrate and person flowrate. The content of airborne microbes, in ticket lobby of railway station and coach station are obviously more than outside the station. Total average indoor airborne microbes, are 2574cfu/m<sup>3</sup> and the total average number of outdoor airborne microbes, are 1580 cfu/m<sup>3</sup>, the main reasons of those are due to poor indoor air flow, so many people and crowded environment. There are great difference on the content of airborne microbes, between green belt and non green belt area. The content of airborne microbes, in greenbelt areas are less than those in non green belt areas. (See Table 9) Analyze on heavy traffic area, the content of airborne microbes, of railway Station and Terminal Plaza where is non greenbelt is 3258 cfu/m<sup>3</sup>; however, this in the roadways with better greenbelt is 3061 cfu/m<sup>3</sup>, Analyze on the functional areas, the content of airborne microbes, is relatively low which is 4700 cfu/m<sup>3</sup> in Shenzhen Wetland Bay Park area which is near the beach has better environment, better condition of ventilation and less flowrate of person and car. However, the content in the heavy traffic area is 15210 cfu/m<sup>3</sup>, 21340 cfu/m<sup>3</sup>, and the content of airborne microbes, in the commercial area which is 15800 cfu/m<sup>3</sup> is higher than other areas.

## 4. Conclusion and Discussion

Statistics on analysis of monitoring data shows that the content of airborne microbes, is relatively high in Guangzhou and Dongguan of Pearl River Delta' Urban agglomeration, thereinto bacteria is more than fungi and the content of airborne microbes, which are indoor higher than outdoor and non greenbelt areas are more than greenbelt areas, are relatively high in spring and summer.

Mathematical Statistics on the relativity analysis, Unary Linear Regression and multiple linear regression analysis indicates that the atmospheric environmental factors include wind speed, humidity, temperature, total suspended particulates(TSP) are obviously relative with the average content of airborne microbes fungi and bacteria, and most of those are positive or negative linearity relations. Temperature, wind speed is the most important environmental factors on the content of airborne microbes,. Comparative analysis of the statistical data shows that the population flowrate, condition of afforestation are obviously relative with the content of airborne microbes, Prevention and control on atmospheric pollution and microbiological hazards have become main research topics on health and epidemic prevention and control of atmospheric pollution(Ouyang yousheng, xie xiaobao , chen yiben., 2006)(Ren qiwen, wang cheng tun. Guanghua, 2006)(Liyong, 2007). Rapid development of the Pearl River Delta cities, high concentration of the population and quality of living environment, all of these impact directly on the people's health, hygiene and disease control and implementation of environmental improvement, and consequently the future should be further strengthen research in this area.

In spring and autumn, the meteorological factors such as temperature, humidity, pressure and environmental factors change greatly and it is also reproduction season for fungi and bacteria. We should strengthen work on health and epidemic prevention, do well in sanitation of the ground, improve indoor ventilation and illumination, improve urban traffic conditions, control emissions of pollution, do well in virescence and beautifying the environment and strengthen the air disinfection in order to improve the environmental quality of urban agglomeration in the Pearl River Delta' Urban.

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Table 1. The contents of fungi and bacteria in 8 cities in four seasons (cfu/m<sup>3</sup>)

Location	fungi (cfu/m <sup>3</sup> )	Ratio of fungi (%)	Bacteria (cfu/m <sup>3</sup> )	Ratio of Bacteria (%)	Total number of microorganism (cfu/m <sup>3</sup> )
Guangzhou	32176	19.54	132465	80.46	164641
Dongguan	17980	21.18	66928	78.82	84908
Shenzhen	8206	29.53	19583	70.47	27789
foushan	22803	58.33	16290	41.67	39093
Zhuhai	3990	26.97	10803	73.03	14793
Jiangmen	6853	32.01	14553	67.99	21406
Huizhou	7341	24.33	22827	75.67	30168
Zhong shan	26764	62.69	15929	37.31	42693
Total up	126113	32.95	299378	78.21	382798

Table 2. Comparison of average contents of fungi and bacteria in main cities base on space distribution (cfu/m<sup>3</sup>)

Region	Indoor (cfu/m <sup>3</sup> )	Outdoor (cfu/m <sup>3</sup> )	green belt (cfu/m <sup>3</sup> )	non-green belt (cfu/m <sup>3</sup> )
7 cities in Pearl River delta	1694.76	1362.31		
Guangzhou	2574 (bacteria 1950, fungi 624)	1580 (fungi 462 bacteria 1118)	1565	1689
Shenzhen	13760 (fungi 2413, bacteria 11347)	15210 (fungi 1889 bacteria 13321)	4700	21340

Table 3. The contents of fungi and bacteria in function district in 8 cities (cfu/m<sup>3</sup>)

Functional district;	Average content of bacteria	Average content of fungi	Total number of microorganism (cfu/m <sup>3</sup> )
In Traffic	1456.95	726.83	2183.78
Out of traffic	6147.714	6807.464	12955.18
Business centre	1093.296	381.6296	1474.926
Residential district	1271.875	1203.333	2475.208
Industrial district	2164.313	764.1875	2928.5
Green belt	479.875	217.375	697.25
Metro gate	312.75	125.125	437.875
Total	12926.77	10225.94	23152.72

Table 4. Contents of airborne microbes in different season of 8 cities (cfu/m<sup>3</sup>)

Item	Spring	Summer	Autumn	Winter
Fungi	26121	23234	11219	18598
Bacteria	88909	83022	83944	35450
Total	115030	106256	95163	54048

Table 5. The relativity between the meteorological factors (temperature, humidity, wind speed and the season and Airborne microbe, (fungi, bacteria) in main cities

City	Time	temperature & fungi R	temperature & bacteria R	humidity & fungi R	humidity & bacteria R	Wind speed & bacteria R	Wind speed & fungi R
Guangzhou	all year	0.348	0.325	-0.350	-0.362	-0.11	0.28
Shenzhen	Sp	0.606,	0.352	-0.759	-0.638	0.448	0.173
	Su	0.693	-0.731	-0.668	-0.729		
	Au	0.803	-0.729	0.943	0.208	0.200	-0.431
	wi	0.929	-0.464	-0.416	-0.723	-0.718	-0.099
Jiangmen	Sp	0.803,	-0.090	-0.034	0.912		
	Su	0.973	-0.578	0.961	0.5747		
	Au	0.340	-0.812	-0.276	0.679		
	wi	-0.7509	-0.534	-0.373	-0.366		
Hui zhou	Sp	-0.889	-0.862	0.954	0.916		
	Su	0.617	0.047	-0.345	-0.014	-0.309	-0.568
	Au	-0.982	-0.623	0.486	0.987	0.176	0.866
	wi	-0.547	-0.688	-0.337	-0.395		
Zhu hai	Sp	-0.599	-0.234	0.495	0.058		
	Su	-0.549	0.7125	0.624	-0.848		
	Au	0.180	-0.496	-0.063	0.237	0.3999	-0.807
	wi	0.465	0.486	-0.545	-0.988		
Zhong shan	Sp	0.896	-0.642	-0.905	0.753		
	Su	0.297	0.822	-0.064	-0.249		
	Au	-0.939	0.961	-1.900	0.024	-0.2728	0.3486
	wi	-0.834	0.324	0.137	-0.604		
Dong guan	Sp	-0.176	0.767	-0.14419	0.537	-0.367	-0.815
	Su	-0.306	0.010	0.412	0.114	-0.822	-0.628
	Au	-0.694	-0.921	0.718	0.922	0.385	0.0751
	wi	-0.162	-0.333	0.584	0.038	0.962	0.6471
Fo shan	Sp	-0.0940	0.828	-0.050	-0.822		-0.411
	Su	-0.0940	-0.122	-0.050	0.1637	-0.217	-0.411
	Au	-0.0940	-0.094	-0.050	-0.050	-0.411	-0.411
	wi	-0.0940	-0.094	-0.050	-0.050	-0.411	-0.411

Table 6. Rank of importance of each environmental factor for contents of fungi in Guangzhou

Confident level	Average temperature	Average air pressure	average humidity	Average Wind speed	sunshine hours	Total suspended particulates	inhalable particulates
value T	5.219	4.208	-3.322	1.401	-1.395	3.058	-2.332
value F	27.238	17.707	11.036	1.963	1.946	9.351	5.438
rank	1	2	3	6	7	4	5

Table 7. Rank of importance of each environmental factor for contents of bacteria in Guangzhou

Confident level	average temperature	Average air pressure	average humidity	Average Wind speed	sunshine hours	Total suspended particulates	inhalable particulates
value T	2.248	2.037	0.407	0.947	0.043	0.415	0.999
value F	5.054	4.149	0.166	0.897	0.002	0.172	0.998
rank	1	2	6	4	7	5	3

Table 8. Rank of importance of environmental factors in four seasons in 7 cities of Pearl River delta

Fungi	Time	Wind speed	Temperature	Humidity	Bacteria	Wind speed	Temperature	Humidity
value T	spring	-1.772	-0.289	-0.756	value T	-1.446	1.145	1.492
value F		3.314	0.084	0.572	value F	2.091	1.311	2.226
rank		1	3	2		1	3	2
value T	summer	0.682	0.295	0.242	value T	-0.920	0.497	0.352
value F		0.465	0.087	0.059	value F	0.846	0.247	0.124
rank		1	2	3		1	2	3
value T	autumn	0.083	-2.391	0.914	value T	0.016	-1.958	0.910
value F		0.007	5.177	0.835	value F	0.0003	3.834	0.828
rank		3	1	2		3	1	2
value T	winter	0.483	-1.682	1.585	value T	0.262	-1.682	0.209
value F		0.233	2.829	2.512	value F	0.069	2.829	0.044
rank		3	1	2		3	1	2

Table 9. The relationship between average content of airborne microbes, and the environmental factors (condition of afforestation, population flowrate and car flowrate)

Location	Content of airborne microbe, (cfu/m <sup>3</sup> )	Condition of population and car flowrate	Condition of afforestation
Gate of Shenzhen railway station	15210	Many automobile and people	Many building, but lack of afforestation
Shenzhen swamp park	4700	Less automobile and people	Close to sea and open sward
Shenzhen business center	15800	many population flowrate	Dense building and less green belt
Non green belts in Guangzhou and Shenzhen	23029	Many automobile and people	Lack of afforestation
park and green belts in Guangzhou and Shenzhen	6265	Less automobile and people	Good afforestation
Traffic line in Guangzhou and Shenzhen	18679	many automobile and people	Lack of afforestation



## Impacts of Recreation Activities on Growth and Physiological Characteristics of Upper Mountain Vegetation

A.Z. Azita (Corresponding author)

Department of Forest Production, Faculty of Forestry  
Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia  
Tel: 60-3-8946-7585 E-mail: azitazawawi@yahoo.com

A.H. Hazandy

Institute of Tropical Forestry and Forest Products  
Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia  
Tel: 60-3-8946-7585 E-mail: hazandy@putra.upm.edu.my

