Sustainability: A Vital Concept for Transportation Planning and Development

Michael Replogle

This paper is based on a presentation made by the author at the Conference on Urban Transportation for .CW 11 Developing Countries, Sao Paulo, Brazil, 1990.

Abstract

The current pattern of metropolitan transportation and land development in the majority of countries around the world appears to be increasingly unsustainable from both an economical and environmental perspective. Many factors point to the need for adoption of a new paradigm for sustainable transportation and development in both high and low income countries -- burgeoning populations, growing air pollution, limits on global petroleum reserves, limited physical and economic capacity to expand automobile-based transportation systems without community destruction, and the urgent need to limit global CO2 emissions to slow the pace of global warming.

This paper outlines some of the conceptual differences between the current paradigm for transportation planning and an emerging paradigm for sustainable transportation and land development. It compares the US and European patterns of transport and land development, which often inspire transportation decision-makers and planners in developing countries. The paper reviews the patterns of development in the cities of several developing countries, identifying policies than can enhance sustainability.

Table of Contents

Introduction

There is a growing transportation crisis in many lesser developed countries, the product rapid urbanization and a mismatch between the supply of transportation infrastructure, services, and technologies and the mobility needs of the majority of people, whose incomes are very low. Unsustainable growth in motorization puts increasing strains on environmental quality and many local and national economies, and is increasing social conflict, poverty, and global warming.

The concept of "sustainable transportation" calls for a more holistic approach to policy and investment planning to achieve a diverse and balanced mix of transport modes and a sensible arrangement of land use that enables conservative use of energy and capital to fulfill mobility needs. Sustainable transportation strategies are those that can meet the basic mobility needs of all and be sustained into the foreseeable future without destruction of the local or planetary resource base. **(1)**

Sustainability: A Vital Issue for All

Global Warming and Development. Human civilization faces great challenges as it approaches the brink of the twenty-first century. Global warming promises to be among the biggest problems facing humanity over the next century. Barring major action to alter current trends, worldwide temperatures are anticipated by many scientists to rise 3-5 degrees (F) or more by the end of the next century. **(2)**

This would mean local climate changes highly disruptive to established patterns of agriculture, increased coastal flooding, mass human migrations, and the destruction of whole ecosystems. Tropical deforestation and emissions of "greenhouse gases," especially CO2 and chlorofluorocarbons (CFCs), are the principle causes of global warming. UN experts have estimated that greenhouse gas emissions would have to be reduced immediately by 60 percent to stabilize greenhouse gas levels in the atmosphere at today's levels. If the transport sector continues to be dependent on fossil fuel and continues its growth trends, it will likely contribute more to global warming over the next century than even rainforest destruction, which is currently the most important element in biospheric carbon releases. **(3)** Today motor vehicles alone contribute 17% of current global CO2 emissions, accounting for only one-third less total CO2 than tropical rainforest destruction. While Africa, Asia (excluding Japan), and Latin America today account for only about one-tenth of global transportation-related CO2 emissions, this will likely rise to one-fourth of the total over the next several decades, following current motorization trends. It will be impossible to stop global warming, but it is imperative for human survival to slow down its pace and extent and to restabilize global temperature over then next several generations. The largest responsibility will lie on the affluent countries with the greatest resources, which also account for a disproportionate share of the greenhouse gas emissions. The US alone accounts for nearly one-fourth of the world's carbon emissions from fossil fuel, and the rest of the industrialized world accounts for another fourth. However, no part of the world will be untouched by the effects of this problem, and no part of the world can any longer responsibly avoid looking at the relationship between its development and population control policies and global warming. The Growing Pressures for Global System Reform. While global warming has emerged only recently to raise fundamental questions about the sustainability of current global patterns of development, many other socio-economic and technological systems are have been showing signs of growing unsustainability, especially in developing countries. Rapid population growth is making it nearly impossible to raise living standards in much of the world. Cities are growing to unprecedented size, with insufficient resources to provide even basic urban services such as safe water and sanitation, housing, education, and transportation. Residents of many of these cities now choke on air pollution that frequently reaches toxic levels and face an increasingly Malthusian future. Global debt, much of it incurred to pay for imports of petroleum and motor vehicles for current consumption, continues to hobble effective development in many countries, which struggle to avoid falling farther behind.

