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MIPALCON 2010

Infrastructure Planning and Development in Developing Countries – 'The Way Forward'

First International Alumni Conference

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Foreword

More than 25 years after its foundation in 1983, the Master´s Program Infrastructure Planning (MIP) has qualified more than 300 alumni who are now helping in various ways in more than 68 developing and emerging countries all over the world. There have been successes, setbacks and challenges but through it all a formidable force of intellectuals and professionals had been brought up from this interdisciplinary program. One big success factor is without doubt the multicultural background of the alumni and the present students.

In the past there have been alumni meetings as singular events on the occasion of the 10th and 20th anniversary of the study program, but the idea behind the "MIPALCON" (MIP AL*umni* CON*ference*) is to establish a regular sequence of biannual alumni conferences in order to foster the continuous exchange of knowledge and experience between the members of the MIP network. These conferences shall be linked to "Networks for Mobility" - the conference of FOVUS, the Center for Transportation Research at the University of Stuttgart.

MIPALCON 2010 as the starting point of this series brought together experiences, challenges and best practices from various professionals who have already gone through the MIP studies since 1983. Supported by the DAAD and selected by review of the Scientific Advisory Committee, 15 alumni presented their current work, discussing their ideas with current MIP students, lecturers and experts from the field of infrastructure planning. This publication contains all contributions presented at the conference.

On behalf of the Master's Program Infrastructure Planning and the University of Stuttgart I hope you will find the MIPALCON 2010 proceedings both informative and inspiring.

Prof. Dr.-Ing. Markus Friedrich
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Welcome of the City of Stuttgart

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The City of Stuttgart has almost 600.000 inhabitants. It is the urban centre of the Metropolitan Region of Stuttgart with over 3 million inhabitants and also capital of the State of Baden-Württemberg with 10 million inhabitants.

Stuttgart is an international city and will continue to diversify more in the 21st century.

As of today, people from over 170 nations, speaking over one hundred languages have come to live in Stuttgart during the past decades. The resulting cultural, religious, ethnic, and national diversity makes Stuttgart a "microcosm of the United Nations" in the array of internationality and integration.

Stuttgart's valley location with the steeply rising slopes is unique. Surrounded by three wooded elevations, the city is open in the east to the Neckar and thus has a pleasant climate. Vineyards which reach into the inner city, parks, forests and orchards cover more than half of the 11,000 hectare large city and justify Stuttgart's reputation as one of the most beautifully located large cities of Europe.

Charmingly situated in the heart of one of Germany's largest wine-growing regions, this vibrant metropolis fascinates visitors from all over the world. The state capital of Baden-Württemberg delights tourists not only by virtue of its magnificent panorama, its impressive gardens and parks, its fine squares, splendid palaces and buildings in a wide range of architectural styles, but also by its cultural diversity. Stuttgart's traditional festivals also enjoy world-wide popularity: the great Stuttgart Spring Festival, the elegant Summer Festival whose white pavilions, countless fairy lights and lanterns make it one of Germany's most delightful city festivals, and the Stuttgart Wine Village with some 120 lovingly decorated wine arbours. At the end of September things really heat up during the Stuttgart Beer Festival. Stuttgart is a city that offers excellent quality of life - a harmonious blend of high tech, high culture and high quality. Offering a wide range of cultural and leisure activities, Stuttgart has something to suit everyone. Prominent in the Stuttgart cultural life is the State Theatre Stuttgart with renowned plays, the world famous Stuttgart Ballet and the State Opera. In the Wilhelma, Europe's largest zoological - botanical gardens, you can gaze at more than 10,000 animals and exotic plants.

The Stuttgart region is Europe's leading high-tech region and Germany's strongest commercial metropolitan area. Independent reports continually confirm Stuttgart as one of Germany's leading business locations.

Known around the world are large Stuttgart companies like Daimler, Bosch and Porsche, which stand for Swabian innovation and successful entrepreneurship and which characterize the city as an attractive economic location.

Stuttgart has also made a name for itself as a media location. More than 150 book and periodical publishing companies are located in the state capital. Stuttgart is now increasing its importance as an international trade fair and congress city with the opening of the new state trade fair grounds with around 100,000 m² hall surface and a highly modern congress centre.