H. Mohd-Zaki

Department of Forest Production, Faculty of Forestry  
Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia  
Tel: 60-3-8946-7170 E-mail: zakihamzah@yahoo.com

S. Mohd-Nazre

Department of Forest Production, Faculty of Forestry  
Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia  
Tel: 60-3-8946-7196 E-mail: nazre@putra.upm.edu.my

H.Z. Pakhriazad

Department of Forest Management, Faculty of Forestry  
Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia  
Tel: 60-3-8946-7225 E-mail: asato40@yahoo.com

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### Abstract

This study examines the impacts of recreation activities on Mount Tahan (2187 m a.s.l); the highest mountain in Peninsular Malaysia by assessing tree diameter, height, leaf area, sapwood area, and chlorophyll fluorescence (CF) of selected species. Vegetation cover was also determined by counting the number of species. Two most dominant tree species in the study plots, i.e., *Tristaniaopsis fruticosa* and *Baeckea frutescens* were selected as representative to assess the impacts on the vegetation growth. Both tree species dominated over 50% of total vegetation in both areas. Meanwhile, CF was determined on *T. fruticosa* since this species was the only broadleaf species found in both areas. Four plots sized 20 m X 20 m representing each disturbed and undisturbed were established in camping and trampling areas. The total number of plant species recorded was 29 in both camping and trampling areas but was found less in disturbed plots. Impacts of trampling and camping on all the parameters at higher altitude in disturbed plots were significantly different from those in the undisturbed plots. For trampling, all growth parameters taken in disturbed plots were found lower than in undisturbed plots. For camping, however, the mean values of vegetation cover were found

lower in disturbed plots compared to undisturbed plots but the mean values of tree diameter, height, leaf area and sapwood area were found greater in disturbed than in undisturbed plots. In contrast, all CF parameters were found higher in disturbed plots for both trampling and camping areas.

**Keywords:** Recreation activities, Physiological characteristic, Chlorophyll fluorescence, Upper mountain

## 1. Introduction

Recreation ecology is in a sense a redefining of an age-old activity. Doubtless, human moving through the wilderness or bush have always observed the impacts of others who may have gone before them (Liddle, 1997). The impacts of outdoor recreation, including ecotourism, are extensive and increasing; focusing more and more on the world's remaining natural areas. As attitudes to nature in its untamed state changed from fear to admiration, so many people ventured further and more frequently to explore natural areas, climb mountains and generally to create recreation impacts.

Recreational use of wilderness inevitably results in some change to resource conditions. A variety of impacts to soils and vegetation occur at wilderness campsites and other destinations (Cole & Marion, 1988). Large and sometimes ecologically sensitive areas have been developed with facilities to accommodate visitor use and recreationists unintentionally trample vegetation, erode soil, and disturb wildlife. By virtue of their massive numbers, protected area recreationists pose a real and significant threat to the very resource they so cherish. This is particularly true at backcountry attraction sites, campsites, and along trails, where visitation and its effects are concentrated. Specific consequences of visitation to these areas include the trampling and subsequent loss of ground vegetation, shrubs, tree seedlings, and felling of saplings; erosion of surface litter and humus; exposure, erosion, and compaction of mineral soil; and exposure of tree roots and damage to tree trunks.

In this study, we evaluated the impact of camping and trampling activities on vegetation both in the disturbed and undisturbed areas at Mount Tahan. Mount Tahan has important environmental, cultural and economic values which is important not only in its biological richness but more for its other ecological functions. The objective of this study is to quantify the impacts of camping and trampling on growth and physiological attributes of vegetation in upper mountain area both in disturbed and undisturbed areas. The type, magnitude, and, in some instances, the causes of resource deterioration and improvement can be detected and evaluated. Deteriorating conditions can be detected before severe or irreversible impacts occur, allowing time for implementing corrective actions.

## 2. Materials and Methods

### 2.1 Study area

The study was carried out in Mount Tahan (2,187 m a.s.l.), which is the highest point in Peninsular Malaysia located within the Taman Negara (national park), in the state of Pahang with the coordinate of 4°38'N, 102°14'E and with an area of 1,677 square miles (4,343 square km). Mount Tahan is considered as the toughest trek in Southeast Asia. The elevation of the study areas ranged from 1800 m above and topography is hilly with slopes of 50 to 70 degrees. The soils have a high percentage of sandy, loam and rock. There are three ways of climbing this mountain, of which the two most popular ones are from Kuala Tahan and Merapoh. The number of visitors that reached the summit was estimated about 1892 to 2838 from 1996 to 2005.

### 2.2 Experimental design

This study followed a standard experimental procedures for studying recreational trampling of vegetation proposed by Cole and Bayfield (1993). Most studies has derived conclusions by comparing the vegetation of trampled sites with the vegetation of un-trampled sites. The types of vegetation impact that can be described are changes in vegetation cover, chlorophyll fluorescence measurements and growth attributes. i.e vegetation height and leaf area. In this study, four plots sized 20 X 20 representing disturbed and undisturbed were established in each camping (Botak area) and trampling (trekking trail) areas. For undisturbed, plots were located about 20 m away from disturbed plots whether on the left or the right side depending on the topography of the selected areas. All species were counted and identified whereas two species, i.e., *T. fruticosa* and *B. frutescens* were selected for growth and chlorophyll fluorescence measurements as well as for anatomical studies. For each species, 20 individual trees were randomly selected and labeled.

#### 2.2.1 Diameter, height, leaf area, sapwood area and vessel size measurements

Tree growth is an important facet of stand dynamics. Information about growth can be used to determine if there are any unusual spatial or temporal patterns in growth rates; or if the balance between growth and mortality is adequate to sustain a forest ecosystem. Tree growth data contribute to the investigation of several key forest ecosystem attributes such as sustainability, productivity, and aesthetics. Measurements of stem diameter were taken at about 10 cm above the ground using a digital veneer caliper, whereas height was measured with a meter ruler and a height stick depending on the height of the selected trees. Five trees in each plot were chosen for destructing sampling. All the leaves were excised and bagged. Total leaf area was measured by using LiCor 3100 leaf area meter (LiCor, USA). Meanwhile, sapwood

area was determined from cut stem at 10 cm above the ground. About 10 cm disc from each destructed tree was brought back to the laboratory for anatomical studies.

### 2.2.2 Chlorophyll fluorescence measurement

Chlorophyll fluorescence is also very useful to study the effects of environmental stresses on plants since photosynthesis is often reduced in plants experiencing adverse conditions, such as water deficit, temperature, nutrient deficiency, polluting agents, and attack by pathogens. Fv/Fm has been used and widely accepted for many years as an indication of the maximum efficiency of Photo system II. It is highly effective and sensitive parameter which may be used as an indicator of sample stress. For each plot, five trees of *T. fruticosa* sp. were chosen for chlorophyll fluorescence measurements. Leaf clips were placed on three leaves per tree with shutter in closed position for dark adaptation. The dark adaptation took about 5 to 10 minutes. A record of one second at full intensity was set using the fluorimeter (Hansatech Handy PEA, UK).

### 2.3 Data Analysis

All data were analyzed and compared using T-test. The statistical analyses were performed using Social Package for Social Sciences version 12.0 and the significance level was set at 0.05. Species composition and the number of unique species were determine by using Jackknife estimate for quadrat counts ecological software

## 3. Results

### 3.1 Species composition

Total species found was 29 in both camping and trampling areas. About 23 species were recorded in undisturbed plots whereas only 14 species were found in disturbed plots (Table 1). However, the number of unique species was 25 based on Jackknife estimate for quadrat counts. It has been recorded that *T. fruticosa* dominate most of the area both in disturbed and undisturbed sites. From the table, we can see that trampling and camping resulted in significant declines in species composition in the study area.

### 3.2. Growth attributes

In camping areas, the mean values of growth attributes were found higher in disturbed plots than in undisturbed plots (Table 2). For trampling areas (trekking trails) the results are as expected which indicated that the mean values for all the parameters taken in undisturbed plots are higher than those in disturbed plots

### 3.3. Chlorophyll measurements

The mean values of Chlorophyll fluorescence (CF) parameters were found higher in disturbed plots than in undisturbed plots for both camping and trampling (Table 3). The reading shows that the highest CF values were found in Botak campsite area followed by trekking trail (Figure 1). The lowest mean values of CF were found in undisturbed Botak area.

## 4. Discussions

In our preliminary studies, significant impacts of camping and trampling activities were found on all the parameters taken. It has been recorded that *T. fruticosa* dominated most of the area both in the disturbed and undisturbed plots. Table 1 shows that trampling and camping activities resulted in significant declines of species composition in the area. In general, species diversity was found lower in affected areas than in those in which conditions are optimal. Higher diversity is always found in ecosystems that are not stressed, that is, they are well watered, have deep rich soils and optimum temperatures for photosynthesis which consisting water availability that exceeds evapotranspiration. Above the optimal temperature, respiration exceeds photosynthesis and growth decreases while below the optimal temperature, metabolic rates are low. Thus, both high and low temperature can be considered as stressful. Diversity generally decreases along a gradient of increasing stress, that is where climate becomes too hot or too cold.

The contrasting results of growth attributes in disturbed and undisturbed plots were found between camping and trampling areas (Table 2). Higher soil minerals and moisture caused by human waste disposals in camping areas might contribute to the results obtained. For camping and trampling, it has been observed that shaking and bending may have caused the stomata to open as leaf water potential fell, thus causing a higher transpiration rate which, in turn, caused lower water potential and consequently reduced extension growth. Besides, compacted soil slows tree growth and resulting in subsequent loss of ground vegetation. Trampling also reduces leaf area where all carbohydrates produced may be utilized in restoring leaf structure.

Unexpectedly, the mean values of CF parameters were found higher in disturbed plots than undisturbed plots for both camping and trampling (Table 3). Normally, CF values is reduced in plants experiencing adverse conditions, such as water deficit, temperature, and nutrient deficiency. These contrasting results could be related to the site quality factors such as higher light intensities in disturbed areas due to more exposure created by human, and breakdown and transport of particles of soil and rock contained minerals. Botak undisturbed area received direct exposure of sunlight and wind

and this coupled with the increased intensity of radiation received at high altitudes on clear summer days which makes the area have higher light intensities and temperature which can place the plants under severe water stress.

The results obtained have shown that the impact of recreation activities on Mount Tahan vegetation is still not alarming. Inconsistent results observed in this study might due to the difference of site conditions and environmental factors. Apart from the generalized effect of recreation activities in terms of exposure and stress, specific site condition and characteristics form particular and specialized habitats for plant growth. Impacts of camping and trampling can be minimized by encouraging the repetitive use of a small number of sites, and concentration use where amount of impact is influenced by the amount of use, vegetation fragility, vegetation density and also type and distribution of recreation activities.