The developing countries that are most rapidly urbanizing are, with some exceptions, adopting unsustainable motor-vehicle dominated transportation systems and land use patterns. Billions of dollars are being invested by both the formal and informal sectors to create urban forms that will be very difficult and slow to change once they are established. Thus, it is of vital importance to assess how transportation and land development can be made more sustainable, especially in rapidly growing cities.

Towards a Sustainable Transportation Paradigm

What's Sustainable? Sustainable systems can be described as those that can function for the foreseeable future without collapse or depletion of the resource base upon which they depend. Like ecological systems, they are not steady-state systems, but rather dynamic systems with many feedback loops for to provide self-regulation and to keep growth of each part of the system coordinated with the other parts as the system evolves. Sustainable systems usually achieve robustness through diversification and decentralization, complex system interconnection and interdependency, and high degrees of system specialization to utilize resources efficiently.

The current unsustainable development pattern is largely the product of the mechanistic, linear, reductionist paradigm of the world that has guided Western civilization since the industrial revolution. If human civilization is to evolve towards a sustainable pattern of development, this paradigm for transportation and development needs to be replaced with amore holistic paradigm of the world that borrows concepts from biological, ecological, and systems theory, and that places human civilization within, not above nature.

It is important for planners and economists to evaluate the paradigms that guide their understanding of transportation and land use systems. Current approaches usually reduce these systems to traffic zones, roads, and bus lines that can be assembled with the whole being the sum of the parts, like a great

machine. The emerging paradigm, based on the principles of biological and ecological systems, looks instead at the overall pattern, texture, connectivity, and functionality of land use and the various circulatory and communications structures within the system at various levels from smallest to largest. The connectivity and interaction between parts makes a whole that is more than just the sum of the parts.

The current paradigm for transportation planning seeks to maximize circulatory capacity, travel speed, and mobility, generally within the context of large subsidies to motorized transportation. The emerging sustainable transportation paradigm seeks to maximize efficiency in overall resource utilization. This is achieved by increasing modal diversity, paying more attention to the pattern of transportation and land use, and encouraging use of efficient transportation modes whenever practical, charging users the true costs of transportation, and encouraging better connectivity between modes.

Ecological systems are healthiest when they display great species diversity and many niches for specialization of function and resource utilization. So too are transportation systems healthiest when they display great modal diversity, offering opportunity for selection of the most efficient specialized mode or combination of modes to meet different functional and qualitative demands for the movement of people or goods.

Biological organisms increase in specialization of function as they grow in size, developing more complex circulatory, communication, and reproductory structures. So too must metropolitan transportation and land use systems increase their modal diversity as city size grows from village to town to metropolis. Atrophication of the small scale structures of the metropolis -- for example, the systems that facilitate walking or use of bicycles -- reduce the system efficiency and threaten the health of the metropolis just as loss of capillary circulation poses the threat of gangrene in one's limbs. When less resource intensive modes are marginalized, made unpractical, or unsafe, people have fewer choices about how to travel and must either give up travel or use a less efficient or more resource-intensive mode.

Nature limits single-celled organisms to very small sizes. One finds larger organisms only of a multi-celled variety. Similarly, single-use land areas can be of only limited size in cities before they become dysfunctional. As cities grow, multiple urban village clusters accessible to efficient circulatory systems of the larger metropolis offer the most efficient and robust form of organization of land use, reducing the needs for internal circulation that would be caused by excessively large centers. Interdependent diversification of function of these small-scale centers can enhance the efficiency and robustness of the metropolitan system just as the differentiation of different organs contributes to the enhanced functions and dominance of higher organisms in the biological world. Efficient and sustainable transportation strategies for person movement do not pretend that all movements can be made by bus or car or ignore the problems of pedestrians and cyclists. Nor do they pretend that trucks and buses will solve all goods movement needs and ignore the problems of low income people who haul products, fuel, and water on their backs or heads, in smaller quantities over shorter distances. Efficient and sustainable strategies strive for a moodily balanced system, augmenting traditional transportation with larger volume, longer distance, and faster speed movements and promoting infrastructure and land use patterns that maximize opportunities for pedestrian, cycle, and cart traffic to meet short distance movements, including access to the higher speed, larger capacity motorized or rail transport system. Efficient and sustainable strategies promote the mechanization of goods and person movements made by low income people, replacing the sheer drudgery of unaided human-powered transport with greater use of bicycles, carts, trishaws, and other non-polluting, non-resource intensive low cost tools for transport. They recognize the large externalized costs of motorized transportation by reducing or eliminating subsidies which favor over-consumption of motorized transportation.