The City of Stuttgart is very active in the field of development cooperation. Stuttgart believes that, in the age of globalization, it has the responsibility of participating in ensuring that cities around the globe are in the position to offer their inhabitants a future where life is worth living.

This is why in July 2005, over 150 organisations, associations and initiatives which have their home in Stuttgart joined forces to create the "Stuttgart Partnership One World". This new network is an alliance of partners which maintain intensive contacts with many countries around the world. All associations, organisations, groups, and initiatives are called upon to work towards the observation of the principles and values of the Charter of the United Nations today and in the future to make sure that the greatest possible number of people may benefit from this Charter in their daily lives. On the international level, Stuttgart is engaged in several projects and networks in the field of mobility, urban planning, environment, integration, development cooperation, town twinning, youth and children, culture and sports. Mayor Dr. Wolfgang Schuster is currently the president of European Council of Municipalities and Regions and Vice-president of United Cities and Local Governments, the world's most important association of local authorities.

Known as the "cradle of the automobile", today Stuttgart counts on a globally unique mobility cluster made up of many large and medium-sized companies which are connected all over the world. They work closely together with local education, science and research institutes. An example for the linking between local and international research in the field of urban mobility is the biennial symposium "Networks for Mobility" organized by the University of Stuttgart. Regarding urban mobility, the City of Stuttgart has initiated and coordinates the global network “Cities for Mobility” which brings together over 600 partners in 82 countries aiming at to develop new concepts for sustainable urban mobility in urban regions (for more information please visit www.cities-for-mobility.org). There are also some fantastic places to know more about the tradition and the future of the automobile: The Mercedes-Benz Museum, the Porsche Museum and the Centre for Electro-Mobility with the worldwide first showroom on all types of e-mobility.

Source: Wikipedia

The Evolution of Transportation Planning in Bogotá

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Abstract: This paper provides a chronological overview on the evolution of the planning of public transport in the City of Bogotá, the capital of Colombia in South America. It begins, with presenting the city with the first model of private operation that run between 1884 and 1910 to operate the tram system and its development under the public administration until 1951. In that area also trolley buses where in use. This well functioning system was followed by a private-public model, operating on bus routes and using buses with gasoline engines. These companies got their licenses from the state. The state got his income, still like today, from vehicle registration fees and from monthly payments for the route licences. This provided the municipality an income without any risk, which is assumed in part by the owner of the vehicle and directly by the driver who is paid per passenger transported This modal became very common and it served up to 90 % of public transport in Colombia. Today it makes up to 48 % (country-wide). In Bogotá, this model had the jurisdiction of the municipal corporation with the operation of electric buses and diesel between 1910 and 1991 when it disappeared.

The document continues by highlighting the entry into the operation of a mass transit system by buses. TransMilenio came into operation in 2000 and has been consolidated as a transport model of high operating efficiency according. It can compete with mass transit systems as the subway. The operation of bus rapid transit (BRT) led the city administration to seek for improvements in the traditional public transport service and to integrate it with the BRT system.This leads to the Integrated Public Transport System (SITP). This system will be operated by just 13 companies, which will be responsible for the service, to buy the buses and to hire the drivers. SITP will have fixed stops and stations and will be fully integrated with TransMilenio by special interchange stations.

The end of the document gives an overview on various studies conducted over the past 30 years, in order to implement a Metro in Bogotá. But ít also explains why none of the several proposals submitted by consultants and the state finally was implemented. With the most recent study (2010) the administration wants to implement a Metro in Bogotá, following election promises. Finally, the program for the integration of the mobility system of the City of Bogotá with the Department of Cundinamarca is described.