## 5. Conclusion

All mountain ecosystems have one major characteristic in common which are rapid changes in altitude, climate, soil and vegetation over very-very short distances. Mountain ecosystems sport a high range of biodiversity which is a home to million of different species of plants and animals. This study illustrates that some high elevation vegetation community are relatively benefited from camping and trampling (trekking) activities but it may depend on the degree of disturbance. These preliminary results showed some contrasting outcomes resulted from two main recreation activities at upper areas of Mount Tahan. The differences of tree diameter, height, leaf area, sapwood area and chlorophyll fluorescence (CF) occurred due to the differences in site quality factors. This is all mainly due to elevation changes which produces zones of differing climates, soils and vegetations and also impacted by some disturbances cause by interruption of human activities. However, the damage on vegetation caused by the climbers from low level of recreation activities in Mount Tahan is still not alarming. Where group sizes remain small, recovery can easily be established.

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Table 1. List of species in undisturbed and disturbed plots for both camping and trampling areas

Species	Undisturbed	Disturbed
<i>Baeckea frutescens</i>	86	59
<i>Tristaniosis fruticosa</i>	104	83
<i>Baeckea</i> sp.	78	-
<i>Dacrydium faculifurus</i>	10	-
<i>Beackea</i> sp.	-	14
<i>Auxlonkia backea</i>	11	-
<i>Gleichinea microphylla</i>	4	-
<i>Gaultheria</i> sp.	3	-
<i>Hedyotic</i> sp.	111	58
<i>Citrus</i> sp.	13	-
<i>Melastoma</i> sp.	2	-
<i>Scleria</i>	19	73
<i>Smilax</i> 1	6	-
<i>Smilax</i> 2	3	-
<i>Eria ornate</i>	-	27
<i>Spathoglottis</i> sp.	3	-
<i>Epigeneium</i> sp.	29	
Orchid sp. (1)	27	21
Orchid sp. (2)	11	-
<i>Styphelia malayana</i>	10	23
<i>Scirpus</i> sp.	-	91
Rutaceae	-	36
<i>Nepenthes</i> sp. (1)	51	51
<i>Nepenthes</i> sp. (2)	-	6
<i>Nepenthes</i> sp. (3)	7	29
<i>Dendrochilum</i> sp.	-	14
<i>Dianella</i> sp.	2	-
<i>Coelogyne</i> sp.	38	-
<i>Dipteris conjugata</i>	10	-
Total species	23	14

Table 2. Characteristics of *Baeckea frutescens* used in this study. The values presented in the table are mean and standard error with significant level at  $p < 0.05$ .

Parameters	Camping area			Trekking trail		
	Disturbed	Undisturbed	F value	Disturbed	Undisturbed	F value
D (cm)	2.25 ± 0.72	1.83 ± 0.26	0.17*	1.61 ± 0.99	1.75 ± 0.27	0.22*
HT (cm)	88.50 ± 7.2	82.65 ± 4.15	2.29*	90.40 ± 8.98	96.90 ± 4.62	1.83*
A <sub>L</sub> (m <sup>2</sup> )	0.36 ± 0.02	0.27 ± 0.01	0.33*	0.24 ± 0.01	0.29 ± 0.02	0.41*
S <sub>A</sub> (cm <sup>2</sup> )	0.72 ± 0.07	0.61 ± 0.05	0.62*	1.01 ± 0.16	1.22 ± 0.24	0.12*

Table 3. The values presented in the table are mean and standard error of chlorophyll fluorescence parameters of *Tristanopsis fruticosa* with significant level at  $p < 0.05$ .

Parameters	Camping area			Trekking trail		
	Disturbed	Undisturbed	F value	Disturbed	Undisturbed	F value
F <sub>o</sub>	248.45 ± 4.56	216.79 ± 4.12	8.13*	227.66 ± 6.31	236.48 ± 5.65	6.89*
F <sub>m</sub>	993.86 ± 22.80	795.13 ± 19.09	12.41*	919.40 ± 27.51	835.95 ± 24.10	15.23*
F <sub>v</sub>	745.43 ± 20.10	578.34 ± 16.56	7.25*	691.75 ± 25.83	599.46 ± 21.29	10.07*
F <sub>v</sub> /F <sub>m</sub>	0.74 ± 0.005	0.71 ± 0.007	0.02*	0.74 ± 0.009	0.71 ± 0.006	0.04*

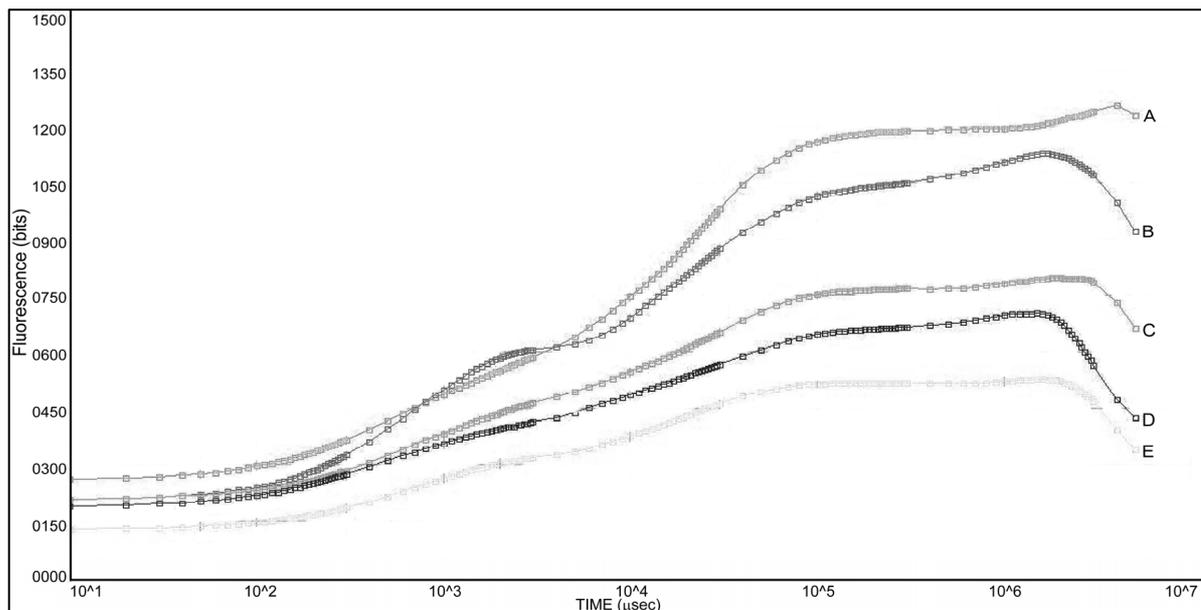


Figure 1. illustrates the means of fluorescence in one second measurement of *Tristanopsis fruticosa* for (A) Botak campsite (B) Trekking trail (C) Undisturbed trekking trail (D) Summit area and (E) Undisturbed Botak



## Quantitative Estimation of Annual Runoff Variation from the Hotan River, China

Lingmei Huang, Lina Wu & Bing Shen

Shaanxi Province Key Lab of Water Resources and Environment, Xi'an University of Technology

Xi'an 710048, China

E-mail: huanglm@xaut.edu.cn

### Abstract

Starting from the existing analysis of runoff from the Hotan River, the varying cause of runoff in the Hotan River is analyzed using the annual runoff accumulated curves and the orderly cluster method, pointing out that the runoff from the Hotan River coming from the mountains falls into the natural runoff with the fluctuations because of being subject to climate changes. It is worth noticing that the Xiaota annual runoff flowing into Tarim River was reduced by 0.322 billion m<sup>3</sup> in comparison of the postior 1989 series with the prior 1989 series and under the join action by both human being activities and climate changes.

**Keywords:** Human activity, Climate change, Runoff

Economic development is very slow and environment is vulnerable because of water shortage, low rate of exploitation and utilization and waste for water resources in the arid area, China. The runoff in the arid area is changing under the climate warming and human activities, so its uncertainty of space-time distribution will increase. Water resource is the key to survival and development for the oasis in the arid area. To study the change of runoff in the rivers can provide the rational advice for the exploitation of soil and water resources, environment protection and sustainable utilization of water sources. Therefore, it is significant to conduct this work in the arid.

### 1. General situation

The Hotan river basin is located at the north of the Kunlun Mountain and the southeast of Tarim Basin. The Hotan River is 1127km long whose area is 48870km<sup>2</sup>. It is the biggest river in the southeast of Tarim Basin and the secondly big river in the north of the Kunlun Mountain. It flows into the Tarim Basin from south to north, comes through the Takelamagan Desert and arrives to the Tarim River. It is the only river throughout the Takelamagan Desert and one of four existing source regions, too.

The Hotan river basin falls into the arid desert climate in the warm temperate zone with abundant light and heat resources. Temperature is 12.2°C yearly and rainfall is 35.6 mm yearly on average. The observed values of water evaporation range from 2159mm to 3137mm. Dry degree is higher than 20, thus making for conduct the plant diseases and insect pests. Strong wind occur in spring and sand storms often break out in April and May that can bring the serious economic loss affect the life of the local persons.

There are two tributaries in the upper reach of the Hotan River. One is the Yulongkashi River; the other is the Kalakashi River. They converge at Kuoshilashi. There are three hydrological stations on the Hotan River (Fig.1), one is Tongzuluoka station on the Yulongkashi River, second is Wuluwati station on the Kalakashi River, and the other is Xiaota station on the lower reach of the Hotan River, whose catchment area is 48870 km<sup>2</sup>. Surface water flowing into and out the Hotan Oasis is determined by three hydrological stations.

The Hotan Basin is one of the aridest areas in Xinjiang. Drought, sand storm and salt-alkalization are three natural disasters in the Hotan Basin; the utilization of soil and water resources is very low. The area of natural forest decreases 36% by disafforestation; the area of soil salt-alkalization accounts for 37.3% of the whole farmland; the area of soil desertification account for 52% of the whole area. The desertification area is increasing gradually because of big wind and sand storm. The lower reach of the Hotan River flows through the Takelamagan Desert where vegetation is very thin and big wind and sand storm is very so that its ecological system is very sensitive for the outer effect. Its capacity of renewing itself is very poor, thus it is the most frangible headstream. The area of vegetation cultivated by human in the middle reaches accounts for 32.4% of the oasis area. At a certain extent, the environment frangibility is improved, but the comprehensive assessment shows that the environment quality of the Hotan River falls into the moderate

vulnerability(Wang, 2001).

Uyre, as a minority in China, is the main people in the Hotan River Basin. Irrigation agriculture plays an important role for the local economy. However, the limited water resources restrict the social and economic development, restoring and building on environment. The change low of runoff from the Hotan River is studied to develop the local economy, improve the life and protect the environment, etc. under the condition of global climate warming and human activities.