Different Models for Transport System Development

Transportation and land use patterns evolve together over long periods of time in any community, each influenced by multiple complex forces. Consumers of transportation services, whether for person or goods movement, are at any point in time faced with a very constrained set of choices between different travel modes for a particular trip or movement of goods. The choice set they are offered is a function of the transportation infrastructure and services provided by the community, the

price of those services, and the arrangement of land uses that generate the need for transportation. These in turn, are the product of historical development and investment patterns, which shape the distance and speed with which people and goods need move within the community to make possible the ordinary transactions of everyday life and economy. Together, these factors determine the level of energy and resource use, pollution, cost, and ultimately the sustainability of the transport and land use pattern of cities.

Transportation technologies available to shape and sustain community development have evolved rapidly over the past 150 years with the advent of railways, bicycles, motor vehicles, and airplanes. For a variety of reasons, various societies at similar levels of affluence have made different choices regarding investment in these different technologies and relative transportation subsidies, leading to significantly different land use and transportation patterns, some more sustainable than others. Planners in developing countries frequently seek advice from transportation experts in affluent countries and look to these countries for visions of how their own cities might evolve. Knowledge gained through international exchanges can indeed be most helpful to avoid mistakes made by others. However, low income countries need to devise development strategies that recognize the unique character, history, and resource constraints and opportunities of their own societies. Nonetheless, it may be useful to contrast the current patterns of development in several affluent societies and to review the sustainability of these patterns.

The Unsustainable Pattern of US Transport and Land Use. When comparing US cities with Northern European and Japanese cities, one finds comparable material standards of living, but far less modal diversity and energy efficiency in the transport sector in the US. Per capita gasoline consumption in US cities is nearly twice as high as cities in Australia, more than four times that of European cities, and over 10 times greater than such Asian cities as Hong Kong, Tokyo, and Singapore. In many American cities more than 90 percent of commuters drive to work, compared with 40 percent in European cities and 15 percent in Tokyo. In contrast only 10 percent of the trips in US cities are by bicycle or foot, compared with 40 to 50 percent in European cities. **(4)** In an increasingly competitive global economic system, this inefficiency will likely threaten long-term US economic health. The biggest factor accounting for these differences appears to be not the size of cars or the price of gasoline, but the efficiency and compactness of land use patterns, which has a major effect on average travel distance and the extent to which alternatives to the automobile are viable. **(5)** The US has been viewed by many developing countries as a model transportation system, with mobility and freedom of travel for all. However, it is becoming increasingly apparent that the US cannot afford to sustain the patterns of land use and transportation it has developed in recent decades.

In the US, the automobile has reached its zenith, inducing very sprawled out and inefficient land use patterns, which force people to travel longer distances to meet daily activity needs. Land use changes and underinvestment have reduced public transportation, once the mainforce guiding metropolitan development, to a meager 3% of all trips. Vehicle miles of travel (VMT) are growing nationwide at 2.5% and in many metropolitan areas by more than 4% annually, leading to severe traffic congestion, as road-building has not been able to keep pace due to both space and fiscal limitations. Nearly 70% of the massive US trade deficit is now accounted for by imports of petroleum and motor vehicles. While the US temporarily sustains current consumption levels through debt financing and sales of its considerable national assets, continued persistence in this pattern will undoubtedly eventually lead to decline in the standard of living in the US. The US now accounts for one-fourth of total global carbon emissions, and these are growing at more than 4% a year, with 30% of the contribution from the transportation sector. Some 59 US cities are in violation of air quality standards and the automobile remains one of the largest contributors to acid rain, which damages agriculture, forests, and water quality.