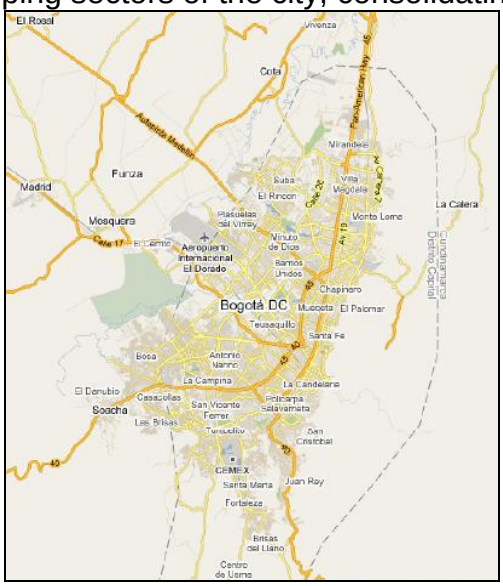
1 The City of Bogotá

Bogotá, the capital of Colombia in South America, is located on the eastern mountains in the east branch of the Andes, at an altitude of 2,600 m above sea level, and covers an area of 177 thousand hectares from which 31 correspond to the urban area.

Source: Google Earth

Photo 1: Localization of Bogotá City

Bogotá is a linear city whose morphological development was stimulated by the former tramway track, which became one of the most important structural elements, not only for its effect on growth and urban design but also by changes induced in relations between developing sectors of the city, consolidating the form of growth.



Source: Google Maps

Map 1: Map of Bogotá City

Bogotá has a population of 7.4 million inhabitants (2010) representing 16.1 % from the total national. It has 15,000 km-lane of roads, with 895,000 cars and is served daily by 16,000 vehicles for public passenger transport, which mobilized 1,220 million passengers each year. In Table 1, we can see the most important basic data of the city.

Concept	Reference Year	Unit	Total
Extension	-	Hectares	177.598
Population	2010	Inhabitants	7.363.782
Male	2010	Men	3.548.713
Female	2010	Women	3.815.069
Households	2005	Units	1.931.372
Dwellings	2005	Units	1.767.808
Streets	2008	Km-lane	14.781
Cars	2008	Units	895.293
Transit			
Transit Buses	2009	Units	15.963
Passengers moved per year	2009	Millions	1.221
Routes	2009	Routes	498
Transport companies	2009	Companies	65
Mass transit			
Trunk Vehicles	2008	Units	1.072
Passengers moved per year	2009	Passengers (millons)	435.6
Road Accidents			
Traffic Accidents	2008	Cases	36.159
Deaths	2008	Victims	537
Injuries	2008	Victims	3.080

Sources: Alcaldía de Bogotá, DANE, Cámara de Comercio de Bogotá, Secretaría de Movilidad.

Table 1: Basic Data of Bogotá

Source: Alcaldía de Bogotá (http://www.bogota.gov.co/portel/libreria/php/01.010101.html)

Photo 2: Bogotá city view from the hills

Source: Alcaldía de Bogotá (http://www.bogota.gov.co/portel/libreria/php/01.010101.html)

Photo 3: Night view of the Bogotá city

2 Means of Public Transport

The public transportation of passengers in Bogotá has evolved until today in three systems:

1. The tram
2. Buses, small buses and minibuses, and
3. The Mass Transit System by Buses - TransMilenio.

This year (2010) is implementing the Integrated Public Transport System and studies are being developed to organize the Comprehensive Program of Mobility of the Capital Region - CPMCR, in order to integrate all systems, including the subway and the future commuter rail (see Figure 1).