## 2. Existing situation of runoff

There is a great deal of glaciers whose area is 10785 km<sup>2</sup> where annual precipitation is up to 800mm in the high mountainous area of the Hotan River distributes, so it is the place where runoff generates; in the low mountainous area falling into the hungriness zone, the vegetation is very thin and the velocity of runoff is very high, therefore it is not benefit for the runoff generation without the regulation fluctuation for the runoff supply; in the middle-lower reaches of the Hotan River falling into the transportation area and dissipation area of runoff, the runoff is gradually decreased, even dry, because of water diversion for agricultural irrigation, strong evaporation and seepage loss.

The Hotan River is the biggest river in the southwest of the Tarim Basin. The total of runoff is  $43.8 \times 10^8 \text{ m}^3$  on average (from 1957 to 2003) which can be taken as the surface water resources flowing into the Hotan Oasis, in which it is  $22.3 \times 10^8 \text{ m}^3$  for the Yulongkashi River, and  $21.5 \times 10^8 \text{ m}^3$  for the Kalakashi River. At the same time, there is  $10.1 \times 10^8 \text{ m}^3$  on average (from 1961 to 2003), accounting for 23.3% of the total of the Hotan River runoff, which is very important to maintain the ecological balance of the Tarim River and the whole Tarim Basin, prevent the desert from erosion and protect the green corridor.

The runoff distribution in a year lies on the supply condition. According to the calculation(Yang, 1987), the runoff from glaciers is  $14.8 \times 10^8 \text{ m}^3$  for the Yulongkashi River, accounting for 66.4% of its total;  $10.01 \times 10^8 \text{ m}^3$  for the Kalakashi River, accounting for 46.6% of its total. In addition, there are 18.3% and 24.3% respectively from the groundwater which is from the glaciers in the mountain area. So it is evident that the glaciers are the main source of runoff. The flood season occurs in July and August affected by the temperature and heat in the Hotan River Basin; the runoff highly concentrates in summer, accounting for 80.7%and 72.9%, respectively for the Yulongkashi River and the Kalakashi River; that is very less than 10% in Winter. Therefore, runoff can not be used effectively in flood season when the pressure of flood control is very large; water shortage is very serious in spring and in winter for agricultural irrigation and hydroelectric power.

## 3. Runoff change

The Hotan River Basin has a long history; oasis economy is closely linked with the runoff from the Hotan River. It is observed that no water is no oasis, no agriculture, either. So the stability of the runoff from the Hotan River is the prior condition of survival and development for the Hotan Oasis. According to the previous findings, it can be known that the runoff from the Hotan River has an unremarkable degression trend and the runoff flowing into the Tarim River has a remarkable degression trend(Huang, 2000).

### 3.1 Accumulated curves of the annual runoff

If the runoff is not affected by human activities, it has stochastic change among high, normal and low water. The accumulated runoff is dotted in a coordinate graph, which has no systematic deviation. By contrast, if the runoff is affected, its accumulated curves take on the systematic deviation. So we can judge whether the runoff series is affected by human activities according to its accumulated curve (Zhou, 2002).

The annual runoff accumulated curves of the Hotan River are made in Fig. 2. These curves of the Kalakashi River and the Yulongkashi River take on the fluctuation, but they basically like as a straight line. Their fluctuation occurs because of the stochastic change of hydrological series with the climate change. It can be seen that the runoff from two tributaries is not affected by human activities. The curve of Xiaota station has an outstanding deviation trend. The deviation dot presents in 1989, that is, the curve basically takes on a straight line before 1989 and it deviate from the straight line after 1989. While the Hotan River flows through the Hotan Oasis, runoff is diverted out the river to be used for agricultural irrigation. It became a seasonal stream in 1962. When the temperature rises in summer and runoff increases, surplus runoff flows through the desert to the Tarim River; no runoff flows to the lower reaches in the other seasons. So runoff under the canal headwork is affected by human. From the curves of Xiaota station, the interference is larger after 1989 than before 1989. The runoff series can be taken as two series from the time angle: one is before 1989; the other is after 1989.

### 3.2 The orderly cluster method

The hydrological series is affected by human activities is different from the intrinsic one. From the 'cluster' angle, it can be taken as two 'cluster'. The cutting point can be found with the orderly cluster method (Liu, 1991).

The cutting point is the outstanding interference point in the hydrological series. It can make the sum of deviation square smallest for the same cluster series (in equation 1 and 2) and the sum of deviation square relatively bigger for the

different cluster series (in equation 3).

$$V_{\tau} = \sum (X_i - \bar{X}_{\tau})^2 \quad (1)$$

$$V_{n-\tau} = \sum (X_i - \bar{X}_{n-\tau})^2 \quad (2)$$

$$S_n(\tau) = V_{\tau} + V_{n-\tau} \quad (3)$$

In which,  $\tau$  is the interference point;  $\bar{X}_{\tau}$  is mean value of hydrological series before the interference point;  $\bar{X}_{n-\tau}$  is the mean value of hydrological series after the interference point;  $S_n(\tau)$  is the total deviation. When equation 4 exists, the outstanding interference point  $\tau$  is found:

$$S_n^*(\tau) = \min [S_n(\tau)] \quad (4)$$

From the runoff accumulated curves, only the runoff series of Xiaota station is affected by human activities. As a sample of Xiaota runoff, the interference point  $\tau$  and its corresponding  $S_n(\tau)$  are calculated with the orderly cluster method. The relation between  $S_n(\tau)$  and year presents in Fig. 3. From the Fig. 3, it can be known that the minimum value of  $S_n(\tau)$  occurred in 1989 consistent with the result of the runoff accumulated curves. Therefore, the outstanding interference point of Xiaota runoff series occurred in 1989. More than 50% runoff is diverted into the irrigation area when runoff flowing through the oasis, especially in spring seeding season, all of runoff is diverted to lead to flow-break in the lower reaches. The runoff flowing through the oasis has been interfered by human since 1961 when the runoff data are observed. According to the orderly cluster method and the accumulated curves, the outstanding point is found, that is 1989. The result is consistent with the practical condition that the plane reservoirs were built, the irrigation area and the intakes under the canal headwork were gradually increased.

### 3.3 Quantitative estimation

According to the former analyses, the runoff from two tributaries is not affected by human. The effect degree for Xiaota runoff is calculated. Xiaota runoff observed by human is not natural, so the absolute effect degree can not be analyzed. Based on the runoff series before 1989, the relative effect degree can be calculated and the future change can be predicted.

According to the outstanding point, Xiaota runoff series become two series, one from 1961 to 1988 (No. I series), the other from 1990 to 2002 (No. II series). Mean values for No. I and II are  $11.66 \times 10^8 \text{ m}^3$ ,  $8.44 \times 10^8 \text{ m}^3$ , respectively. From the mean values, it can be seen that No. II series is affected larger than No. I series. According to the correlation analysis, the correlation equation can be obtained:

$$Y = 11.615t + 0.5997 \quad R = 0.9987 \quad (5)$$

In which,  $Y$  presents the accumulated value of annual runoff,  $10^8 \text{ m}^3$ ;  $t$  presents the time,  $t=1, 2, \dots$ . The correlation coefficient  $R$  is closed to 1, which makes clear that the simple straight correlation exists between annual runoff and year. The relation can be used to estimate the decrease of the No. II series, compared with No. I series. The results are listed in Tab. 1.

From Tab. 1, accumulated decrease of Xiaota runoff is up to  $45.13 \times 10^8 \text{ m}^3$  from 1990 to 2002 on the base of No. I series, which is slightly larger than the total runoff from the Hotan River. Mean decrease per year is  $3.22 \times 10^8 \text{ m}^3$ . The degression trend may continue before the effective measures are made to control over the runoff. The trend is not benefit for green corridor in the lower reaches of the Hotan River and affects the ecological environment of the Tarim River, too.

The main reasons that the runoff decreases are as follows. Firstly, water diversion for irrigation makes runoff in rivers decrease. Rainfall is very rare and evaporation is strong, irrigation is the life line of oasis agriculture. The irrigation area with 1.6 million ha farmland lies on the Hotan River. The river length through the irrigation is 165km, while the total length of canal system distributing in the irrigation area is 16979km. seepage loss and ineffective evaporation because of water diversion from the canal system largely increase. Secondly, the rivers gradually degrade, its capacity of draining floods is weaker and the overflow loss during the flood period is very serious. The main steam under the lower reaches of the Hotan River often is no water; the deserts along the rivers are approaching the rivers. Because of big wind, drift sand covers the river. When flood takes place, a great lot of water flows over the river to make loss. In the oasis, for flood control, flood is diverted into irrigation area from canal headwork to low-lying during flood period. This presented in 2000 and 2001. Lastly, the runoff from the two upper hydrological stations has an unremarkable degression trend. According to analysis, runoff has decreased  $2.77 \times 10^8 \text{ m}^3$  every year since 1989. Water use doesn't change, the runoff flowing to the lower reaches correspondingly decreases. So it can be seen that the main reasons of Xiaota station runoff decrease are human activities and climate change while that of the runoff from two upper hydrological stations is climate change.

## 4. Conclusion

Global climate warming and the effect of human activities make runoff from the Hotan River changing. Climate change

in the south of Xinjiang, the northwest arid regions and the whole globe affects the temperature in Kunlun Mountain to lead to an unremarkable degression trend of the runoff from the source regions of the Hotan River. In the source regions, runoff is not affected by human activities because of under population. When the Hotan River flows through the oasis, a great lot of runoff is diverted into the irrigation area to give rise to obvious runoff decrease flowing from the Xiaota station to the Tarim River. Water diversion for irrigation, evaporation, seepage and overflow are main reason to lead to runoff decrease flowing to the Tarim River, that is, the combination with human activities and climate change.

The change trend of the runoff from the Hoton River is not good to the development of the agricultural economy and ecological environment, not good to the survive and maintainment of the “green corridor” of the main river of Horton River in the Desert, and not good to the ecological protection and economic stability of the Tiam main river. So it is necessary that the scientific planning and comprehensive treatment are carried out for the Horton River.