Many US transport officials put great faith in technology fixes to address these problems. Higher fuel efficiency cars and alternative fuels will help reduce air pollution, energy, and CO2 emissions growth, but these improvements threaten to be significantly offset by growth in total automobile use. Moreover, these technologies will not address the growing traffic congestion crisis that grips the suburbs of most growing US metropolitan areas, where it is often impossible to widen roads due to existing development and fiscal limitations. In Southern California, where there are more freeways than anywhere else in the world, the average travel speed is 33 mph (54 kph) and is expected to drop to 15 mph (24 kph) by the year 2000.

Facing problems in managing transportation to meet environmental and community needs, as well as inadequate financing, some state and local governments are beginning to evolve new more sustainable strategies for transportation and land development that involve clustering land development, increasing modal diversity, and changing the commuter subsidy structure to favor alternatives to the single passenger automobile.

For example, Montgomery County, Maryland, a county with 740,000 people and 350,000 jobs just north of Washington, DC, recently issued a major study that looked at the strategic choices facing the County in transportation and land use over the next several decades. **(6)** This study found that if the County continued its pattern of planned automobile-dependent sprawl within corridors, traffic congestion would soon choke off economic development opportunities even if the pace of growth were slowed significantly.

On the other hand, the study found that the County could accommodate twice as many households and jobs as today if most new growth was clustered in pedestrian and bicycle friendly centers focused on an expanded rail transit and busway system, with shifts in commuter subsidies to favor alternatives to the automobile. Attaining this would require shifting from a 75% automobile driver mode share to a 50% automobile driver mode share for commuter trips made by County residents.

A fundamental conclusion of the study was that the pattern of growth is more important that the pace or amount of growth in determining the level of traffic congestion and resource use. The strategy that clustered development to favor transit, pedestrians, and bicycles led to roughly half the level of energy use and air pollution as the sprawled, automobile oriented strategy. These findings are now being incorporated into revisions of the County's growth management system and master plans for land use and transportation, although it will take years to effect the fundamental reform of many related local policies.

Similarly, in other communities around the US, from New Jersey to California, traffic and environmental problems are leading to reforms that will eventually reduce automobile-dependency and lead to stronger land use controls and more clustered sustainable development. **(7)** Implementing these reforms will require significant increased growth in a new pattern of infill development over a period of many decades. Land use patterns change slowly and only to the extent that significant growth or decay occurs in the region.

The European and Japanese Patterns: Evolving Towards Sustainability. Northern Europe and Japan have for decades pursued significantly different transportation investment patterns and employed stronger land use controls than in the US. This has led to more clustered development and more efficient multi-modal transportation systems. Right after World War Two, Europe and Japan reinvested in their public transport systems. There were several reasons for this. Unlike the US, few could afford cars in these early post-war years. The scarcity of land that could be made developable by highways, especially in Japan and some of the smaller European countries, provided less political impetus to favor an automobile-oriented development strategy. Although the US has now depleted much of its domestic petroleum reserves, Western Europe and Japan had no such reserves and thus had good reason to avoid excessive petroleum dependency.

Rising affluence in the 1960s and 1970s led Western European countries to shift investment to favor the automobile. However, the environmental and energy problems of the 1970s renewed the impetus to preserve modal diversity, aided by pressure from citizens, labor unions, environmentalists, and public transport sectors that were better organized, more powerful, and less dominated by the automobile industry than in the US. Throughout the post-war period, Japan has subsidized the extension of its railways to ever more distant compact suburban areas, while discouraging automobile use through high user charges. As a result, Japan and Western Europe enter the 1990s better positioned in terms of transport and land use patterns than the US to meet the challenges of global warming, petroleum depletion, and world economic competition, despite rising automobile ownership and use.