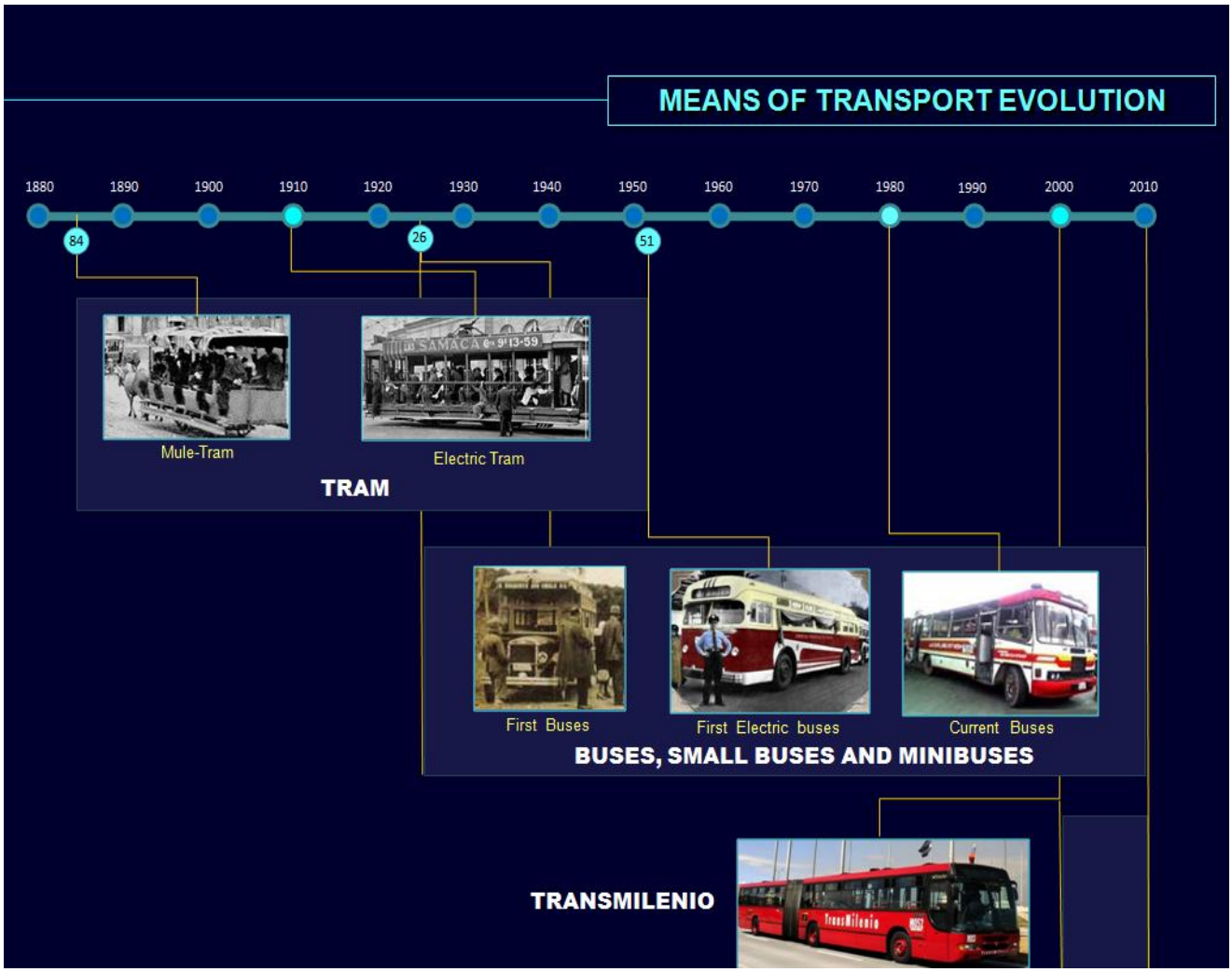


Figure 1: Evolution of means of public transport in Bogotá City

3 The Tram

3.1 The Beginning

Streetcars became the first system for public transportation in Bogotá. It had its origin in 1884 through an exclusive agreement concluded between the municipal government and a private entrepreneur who sold U.S. rights to other investors. He founded the Bogotá City Railway Company Co. to serve a population of 90,000 inhabitants. The scheme came into operation on the 24th of December of that year with 16 two-axle trams pulled by mules that moved over wooden rails coated metal, with a capacity of 20 passengers seated and some standing as shown in Photo 4. The route connected what is now the downtown and a village in a distance of 6 kilometers which is now the traditional neighbourhood Chapinero (see Map 2).

Source: Allen Morrison. http://www.tramz.com/co/bg/t/ts.html

Photo 4: Mule-drawn streetcars

In 1910 the electric trams came into operation (see Photo 5). In that same year, after a citizen boycott due to dissatisfaction with the service delivered, the system returned to public service and the operator became the Municipal Railway Company Bogotá that operated until 1951. During this time and especially since 1923 the tramway worked in open competition with bus companies, whose owners are accused of forcing the demise of the tram, by burning many of the cars (see Photo 6). This took place during the events of April 9th, 1948, when the people, enraged by the murder of one of their leaders, led a revolt that destroyed a big part of downtown. Three years later the tram disappeared giving way to private service buses, operating on a model in force until today.