**Acknowledgement**

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Table 1. Quantitative estimation of annual runoff from Xiaota station for human activity(unit: 10<sup>8</sup> m<sup>3</sup>)

Year	Accumulated	decrease	Year	Accumulated	decrease
1989	337.4	7.31	1997	430.4	31.71
1990	349.0	5.41	1998	442.0	36.50
1991	360.7	8.26	1999	453.6	38.09
1992	372.3	15.24	2000	465.2	40.63
1993	383.9	26.48	2001	476.8	42.09
1994	395.5	14.36	2002	488.4	45.13
1995	407.1	24.96	Average		3.22
1996	418.7	28.11			

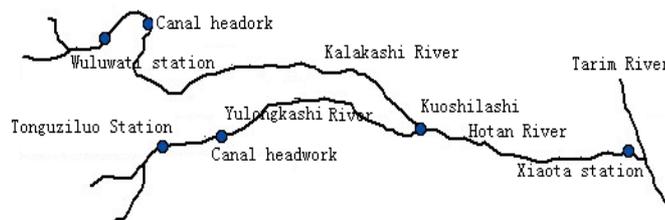


Figure 1. The water system of the Hotan River

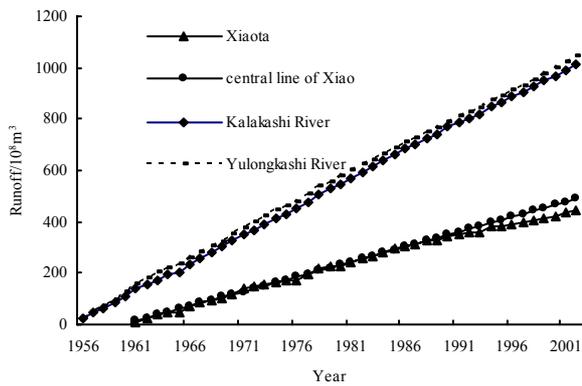


Figure 2. The annual runoff accumulated curves about three gauging stations of the Hotan River

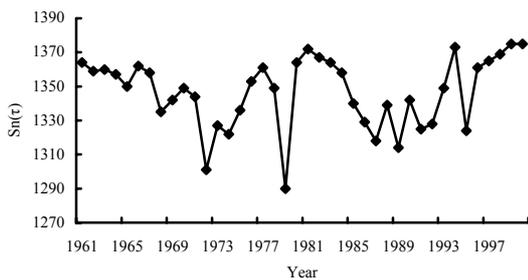


Figure 3.  $S_n(\tau)$  hydrograph of annual runoff from Xiaota station



## Estimation of Methane Emission from a North-Indian Subtropical Wetland

Shekhar Mallick

Ecotoxicology and Bioremediation Group, Environmental Sciences Division  
National Botanical Research Institute (NBRI), Lucknow 226 00 (UP), INDIA

E-mail: shekharm@hotmail.com

Venkatesh Dutta

School for Environmental Sciences (SES), Babasaheb Bhimrao Ambedkar University (Central University)  
Lucknow 226 025 (UP), INDIA

E-mail: dvenks@gmail.com

### Abstract

Methane emission from wetlands and its upscaling is a frontier area of research in global biogeochemical cycling including global warming. Though process based models are needed to account for variability in various types of wetland ecosystems, due to lack of required field data, it is still in infancy especially in the tropical countries. An attempt has been made through this study to estimate the quantitative and temporal variation of  $CH_4$  emission from a subtropical wetland of North India dominated by *Scirpus littoralis*. A wide variation in rate of  $CH_4$  emission was observed in an annual cycle with maximum rate reaching up to  $129.82 \pm 19.08 \text{ mg m}^{-2} \text{ h}^{-1}$  during March to April and negative emission rates were observed in hot and dry summer months between May to July. This finding suggests that tropical wetlands act both as source and sink of  $CH_4$  emission depending upon the specific ecological and environmental conditions. Therefore, extrapolation of single value of rate of emission for the entire year is not correct in estimating total annual  $CH_4$  flux.

**Keywords:** Sub-Tropical wetlands, Methane emission, *Scirpus littoralis*, Carbon fixation

### 1. Introduction

Wetlands are the areas on the landscape where land and water meet and usually lie in depressions or along rivers, lakes, and coastal waters where they are subjected to periodic flooding. Wetlands in India are distributed in various ecological regions ranging from the cold and arid zone of Laddakh through the wet Imphal and Manipur, and the warm and arid zone of Rajasthan-Gujarat to the tropical central India, and the wet humid zone of the southern peninsula. Prediction of future climatic changes and global productivity estimation depends largely on realistic assessment of green house gases from terrestrial and aquatic ecosystems with reasonable accuracy understanding the relationship between the physical environment, anthropogenic and biological activities. Wetlands, both man-made and natural are considered as one of the major contributors to atmospheric methane ( $CH_4$ ), and there exists complexity of processes which regulate net  $CH_4$  flux between wetland soils and the atmosphere (Keppler & Rockmann, 2007; Chen & Prinn, 2006; Keppler, *et al.*, 2006). There have been relatively few studies in the annual fluxes of  $CH_4$  in lakes of subtropical regions. Recent efforts in atmospheric modelling and attempts to constrain  $CH_4$  source strengths have indicated the need to delineate the processes responsible for the large variations in emission rates found within and across wetland types. To understand and assess the possibility and implications of temporal variations in atmospheric  $CH_4$ , improved quantitative knowledge of  $CH_4$  sources and sinks as well as improved estimation technique is required. Natural wetlands are responsible for approximately 76% of global methane emissions from natural sources, accounting for about 145 Tg of methane per year, while the global total  $CH_4$  emission is estimated at ~611 Tg, giving an atmospheric lifetime for  $CH_4$  ~8.5 yr (EPA, 2006). Next to the water vapour and carbon dioxide,  $CH_4$  is most abundant greenhouse gas in the troposphere with an average concentration of 1.8 ppm (Keppler, *et al.*, 2006). Its atmospheric concentration has tripled since pre-industrial times (Houghton, *et al.*, 1996; Lelieveld, *et al.*, 1988). Although its tropospheric concentration is rather low compared to  $CO_2$  (~378 ppm) (IPCC, 2001), it is of particular importance as it is a major greenhouse gas that contributes approximately ~20% of the current total global annual emission of ~600 Tg ( $10^{12}$  g). One molecule of  $CH_4$  traps about 23-30 times more heat than  $CO_2$  over a 100-year time scale, thus, contributing about 20% to global warming (Keppler & Rockmann, 2007; Watson, *et al.*, 1990; Thompson & Cicerone, 1986; Ramanathan, *et al.*, 1985).

Wetlands could be a source or sink of greenhouse gas based upon the net balance of three inter-related processes of the carbon cycle within wetland ecosystems i.e. carbon fixation, respiration and  $CH_4$  emission. However, the role of wetlands in the net global greenhouse gas emission is conflicting. According to some reports, wetlands act as a source (Liikanen, *et al.*, 2006), while some indicate that it acts as sink for greenhouse gases (Turunen, 1999; Alm, 1997). In a waterlogged condition, swamp soils are a net source of  $CH_4$  to the atmosphere, while during dry conditions swamp soils consume atmospheric  $CH_4$  (Harriss, *et al.*, 1982).

The annual rate of fixation of  $CO_2$  in tropical wetlands is highest compared to the other ecosystems. Estimates of average peak aboveground biomass in freshwater tidal wetlands range from 432  $g/m^2$  in *Sagittaria latifolia* to 2311  $g/m^2$  in *Spartina cynosuroides* with *Scirpus* sp. being 606  $g/m$  (Chen & Prinn, 2006; Whigham, *et al.*, 1978). The global annual productivity of wetlands amounts to 4 to  $9 \times 10^{15}$  g of dry matter (Aselmann & Crutzen, 1989). This amounts to about 3 to 9% of the entire continental net primary productivity calculated at a rate of about 1000  $g\ m^{-2}\ yr^{-1}$  in comparison to the global mean of all vegetation types which is less and ranges between 770 – 900  $g\ m^{-2}\ yr^{-1}$  (Fung, *et al.*, 1983). Reality is lost between fluxes of  $CO_2$  and  $CH_4$  of the same carbon cycle within wetlands. On an annual basis up to 15% of the net carbon fixed by the wetlands may be released to the atmosphere as  $CH_4$ . Besides there are recent reports of  $CH_4$  being emitted from terrestrial living plants to the tune of 62-236  $Tg\ yr^{-1}$  and 1 – 7  $Tg\ yr^{-1}$  from plant litter (Keppler, *et al.*, 2006).

Nevertheless, wetlands remain the single largest natural source for  $CH_4$  emission, a share of 225 million metric tons (MMT) out of a total ~600 MMT (Keppler & Rockmann, 2007). Methane emission is influenced by seasonal, spatial and geographic differences and high variation exists between wetlands of different climes. Freshwater wetlands differ from coastal and other saline wetlands, in terms of  $CH_4$  emission as the ecosystem is devoid of salinity; hence, rate of methanogenesis in freshwater wetlands is higher than the saline conditions (Verma, *et al.*, 2002; Purvaja & Ramesh, 2001).

There are major uncertainties about seasonal  $CH_4$  production periods as well as differences in the relative importance of the role of climatically and ecologically distinct wetland ecosystems, particularly tropical/subtropical wetlands (Matthews, 2000). Also, the time periods of carbon fixation and  $CH_4$  emission vary seasonally and diurnally (Brix, *et al.*, 2001). Numerous biogeochemical factors are known to affect the activity of methanogenic bacteria (Freeman, *et al.*, 1997; Conrad, *et al.*, 1989; Rudd & Taylor, 1980) and although there has been some success in relating water level (Harriss, *et al.*, 1982; Cui, *et al.*, 2005; Roulet, *et al.*, 2005; Moore, *et al.*, 1990) and temperature, (Schutz, *et al.*, 1989; Crill, *et al.*, 1988) to  $CH_4$  emissions within particular systems, these variables are insufficient for predicting emissions across a variety of wetlands (Aselmann & Crutzen, 1989; Whalen & Reeburgh, 1992).

The tropical wetlands behave much differently than temperate wetlands because of difference in type of soil (organic or mineral), composition of vegetation, temperature, hydroperiod and nutrient availability (ombrotrophic or minerotrophic) (Alm, 1997). Tropical wetlands are mineral soil wetlands and store little organic matter as they are subjected to alternate wet and dry periods (Armentano & Verhoeven, 1990).

Methane flux measurements in Asian wetlands, particularly Indian subcontinent, are still scanty from the published literature (Matthews, 2000). Most of the work on  $CH_4$  flux in India has been reported from saline wetlands such as mangroves (Mukhopadhyay, *et al.*, 2002; Purvaja & Ramesh, 2000), lagoons (Verma, *et al.*, 2002) and coastal estuaries (Shalini, *et al.*, 2006) with very few studies on freshwater tropical wetlands. An attempt has been done recently to quantify  $CH_4$  emission from India using coarse resolution thermal data during months of May 2005 and October 2005 (Agarwal & Garg, 2006). Results indicated that  $CH_4$  emission in the month of May 2005 was 10,515 kg from 29,419 sq. km. of area whereas in the month of October 2005 total emitted methane was 38,069 kg from 93,995 sq. km. However, their study is representative of only two month viz. May and October using coarse resolution thermal data of land surface; therefore, uncertainties abound on total methane emission.

An attempt has been made through this study to estimate the quantitative and temporal variation of  $CH_4$  emission from a subtropical wetland of North India. Further, comparison has been made with similar studies from the Indian subcontinent. As potential complexities of processes regulate net flux of  $CH_4$  between wetland soils and the atmosphere, it is difficult to extrapolate net flux for the entire area. This study demonstrates that the  $CH_4$  emission from tropical wetlands dominated by *S. littorals*, is only for a short duration in a annual cycle and extrapolation of single value of rate of emission for the entire year is not correct in estimating total annual methane emission from tropical wetlands.