The policies of European and Japanese local governments recognize the need to preserve a balance between modes and to link transportation and land use policy. As the traffic policy paper of the League of German Cities notes, "Public mass transit and individual transport, either on foot, by bike, or in a car, must be seen as a holistic system. Each mode needs to be promoted where it offers the greatest

advantage in economic, environmental, and social terms. With the help of development policy decisions, building and traffic regulations and associated planning measures, we must help achieve a reduction in transport that is avoidable and shape the unavoidable traffic in a manner that improves the living and environmental conditions of our citizens." **(8)** The Netherlands and Denmark are perhaps the best models of integrated multi-modalism with sound land use planning. In both countries public transport and bicycle use fell dramatically in the 1950s and 1960s with suburbanization and rising investment in roads and automobiles, although even during this period, bicycles came into ever greater use for access to suburban rail and bus stops. Starting in 1975, it became Dutch national transport policy to devote at least 10 percent of the surface transportation budget to bicycle facilities as a way to reduce the expenditures for public transport subsidies and roads, while favoring the environment and urban quality. Today, more than 30 percent of all trips in the Netherlands are made by bicycle, and 25 percent of all access trips to railway stations are by bicycle. **(9)** Over the past several decades, the Dutch have made major efforts to maintain and expand their efficient and integrated public transport network, which relies heavily on various bus and railway modes.

In the 1988, the Dutch Transport Minister announced a bold plan to lower automobile ownership to 3.5 million cars from the current 5 million, which had been projected to grow to 8 million in just two more decades. The proposed plan included increased taxes on automobile ownership and use and expanded subsidies for public transportation, with an intent to cut CO2 emissions by 8 percent by the year 2000. Although these plans have since been weakened or slowed, current national policy remains committed to reducing transport sector CO2 emissions through strategies including significant pricing and demand management.

In Denmark, car owners pay a nearly 200 percent sales tax when purchasing a car, approximately US $1000 per year in automobile registration fees, and US $1 a liter for gasoline. Much of the tax proceeds benefit public and bicycle transport. The City of Copenhagen, for example, installed cycle paths along a large portion of the major arterial roads throughout the city in the late 1970s and 1980s and thus reversed the decline of bicycle use, which now accounts for 30 percent of all trips in the city. A new network of higher quality, higher speed, limited access cycle paths is being planned for the city to attract more long trips to bicycle use, as part of the Danish government pledge to reduce CO2 emissions by 10 percent in the next decade.

Unsustainable Patterns in the Developing World. Just as there are great differences in the transportation and land use patterns in the US, Europe, and high income Asian cities, so too are there great variations in these patterns in the cities of lower income developing countries. At the one extreme are many cities in China and South Asia, where land use is extremely compact and served primarily by cycling and walking, augmented by public transportation, and where automobiles play only a minor role. At the other extreme are fast-growing cities like Jakarta, Sao Paulo, and Mexico City, which are rapidly moving towards unsustainable motorization, with declining modal diversity, growing trip lengths, and increasingly low-density sprawled development patterns.

Computer simulations of future energy use and air pollution for Mexico City and Jakarta **(10)** project per capita gasoline use for personal transportation and average carbon monoxide levels in both cities roughly doubling over the next ten years given current trends. Both cities are adding extensive low density areas at the edges with declining overall urban population density. The importance of the central city areas is declining as the regions move towards greater use of motor vehicles and less use of traditional walking and cycle modes. .CP 3

Mexico City has not expanded capacity on its highly congested and extensive subway system to keep up with growth. Jakarta has built extensive freeways while suppressing the use of pedal-powered cycle-rickshaws by seizing 100,000 of them and throwing many of them into the sea. Jakarta authorities plan a complete ban on cycle-rickshaws in the city. The automobile culture of North America has strongly influenced the pattern of transport system development elsewhere, especially in Latin America, where transportation is dominated by buses for lower income levels and private cars for the elite. While most of the developing world aspires to achieve a modern automobile-oriented society like the US, out of every thousand people, less than 7 are car owners in China, Indonesia, India, Bolivia, Zaire, and Honduras, less than 14 in Liberia and Thailand, only 60 in Brazil and Mexico, and only 90 in Venezuela, compared to 300 in Europe and 500 in the US. Although bus transport is relatively cheap in many

developing countries, many cannot afford it. Transport by foot, animal, and bicycle is still widespread. Venezuela spends half its public works budget on roads and highways and countries like Haiti and El Salvador spend one third of their import budget on fuel and transportation equipment, while failing to meet a large share of the basic mobility needs of the population. **(11)** Air pollution in Santiago, Chile, Mexico City, and other cities across Latin America is among the worst in the world, largely due to growing motor vehicle use.