Source: Allen Morrison. http://www.tramz.com/co/bg/t/ts.html

Photo 5: Electric trains when it started in operation in 1910

Source: Allen Morrison. http://www.tramz.com/co/bg/t/ts.html

Photo 6: Tram burning in 1948

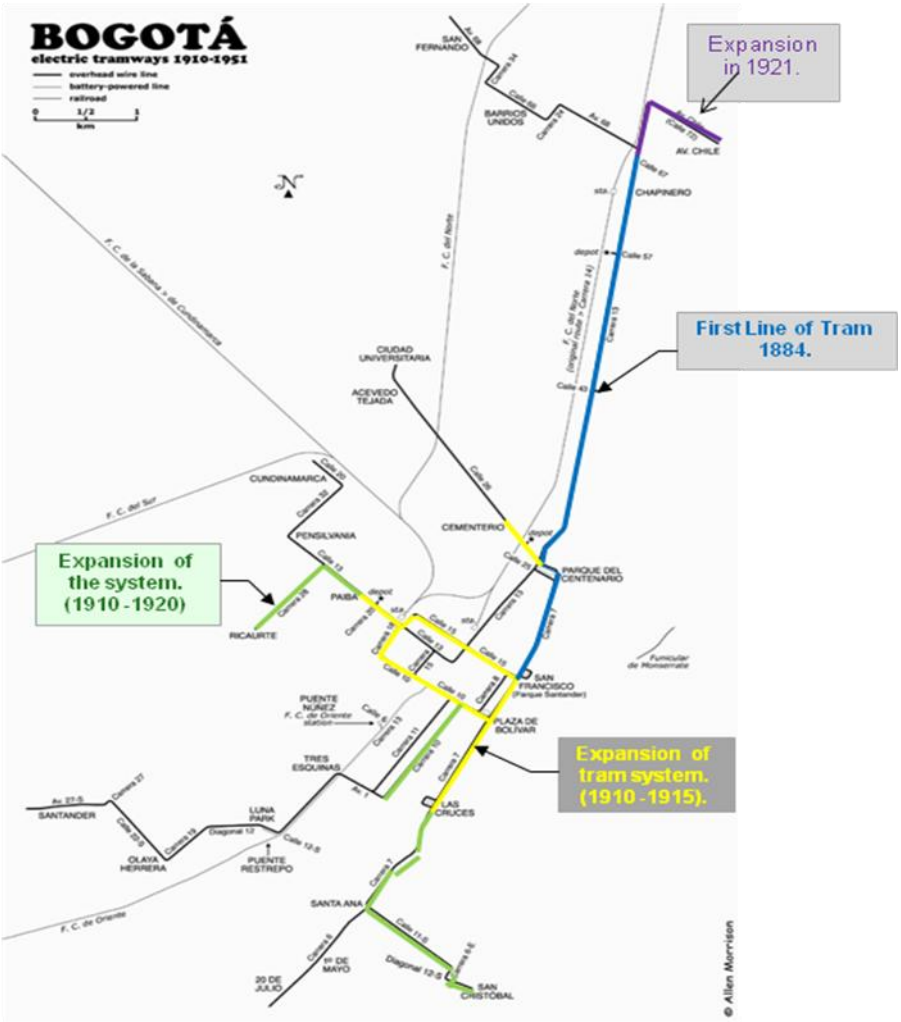
3.2 First Private Model of Operation

The obligation of the private contractor between 1884 and 1910 included the construction of infrastructure, purchase of cars and the operation of the routes, which became the first private model for the operation of passenger service. This service was supported by the city with a credit of $ 12,000. The system was used by approximately 66,000 passengers, and the fare was $ 0.02. During the operation of the municipal company, in 1916 the Eastern Railway Company received a franchise to operate a service from Carrera 13 to Yomasa Neighborhood (see Map 2), which became a second private operation of the tram.