## 2. Materials and methods

### 2.1 Sampling Location

The study was carried in the littoral area of Lake Bhalsawa located in the floodplain of river Yamuna, which is a natural freshwater wetland located on the northern outskirts of Delhi (28° 44' N, 77° 10' E) (Figure 1). The lake is formed in a depression and the source of water is primarily rain (approximately 612 mm/year). It is estimated to be about 32,000 sq.

meters in area and average depth of 1.5 meter (Mehra, 1986). It has narrow littoral zone, roughly 80 mts, width along the western shore dominated by macrophytes such *Scirpus littoralis*, *Cyperus* sp., *Bacopa* sp. and few patches of *Typha* sp. The study was carried out in a small area of 4800 sq. meters, at the northern end of the lake. The area is a relatively undisturbed and dominated by *Scirpus littoralis*.

The climate of Delhi is semi-arid with distinct seasonality and high variation between summer and winter temperatures. The average temperature ranges from 25°C to 46°C during summer and 2°C to 5°C during winter.

## 2.2 Gas sampling method

CH<sub>4</sub> flux was determined using a closed chamber technique (Parashar, 1996) over areas both with *Scirpus littoralis* and without macrophytes from August 2001 till July 2002. The rate of methane emission for two consecutive hours were estimated and averaged out. Closed chambers were fabricated with transparent perspex sheet of 4 mm thickness. The gas samples were analyzed on a Nucon gas chromatograph series 5765 (Nucon engineers Pvt. Ltd. India) and partly on Perkin Elmer ASXL (USA) gas chromatographs. Both the instruments were fitted with Flame Ionization Detector (FID) and Porapak Q column (1.5m long with a mesh size of 80/100). FID was fired by hydrogen and compressed air. Nitrogen was used as carrier at a flow rate of 30 ml/min. The oven temperature was maintained at 45°C, injector at 80°C and detector temperature at 150°C. Standard curve was prepared from standard CH<sub>4</sub> (180 ppmv) obtained from EDT Research, London supplied by Nucon Eng. Ltd (Delhi).

## 2.3 Estimation of methane emission

Rate of CH<sub>4</sub> emission were estimated by using the following equation:

$$CH_4 \text{ flux} (mg m^{-2} h^{-1}) = \frac{(BV_{stp} \times C_{CH_4} \times 16 \times 1000 \times 60)}{(106 \times 22400 \times A \times t)}$$

$$BV_{stp} = \frac{(BV \times BP \times 273)}{[(273 + T) \times 760]}, \text{ where } BV_{stp} \text{ Box air volume in cc at STP}$$

$$BV = H \times L \times W - (\text{volume of biomass inside the chamber})$$

$H$  = Height of the chamber

$L$  = Length of the Chamber

$W$  = width of the Chamber (cm)

$C_{CH_4}$  = difference in CH<sub>4</sub> concentration in (ppm) between  $t_0$  and  $t_x$  sampling

$A$  = area covered by the chamber in m<sup>2</sup>

Total volume of the biomass inside the enclosure was deducted from the internal volume of the chamber during calculation. The volume of the biomass was calculated by considering *Scirpus* leaves as cone. Height and the base diameter of *Scirpus* leaves inside every enclosure were recorded to calculate the volume of total biomass. All the measurements were carried between 10:45 am to 3:45 pm.

## 2.4 Biomass estimation

Biomass was estimated by harvest method at monthly interval. Aboveground (AG) and belowground (BG) biomass from an area of 50 × 50 cm were harvested from the wetland in triplicates, brought to the laboratory and washed under running tap water to remove the soil and silt. The biomass was further segregated into species and AG, BG, inflorescence, litter etc. Further the biomass were enclosed in brown paper and dried in oven at 80°C till constant weight. The weight of the dried biomass was recorded on a scale balance.

## 3. Results

Higher rate of emission was observed during February to April from both areas dominated with and without macrophytes. Methane emission showed a wide variation over *S. littoralis* dominated region and it ranged between  $-0.36 \pm 0.27$  to  $-0.664 \pm 0.27 \text{ mg m}^{-2} \text{ h}^{-1}$  from September to January,  $129.82 \pm 19.08 \text{ mg m}^{-2} \text{ h}^{-1}$  to  $2.986 \pm 0.14 \text{ mg m}^{-2} \text{ h}^{-1}$  during February to April,  $-2.074 \pm 1.34 \text{ mg m}^{-2} \text{ h}^{-1}$  to  $0.075 \pm 0.007 \text{ mg m}^{-2} \text{ h}^{-1}$  between May to July. (Fig 2) Whereas, over the areas devoid of any vegetation it ranged between  $0.56 \pm 0.29 \text{ mg m}^{-2} \text{ h}^{-1}$  and  $0.0014 \text{ mg m}^{-2} \text{ h}^{-1}$  during September to January,  $32.42 \pm 13.94 \text{ mg m}^{-2} \text{ h}^{-1}$  and  $2.75 \pm 1.71 \text{ mg m}^{-2} \text{ h}^{-1}$  between February to April and  $-0.16 \text{ mg m}^{-2} \text{ h}^{-1}$  to  $0.29$  during May to July. A net total annual flux of  $201.23 \text{ mg m}^{-2} \text{ h}^{-1}$  over *S. littoralis* dominated areas and  $41.74 \text{ mg m}^{-2} \text{ h}^{-1}$  over areas without macrophytes is obtained.

Aboveground biomass of *S. littoralis* (Table 1) ranged between  $123 \pm 16.21 \text{ g/m}^2$  in April to  $362.56 \pm 81.97 \text{ g/m}^2$  in October, whereas, belowground ranged between  $71.14 \pm 0.48 \text{ g/m}^2$  in July to  $1816.53 \pm 395.98 \text{ g/m}^2$ . The total biomass ranged between  $553.90 \text{ g/m}^2$  in May and  $2669.89 \text{ g/m}^2$  in January. The average rate of carbon fixation ranged between  $3.4 \text{ g m}^{-2} \text{ day}^{-1}$  in November to a maximum of  $55.2 \text{ g m}^{-2} \text{ day}^{-1}$  in January.

#### 4. Discussion

In the present study, areas dominated by *S. littoralis* were found to emit  $CH_4$  at higher rates than from the areas devoid of macrophytes. The rate of  $CH_4$  emission was high in summer and low in winter. The higher rate of emission during March to April from areas dominated by *S. littoralis*, could be due to the several favourable conditions taking place simultaneously. Factors such as temperature (41- 29 °C) water level (16.5 to 3.25 cm) and decaying macrophytes were favorable for methanogenesis. Primary production providing fresh organic material for degradation is known to be one of the most important variables controlling  $CH_4$  emissions from wetlands (Whiting & Chanton, 1992). It is also reported that up to half of the annual  $CH_4$  emissions from eutrophied boreal lakes can be emitted during a short period in spring (Huttunen, et al., 2003). It was followed by a dry summer when most of the aboveground vegetation disintegrated. In absence of water, anaerobic condition could not prevail, hence negative or no emission of  $CH_4$  was observed. The water table changes had a remarkable effect on  $CH_4$  fluxes and this decrease in the water table decreases methane flux (Cui, et al., 2005). Exposed soil surface of wetlands can become a net source of atmospheric  $CO_2$  as photosynthesis is decreased and respiration loss is enhanced. This spatial and temporal variation in rate of emission is in conformity with other studies (Verma, et al., 2002). Negative emission rates were observed during the months of April and May from Sundarban mangrove near Bay of Bengal (-10 to -42  $\mu g m^{-2} s^{-1}$  approx.) (Mukhopadhyay, et al., 2002). An earlier study also confirmed that swamp soils can act both as a source and sink for atmospheric methane (Harriss, et al., 1982). In a waterlogged condition, swamp soils are a net source of methane to the atmosphere whereas during drought conditions, swamp soils consume atmospheric methane.

Post monsoon (September and October), water level rose to 44.6 cm, with little organic matter in its substrate, the rate of  $CH_4$  emission was low (0.03±0.02 to 0.17±0.15  $mg m^{-2} h^{-1}$ ). Although significant amount of standing biomass was observed (Table1) and temperature ranged between 29.3 to 33.6 °C, lack of organic matter in the substratum could be the reason for low rate of emission. The accumulation of organic matter is generally high in wetlands soil during the summer and pre-monsoon seasons. High rate of decomposition of organic matter creates oxygen stress, eventually resulting in the formation of  $CH_4$  in the subsurface (Purvaja & Ramesh, 2000).

No  $CH_4$  emission was observed during winter months (December to January), that was inferred from negative emission rates of emission. During the wet season, immediately following the monsoon, the height of the water restricts the transfer of  $CH_4$  from the subsurface to the atmosphere, resulting in a decrease in  $CH_4$  flux rates (Purvaja & Ramesh, 2000). Besides, decrease in daily temperature (27.3 to 19.3 °C) inhibited methanogenesis, as the optimum range of temperature for methanogenesis has been found to be 25 to 30 °C (Dunfield, et al., 1993) and 30 to 32 °C (Parashar, et al., 1994). Methane flux rates is generally high during summer and pre-monsoons, indicating that soil temperature has a major influence over methanogenesis.

Highest rates of emission were recorded during spring season (March) over *S. littoralis* dominated areas and over areas devoid of macrophytes. The possible reasons for higher emissions during this time of year may be explained by several favorable physical and chemical processes taking place simultaneously. Factors such as shallow water level (15.3 cm) maintains required redox potential for methanogenesis (>-250 mV), gradual death of standing biomass adds to substrate organic matter; and, the temperature range is optimum for methanogenesis (35 °C). *In vitro* incubation of wetland sediment under anaerobic conditions indicated a progressive decrease in benthic methanogenesis with sediment desiccation and exposure to air (Boon, et al., 1997). Ephemeral inundated floodplain wetlands may be sites of significant  $CH_4$  emission, especially over the summer months. Months following the spring are hot and dry, exposing the wetland substrate, thereby shifting the anaerobic condition of sediment to aerobic condition. Negative  $CH_4$  emission rates observed during this period (April till July) exhibited a distinct seasonal pattern. The negative emission rates could be also due to consumption of  $CH_4$  by methanotropic bacteria present in the surface of soil at the interface of aerobic and anaerobic environments (Neue & Roger, 1993).

The standing biomass observed during this study is in conformity with studies done earlier (Sah, 1993). The peak biomass observed during January, could be due to abundant standing water and favorable temperature. The aboveground biomass of *S. littoralis* showed a decline during the hot and dry periods, explaining the aquatic characteristic of the plant.