Many African cities remain largely walking cities, but as their population grows, many people end up spending many hours each day traveling on foot, due to grossly inadequate public transportation and the unavailability of bicycle transportation. In many African countries, bicycles are beyond the financial reach of a large share of the population, due to low incomes, lack of small-scale credit systems, high import taxes on bicycles, and lack of local production of bicycles of workable quality. However, in many cases, bicycles are available to a significant number of people, but the road infrastructure denies cyclists a safe place to ride.

For example, in many low income areas near Nairobi, Kenya, bicycle ownership ranges from 250 to 400 per 1000 working males, but most walk distances of 7 to 15 km. to work because the roads are too dangerous for cyclists. **(12)** However, progress towards sustainability is being made. As a result of lobbying by local activists, the Kenyan government in April 1990 announced plans to build lanes for cyclists and pedestrians where roads pass through densely populated areas. **(13)** Sustainable Strategies for Cities in Developing Countries. It is important for cities in developing countries to avoid making the mistakes of US transportation policy. The Netherlands, Denmark, and Japan would serve as better long-term models for transportation and land development. Yet even these countries now afford far higher levels of automobile use than will likely be sustainable on a global basis, given limited global petroleum reserves, limited global capacity to absorb more CO2 emissions, and limited capital to provide mobility for fast growing urban populations in developing countries. New models for transportation and land development suited to the conditions of different countries need to be devised, not just borrowed from the affluent countries. Latin America and Africa may find good examples of sustainable strategies in many of the bicycle cities of Asia.

China's cities provide many examples of how well non-motorized transportation can meet basic mobility needs without requiring substantial capital or fossil energy inputs. For decades, China has invested in low-cost mass production of bicycles, invested a significant portion of infrastructure spending on non-motorized transportation improvements, and offered workers subsidies for commuting by bicycle. Special bicycle streets with six lanes are not uncommon in Chinese cities. Motor vehicles, pedestrians, and cyclists are often separated on three-track roads. Guarded bicycle parking convenient to workplaces and shops is commonplace. As a result, in typical Chinese cities, between 50 and 90 percent of daily trips are made by bicycle. China has been able to provide relatively fast and high quality personal transportation to a large share of the population while deferring heavy public transportation investments.

Growth in incomes in the 1980s brought sharply increased bicycle ownership levels in Chinese cities, leading to serious traffic congestion. As a result, Chinese authorities are working to improve traffic management and public transportation, seeking to shift longer distance bicycle trips to buses, staggering work hours, trying to move workers closer to workplaces, and to develop local business centers. Given limited capital to expand bus fleets, bicycles will continue to be a sustainable and predominant mode of urban transportation in China for the foreseeable future. **(14)** China may offer important lessons for Latin America and Africa, where in many countries, the growth of public transportation has failed to keep up with population growth and where sprawling informal settlements at the fringe of cities are very difficult to serve by public transportation at a cost low income residents can afford. A study of different transportation scenarios for Bogota, Columbia, in the year 2000 has shown that promoting bicycles and public transportation to meet expanded transport system needs, including building a subway, could be accomplished at one-third of the cost of unhindered private motorization. If private motorization continues at expected rates, a three to six-fold expansion of the present road network would be needed to serve traffic demand. **(15)** The largest industrial bakery in Bogota provides a good example of sustainable transportation principles. In the early 1970s, the Ramo bakery delivered products direct from the factory to 60,000 small shops in Bogota using 135 trucks, which often operated with partial loads and had trouble parking near their deliveries. The bakery changed its distribution

system so that a much smaller fleet of trucks were used haul products to satellite warehouses, where a fleet of 900 cargo-tricycles picked up the baked goods for final delivery. Total costs of the delivery/sales system dropped by two-thirds from their previous level through this intermodal integration and differentiation. **(16)**

This type of transport system refinement for sustainability, where a single mode is replaced by a combination of modes to accomplish a transportation task more efficiently, is needed in cities and countries around the world. An analogous combination in personal transport is bike-and-ride systems. Hundreds or thousands of bicycles are frequently found parked at railway stations in many cities in China, India, Japan, and Europe, where the predominant means of access to express railway stations is often the bicycle. Such systems can expand the market area for stations at both home or work ends if secure bicycle parking is available and if it is safe and feasible to cycle in the surrounding area. Bike-and-ride system development is an important sustainable strategy for large cities with long average trip lengths.