3.3 Expansion of the System

Under the municipal administration (1910 - 1951), the company improved services and expanded lines progressively through the city as shown on Map 2. Between 1910 and 1915 the system got extended to the South on Carrera 7 to Las Cruces

and to the West by the Calles 10 and 15 to the Paiba Station and from 26th Street to the Central Cemetery. Between 1910 and 1920 the service was extended to station Paiba Ricaurte and also from Las Cruces to San Cristobal. There was also a new line down the Avenida Carrera 10 to 1. In 1921 the system covered also the Calle 72 westbound and Carrera 13 to Calle 67. Later electric tram services were developed to the northwest along the Avenue 68 to San Fernando, on 26th Street to University City and to the Southeast neighbourhoods July 20, the Olaya Herrera and Santander neighbourhoods.



Source: A*llen Morrison* "The Tramways of Bogotá Colombia" http://www.tramz.com/co/bg/t/tm.html

Map 2: Tracing the tram lines of Bogotá

4 Public Transport Passenger by Buses

4.1 The Beginning

Photo 7: The First Buses – 1923

In 1926 a first private bus company was founded, which disappeared a few years later due to the regulations to be imposed and the "war" unleashed by the tram. These busses often moved without any organization and with great flexibility. During the late twenties first routes were created, but there was no obligation to comply with them.

In 1934 the appearance of new private companies started to transport passengers in the form of cooperatives, whose goal was to be in possession of the routes and to operate them granted by municipal authorities. These cooperatives were formed by bus operators (owners of buses) who bought shares of the cooperative in relation to the number of buses they owned. Furthermore, these owners were required to pay a monthly fee for operating on the roads and were responsible for the administration and maintenance of the vehicles and for hiring drivers, who were paid by the number of passengers they carried. This model of operation of the service is currently in force with some modifications.

4.2 The Municipal Electric Bus Service "Trolleybuses"

With the unfortunate demise of the tramway in 1951, the municipal utility service enters the city with an electric bus system that went to compete with private buses and quickly filled the gap left by the tram. Between 1952 and 1958 the municipality sought to respond to the transportation of the city with the District Transport Company, which by 1954 had 15 trolley busses and 83 gasoline driven busses.

Source: Ospina Andrés, Vladimir Mosquera. “Historia de transporte público en Bogotá” (http://www.museovintage.com/transporte/1970.htm)

Photo 8: First Electrical Buses - 1951 Photo 9: Trolley bus services in 1970

4.3 City Bus Company

In 1959 the transformations of the tram company were finished by the creation of the Urban District Transport Company with a system composed of trolley busses and diesel buses, but with low coverage compared to private transport. In 1962 it covered 10 routes with 85 diesel buses and 25 trolley buses. In total, 46,000 passengers per day in a city with 1.6 million inhabitants were transported. In 1970 it moved 36 million passengers. In 1985 the number of passengers fell to 13 million and in 1990 to 5 million. After several attempts of modernization, financial problems and significant differences between union workers and managers the company disappeared in 1991. The municipal transport company was gradually losing its dominant position in comparison to private transport. For example, the share of passengers transported by the tram fell from 75 % in 1951 to 30 % in 1953. Accordingly the share of private companies grew between 1957 and 1967 from 62 % to 92 %, and in 1973 they covered 95 % of journeys. The public model was unsuccessful due to high operating costs, due to a disproportionate workload and in comparison with the performance delivered to the client and due to bureaucratic management.

4.4 Public Transport Service nowadays

After with the Urban District Transport Company the last public company for public transport dissappeared we had the following situation:

- The state planned, regulated and controlled the service.
- The government provided the infrastructure necessary for operation.
- Private operators provided the service under market conditions.

The result of this is shown in Photo 10.

Photo 10: Public transport operation in Bogotá

In 2009 in Bogotá 66 companies are operating in public transport, with 15,963 vehicles (buses, small buses, minibuses, see Photos 11 - 13). They operate 498 routes throughout the city and mobilize 1,221 million passengers annually, with a prevalence between 65 % and 85 % of motorized trips.