However, these values alone cannot be considered to estimate annual  $CH_4$  emission from tropical wetlands as there are wide spatial and temporal variations within the wetlands of tropical regions. Studies with small sample sizes (premonsoon, monsoon and post-monsoon) are insufficient to calculate the yearly  $CH_4$  emission. Methanogenesis is influenced by a range of factors, such as anaerobic conditions, organic matter, pathway of its release to the atmosphere, soil temperature, soil pH etc. As these factors vary from site to site, extrapolation for larger wetlands areas is not accurate. In light of this inherent problem, it is important to have more representative values from more specific bio-geographical locations to enable meaningful estimation.

## 5. Conclusion

The rate  $CH_4$  emission and carbon fixation in a subtropical wetland have shown high seasonality and spatial variation. The study has observed that there is a distinct pattern of  $CH_4$  emission, which follows a seasonal trend directly coinciding with the temperature, decomposing biomass, declining water level and growth of the dominant macrophyte. In general, the areas dominated by *S. littoralis* were found to emit more  $CH_4$  than the areas devoid of the macrophytes. In an annual cycle, wetlands exhibit both as a source and sink for  $CH_4$  emission, and positive flux rate could be obtained only during certain months, in our study this being evidenced during January to April. Therefore, extrapolation of single value of rate of emission for the entire year is not correct in estimating total annual  $CH_4$  emission from tropical wetlands. The rate of carbon fixation also followed distinct seasonality with average rate of carbon fixation highest during January and lowest in November.

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Table 1. Biomass of *Scirpus littoralis* and other plants sampled at monthly interval

Months	<i>S. littoralis</i> (AG)	<i>S. littoralis</i> (BG)	Cyperus sp. (AG)	Cyperus sp. (BG)	Grasses (AG)	Grasses (BG)	Litter & BP	<i>Suaeda</i> sp.	<i>Echinochloa</i> sp.	<i>Bacoppa</i> sp.	Inflorescence	Dry Standing Biomass	Total g/m <sup>2</sup>
September	14.00	107.55			323.04	35.28	88.64						568.31
October	446.51	234.77					106.39		277.60	224.00	10.99	17.00	1317.25
November	183.56	248.68			74.04	19.28	83.82		207.12		3.86	25.00	845.36
December	188.36	328.07		21.64	102.63	28.17	107.51			113.34	7.36		958.03
January	299.60	1816.53			277.56	11.48	264.72						2669.89
February	125.53	318.48			61.60	80.48	169.73	76.64					832.47
March	144.90	616.22		10.56			227.36			163.80		52.04	1228.56
April	123.22	414.22		35.36	152.36		132.90		251.30		4.92		1143.88
May	0.00	215.24					119.06		219.60				553.90
June	0.00	240.08		26.32			214.77						688.77
July	0.00	659.43			290.80		232.55					61.48	1244.25



Figure 2. Area and extent of Bhalsawa lake in Delhi showing the sampling location

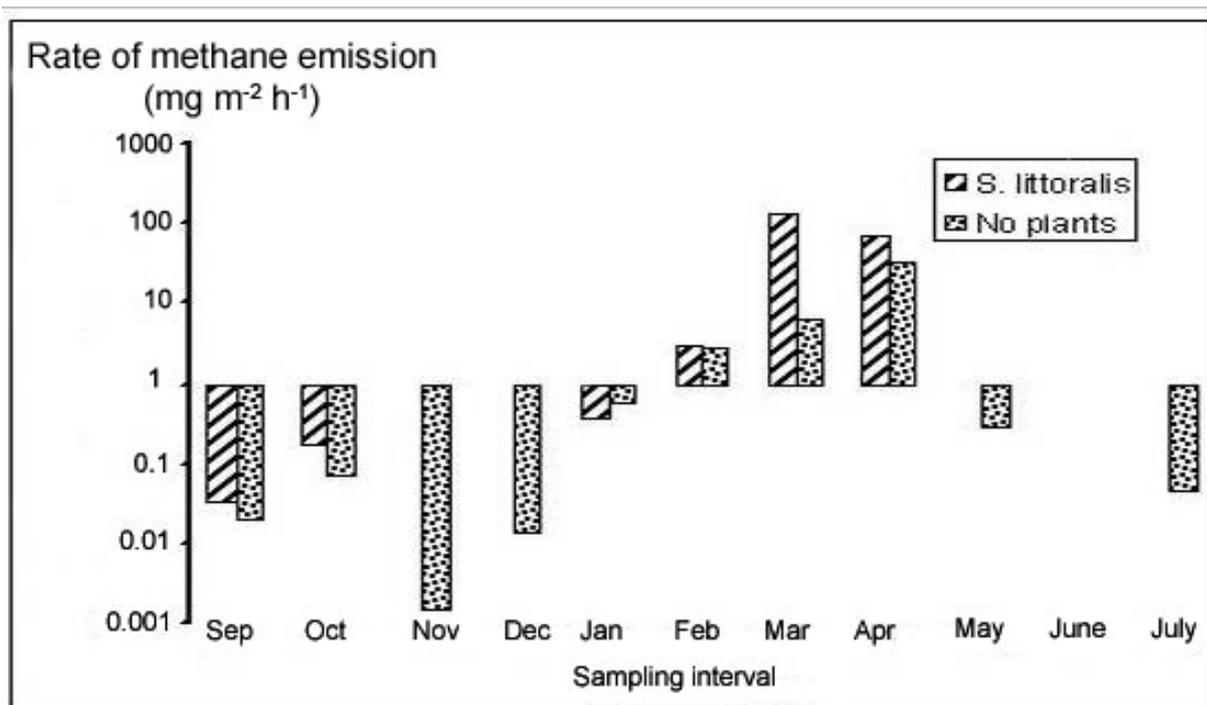


Figure 3. Average rate of Methane emission from *S. littoralis* dominated wetland



## Study on the Treatment Process of Wastewater from Cephalosporin Production

Haixia Duan (Corresponding author)

School of Equipment Engineering, Shenyang Ligong University, Liaoning, Shenyang 110186, China

E-mail: d\_h\_x@163.com

### Abstract

Wastewater from cephalosporin production with high bio-toxicity is hard to degrade, and could cause great harm to environment and human being. In the present paper, wastewater from cephalosporin production was processed with biochemical treatments as follows: hydrolytic acidification- Up-flow Anaerobic Sludge Bed(UASB)-Sequencing Batch Reactor Activated Sludge Process(SBR)-biological activated carbon process(BAC). Among them, hydrolytic acidification could efficaciously enhance the biodegradability of wastewater, and greatly increase effects of the subsequent anaerobic-aerobic treatment. The final BAC process could effectively eliminate chemical oxygen demand (COD) and chroma of wastewater treated by aerobic treatment, where COD attained below 100mg/L and chroma was 40. Therefore, wastewater after the previous treatments basically conformed to the discharge standard of " Integrated wastewater discharge standard "(GB8978-1996).

**Keywords:** Wastewater from cephalosporin production, Hydrolytic acidification, UASB, SBR, Biological activated carbon

### 1. Introduction

Wastewater from cephalosporin production has complicated components, where organic substances and soluble or colloid solid substances are all at a high level with a great deal of suspended matter, and pH value varied often, contains biological toxicity substances of unbiodegradable and bacteriostatic antibiotics. In the present paper, wastewater from cephalosporin production was processed with biochemical treatments as follows: hydrolytic acidification-UASB-SBR-BAC process, which guaranteed that wastewater basically conformed to the discharge standard of " Integrated wastewater discharge standard "(GB8978-1996).

### 2. wastewater quality and outlet requirements

Wastewater was sampled from a pharmacy factory of Liaoning Province. Relative data was listed in detail in Table 1.

### 3. Experimental section

#### 3.1 Methods

- (1) Determination of pH value: glass electrode method;
- (2) Determination of chroma: dilution multiple method;
- (3) Determination of COD: potassium dichromate method(COD<sub>Cr</sub>);
- (4) Determination of BOD: five-day biochemical cultivation

#### 3.2 Schematic diagram of processes

Organic glass cylinder with the height of 100cm, inner diameter of 10cm and effective volume of 6L was used as hydrolytic acidification pool. UASB reactor with the height of 150cm, inner diameter of 8cm and effective volume of 6L, was kept at constant temperature of 37°C by jacket water bath adjusted by temperature-control relay and heater. Each vessel was undertaken at a manner of continuous influent, water flew into hydrolytic acidification cylinder and UASB reactor through the bottom feed inlet and flew out from the top. Biogas resulted from UASB reactor was collected by gas trap hood.

#### 3.3 Hydrolytic acidification

Using hydrolytic and acid-producing bacteria reactions, undegradable organic substances were decomposed into biodegradable matter with small molecule, which further enhanced the biodegradability and thus decreased the charge of following processes.

### 3.4 UASB reaction

Basic structure of UASB reactor was mainly composed of sludge bed, sludge suspension layer, precipitate zone, three-phase separator and intake system, and granular sludge in reaction zone was the key of this reactor (Hu, 2002, PP. 159-166). It is a new type and high effective wastewater treatment equipment, which altered the traditional and laggard treatment of anaerobic fermentation, and have novel insight in the design of inlet manner, influent distribution system, agitated mixing and three-phase separator and intake system, and thus could be regarded as an ideal equipment for dealing with wastewater of high, medium and low pollution level. During the performance process, wastewater flow from the reactor bottom evenly through influent distribution system, and flew upward by reaction zone (sludge zone) to three-phase separation zone (gas, liquid and solid), and finally into the precipitate zone of UASB upside. Sludge in the mixed solutions returned to reaction zone from precipitate zone to three phase separation zone by gravity, and the resultant biogas discharged out of the reactor through collecting chamber by pipeline. No mechanical stirring device existed in UASB system, and slurry mixture was undertaken through the uprising and agitating of biogas resulted from flow elevation and treatment processes. Usually, filler was not necessary, and thus UASB system has a simple structure and was easy to maintain.

### 3.5 SBR trial

SBR method, namely sequencing batch reactor, is a regeneration and modification of early filling-and-emptying reactor (Irvine, 1985). The obvious predominance (Peng, 1993, PP. 29-31) of SBR includes as follows: simple technological process, low cost of capital construction and performance; reaction phase is an ideal plug flow process with strong impetus resulted from biochemical reaction and good efficacy; flexible performance manner, good effect of deamination phosphorus removing, and optimal technology for preventing sludge from swelling; resistance to shock loading, and good capability of dealing with toxic or high concentration organic wastewater. SBR was used as subsequent process of anaerobic treatment, in order to assure that the whole effects of system attained the discharge standard. SBR reactor was a cylinder made of 5mm organic glass with total volume of 4.5L, diameter of 140mm and effective height of 293mm. Aerobic sludge sampled from secondary sedimentation tank of a sewage treatment factory was cultured and acclimated in SBR reactor. 8d later, system performance was basically stable, and the color of sludge appeared deep tan with larger floccule, clear margin and better settling property, which indicated that sludge culture had succeeded. If water inflow was too strong, heterotrophic bacteria in reactor would propagated largely due to sufficient nutrition, while nitrobacteria propagated slowly with small specific growth rate, and accounted for less and less proportion in sludge. Moreover, both bacteria would compete for the substrates and dissolved oxygen, which had inhibitory effect on the generation of nitrobacteria. Therefore, each water inflow should not be above 1.5L, and under such situation, sludge load of reactor was 0.40kgCOD/(kgMLSS·d), and COD removal was 80%~85%. Results were depicted in Figure 4.