Virtually any country in the world has the capability to develop a domestic bicycle assembly industry as one of the foundation elements of a more sustainable transportation system. In recent years, new small-scale bicycle assembly industries have been initiated in several countries, including El Salvador and Nicaragua, following India's model of bicycle industry development. **(17)** Such development strategies offer dramatic potential for employment generation. A US $12,000 investment in a conventional bus system in Patna, India, for example, creates two new direct jobs. If invested in a motorized autorickshaw, six direct jobs are created. The same sum invested in the pedal-rickshaw industry creates 75 jobs. **(18)**

There are many aspects of current transportation and development patterns and policies that need to be reassessed for their impacts on sustainability. Ultimately, no transportation or development system will be sustainable without stabilizing global human populations to match the Earth's carrying capacity and moving towards a more equitable distribution of resources across the world.

Only through open inquiry into the long-term effects of our socio-technical systems can we begin to comprehend the implications of our current actions. We humans are in danger of using up our only home planet. Like the Iroquois Indians of North America, we should begin seeking wisdom by making our decisions based on their effect on the seventh generation that will follow us.

References

(1) Michael Replogle (1989), "Transportation Strategies for Sustainable Development," Proceedings from the 5th World Conference on Transport Research, Yokohama, Japan, July 1989.

(2) "UN Report Predicts Dire Warming," Washington Post, May 26, 1990.

(3) Krauts, Florentine, et. al. Energy Policy in the Greenhouse, International Project for Sustainable Energy Paths, El Cerrito CA, 1989, p. I.3-34.

(4) John Pucher, "Urban Travel Behavior as the Outcome of Public Policy: The Example of Modal-Split in Western Europe and North America," American Planning Association Journal, Autumn 1988, p.510.

(5) Lester Brown and Jodi Jacobson, The Future of Urbanization: Facing the Ecological and Economic Constraints, Worldwatch Paper 77, Worldwatch Institute, Washington, DC 1987)

(6) Montgomery County Comprehensive Growth Policy Study, Montgomery County Planning Department, Silver Spring, Maryland, 1989.

(7) see for example, Reviving the Sustainable Metropolis: Guiding Bay Area Conservation and Development into the 21st Century, Greenbelt Alliance, San Francisco, California, 1989.

(8) cited in Dr. Hans Pflaumer, "Traffic Concepts for the City of Tomorrow: A German View," ITE Journal, July 1988, p.47.

(9) Michael Replogle, Bicycles and Public Transportation: New Links to Suburban Transit Markets, Institute for Transportation and Development Policy, Washington, DC, 1984 (2nd printing 1988).

(10) Mark Hanson, "The Motor Vehicle Dominated City as Non-Sustainable Urban Form: Mexico City and Jakarta," Computers, Environment, and Urban Systems, Vol.13, p.95-108.

(11) Ricardo Navarro, Urs Heierli, Victor Beck, "Bicycles, Intelligent Transport in Latin America," Development, 1986:4, Society for International Development, Rome, Italy, p.45.

(12) Private communication from Njagi Gakunju to Michael Replogle, 14 May 1990.

(13) "Mibei Unveils Road Safety Measures," Daily Nation, Nairobi, Kenya, 7 April 1990.

(14) Marcia Lowe, The Bicycle: Vehicle for a Small Planet, Worldwatch Paper 90, Worldwatch Institute, Washington, DC, 1990.

(15) Ricardo Navarro, Urs Heireli, Victor Beck, La Bicicleta Y Los Triciclos, Centro de Estudios en Tecnologias Apropiadas, Santiago, Chile, 1985, p. 37-64.

(16) Ibid, p.154-156.

(17) "Gridlock Weary, Some Turn to Pedal Power," The Urban Edge, Vol.14, No.2, The World Bank, Washington, DC, March 1990

(18) V.Setty Pendakur, "Formal and Informal Urban Transport in Asia," CUSO Journal, December 1987, p.18-20.