Photo 11: Vehicle type: bus

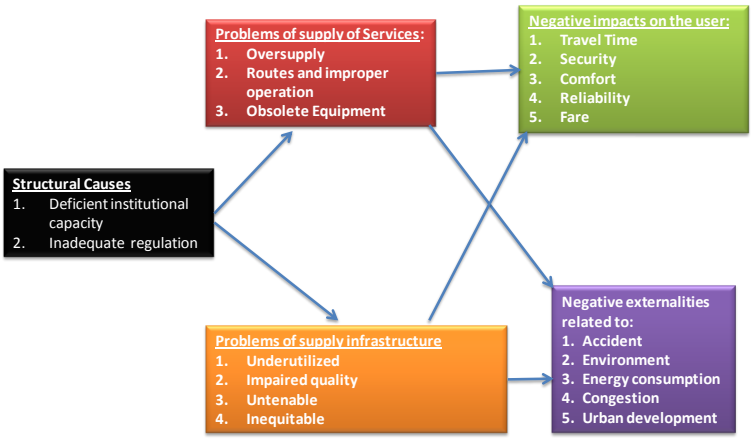
Photo 12: Vehicle type: small bus

Photo 13: Vehicle type: mini bus

4.5 The Public Transport Problem

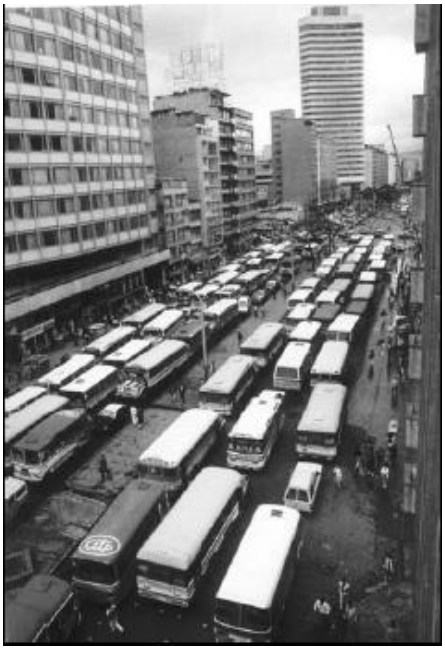
During years this service has suffered structural problems creating negative impacts on users, and also negative externalities, as described in Figure 2.

The structural causes are represented by weak institutional capacity and inadequate regulation. This is the problem's cause for the service supply, represented in over biding routes, improper operation and outdated equipment. A second problem is formed by the infrastructure which is overutilized, unsustainable and inequitable. These problems lead both to negative impacts on the users with respect to travel times, safety, comfort, reliability and the tariff and to negative externalities associated with safety, environment, energy consumption, congestion and urban development.



Source: National Department of Planning, CONPES 3761. 2002

Figure 2: Main problems about urban transit transport in Bogotá



Source: Oscar Aristizabal “Disfuncionalidades perennes de movilidad y transporte en Bogotá. 2009

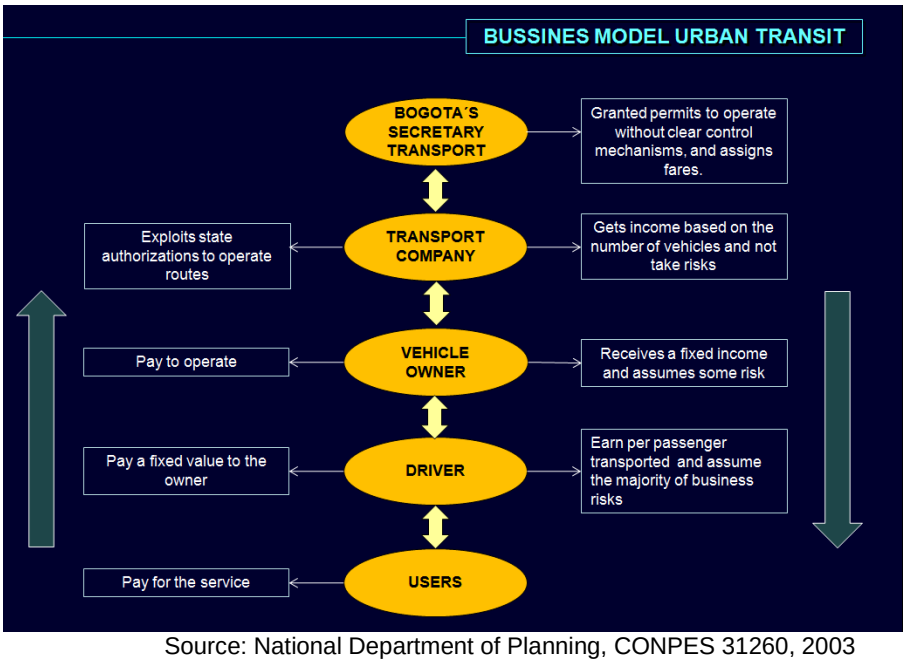
Photo 14: View of public transport operation in 1970