### 3.6 BAC trial

BAC technology used activated carbon with huge specific surface area and developed void structure as carriers for aggregation, propagation and growth of microorganisms, and under the condition of moderate temperature and nutrition, exerted microbiological degradation simultaneously. Such water treatment technology was also called BAC method. Interaction of BAC granule, microorganism and water pollutants (matrix) and dissolved oxygen was involved in the process of wastewater treatment by BAC. From micro perspective, synergistic effect of BAC adsorption and microbiological degradation was not ordinary superposition of both (Woo, 1997, PP. 21-28).

In the present paper, adsorption capacity of BAC was investigated, where granule fragmentary carbon with high adsorption capacity for organic substances was selected as biological carrier, meanwhile diluted pig manure sludge was undertaken to aerobic acclimatization and culture in lab scale, which was applied as biological source to prepare BAC for investigation. 5d later, through the observation of microscope, a layer biofilm was coated in the surface of BAC, which indicated that preparation of BAC has tended to be mature and could be undertaken to treat with wastewater from cephalosporin production.

Wastewater after processes of hydrolytic acidification- UASB-SBR was added to BAC column, in a manner of lower inlet and upper outlet, influents and effluents COD, chroma and removal was presented in Figure 5.

Results showed that BAC advanced treatment could effectively eliminate the COD and chroma of wastewater treated by aerobic treatment, where COD attained below 100mg/L and chroma was 40.

## 4. Conclusions

In the normal process of reactor, COD removal of hydrolytic acidification and UASB reactor effluents was kept 36%~55% and 80%~90%, respectively. Sludge load of SBR reactor was 0.40kg COD/ (kgMLSS·d), and COD removal was 80%~85%. BAC advanced treatment could effectively eliminate the COD and chroma of wastewater treated by aerobic treatment, where COD attained below 100mg/L and chroma was 40. Therefore, wastewater basically conformed to the discharge standard of "Integrated wastewater discharge standard" (GB8978-1996).

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Table 1. Wastewater original quality and outlet requirments

Indices	pH	COD/ mg/L	BOD /mg/L	SS/ mg/L	Chroma
Measured value	5.3	7230	595.1	5890	850
Outlet requirments	6~9	100	30	70	50

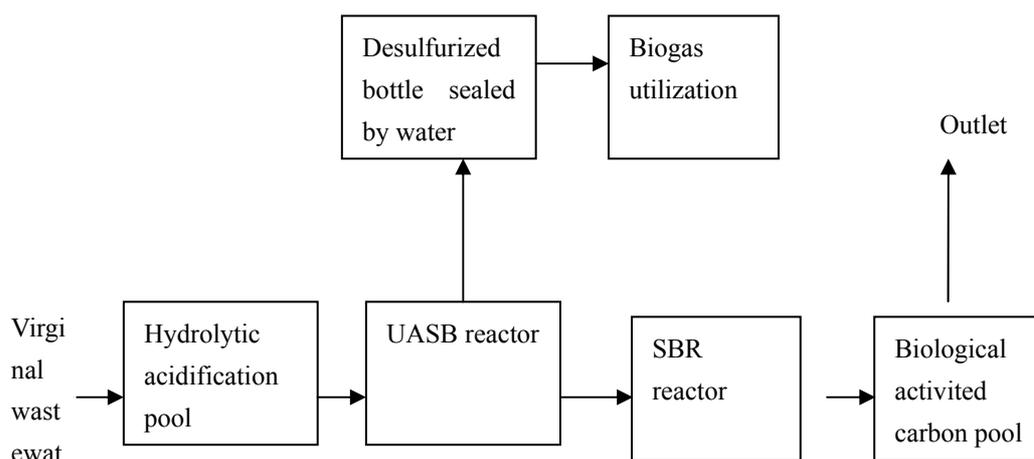


Figure 1. Schematic diagram of processes

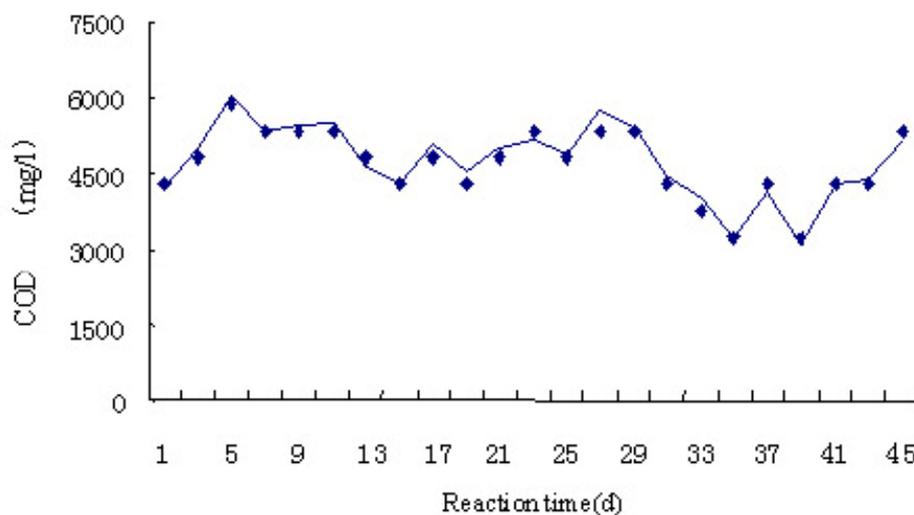


Figure 2. Changing curves of COD in effluents of hydrolytic acidification pool

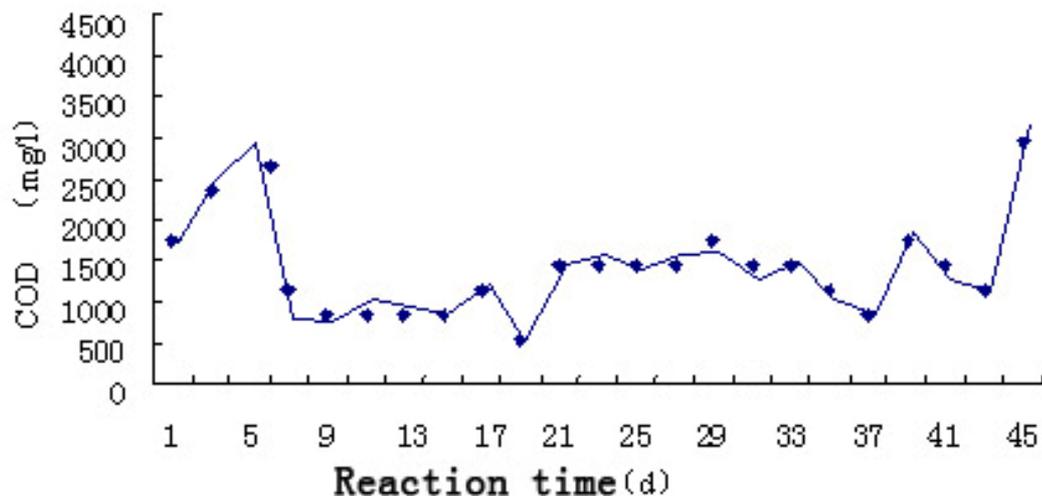


Figure 3. Changing curve of COD in SBR effluents

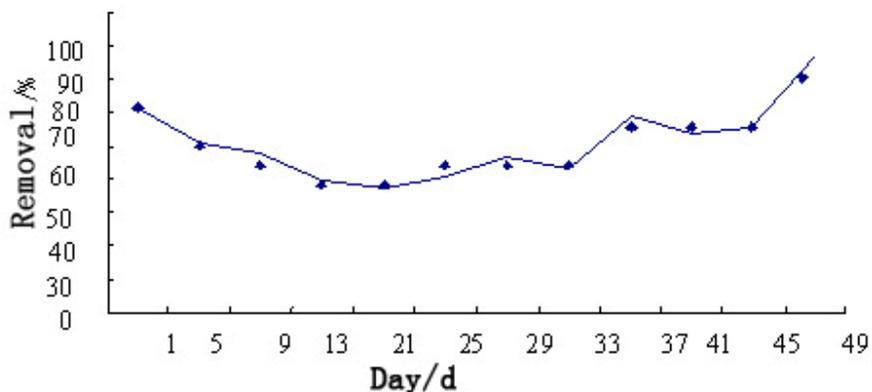


Figure 4. Changing curve of COD in SBR effluents

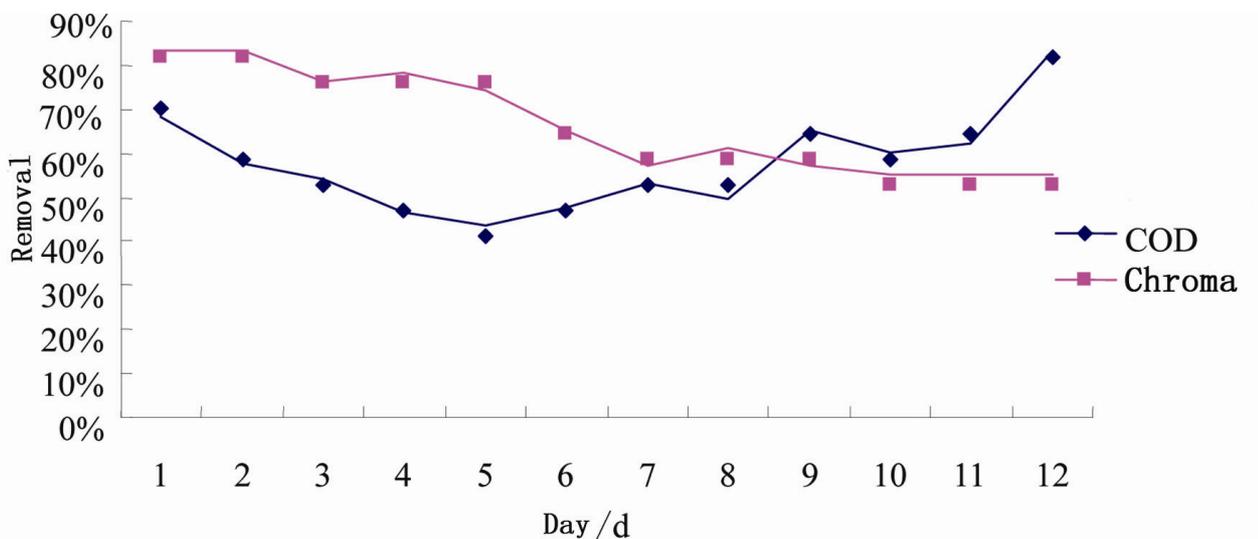


Figure 5. COD and chroma removal of BAC column