Source: Oscar Aristizabal “Disfuncionalidades perennes de movilidad y transporte en Bogotá”. 2009

Photo 15: View of public transport operation in 1990

4.6 Business Model of Public Transport

The business model was inherited from the appearance of the first companies in the early 30s (see Figure 3). It almost has not changed and has remained essentially for nearly eight decades.



Source: National Department of Planning, CONPES 31260, 2003

Figure 3: Business model urban public transport

The municipality, represented by Bogotá´s Secretary of Transport, grants the operating license and permits for the operation of routes to private transport companies. These transport companies sell their permits for a fixed monthly income to the vehicle owners. To operate the vehicles the vehicle owners hire vehicle drivers who are paid per passenger mobilized. So finally the passengers have to pay several participants in the system on different levels. Since the drivers revenues finally are decisive for the whole system the drivers try to catch as many passengers as possible. This

search of passengers leads to a “war for the passenger” on the road between the bus drivers, sometimes also named “penny war”, affecting service quality and increasing the risk.

4.7 Indicators of Urban Public Transport in Bogotá

The main indicators of the public transport system by buses, small buses and mini-buses, which allow us to examine the operating conditions are listed in Table 2. It highlights the fact that in total 16,168 vehicles are in daily service. These buses have an average age of 10 years, the small buses even of 17 years. All the buses are operating in total 505 routes, which have an average length of 54 km, with a average travel speed of 23 km/h and with 1.6 persons per km transported.

Indicator	Unit	Total
Vehicles in daily service	Vehicle	16.168
Average travel speed	KPH	23
Fleet average age	Year	10
Average age of smallbuses	Year	17
No. of registered buses	Vehicle	7.256
No. of registered smallbuses	Vehicle	5.198
No. of registered minibuses	Vehicle	5.357
Average length of routes	Km	54
No. of routes in operation	Route	505
No. of companies	Company	66
Passengers moved per day per vehicle	Passenger	228
Passenger per kilometer rate	PPK	1.6

Source: Cámara de Comercio de Bogotá. “*Observatorio de movilidad - 2008”.* Bogotá.2009.

Table 2: Public transport Indicators - 2008

In the decade of 70´s, when the metropolitan company of transport broke, a process of privatization of the public transport in the city began in which the transit authority adjudged routes to be served by deprived companies of transport. The majority of them without enterprise structure, nor property of the fleet, work like companies that affiliate buses for the operation or service in the route that was adjudged to them. Additionally, these companies do either not have responsibility for the service they offer nor do they have criteria of quality of the service. They solely fulfill frequencies. This scheme of operation generated a number of problems in the public transport of the city. This absence in the planning generated deficiencies in the quality and the security. This created huge economic, environmental and social problems which generated a backward movement in the organization of mobility of the city and lead to 30 years of delay.

5 Mass Transit System by Buses - TransMilenio

5.1 Introduction

In order to address the poor public transport service, reflected in high passenger travel times, accidents, high levels of insecurity, high costs and inefficient operation, the system of rapid transit buses (Bus Rapid Transit - BRT) with the name of Mass Transit System of the Third Millennium - TransMilenio - was launched in late 2000. As part of the Integrated Mass Transit this system not only includes BRT in the city but also comprises the bicycle path network, a future first subway line and the commuter rail.

This system of mass transport of passengers is a organized combination of infrastructure and equipment in a scheme that serves a high volume of passengers and responds to a significant percentage of the needs of urban mobilization.

Source: TRANSMILENIO S.A.

Photo 16: Station of the TransMilenio System

The system is based on rapid transit using articulated buses and high capacity busways with fixed stops, which users access via bus stations. It includes a feeder bus service that takes passengers from some remote areas of the system to intermediate stations.

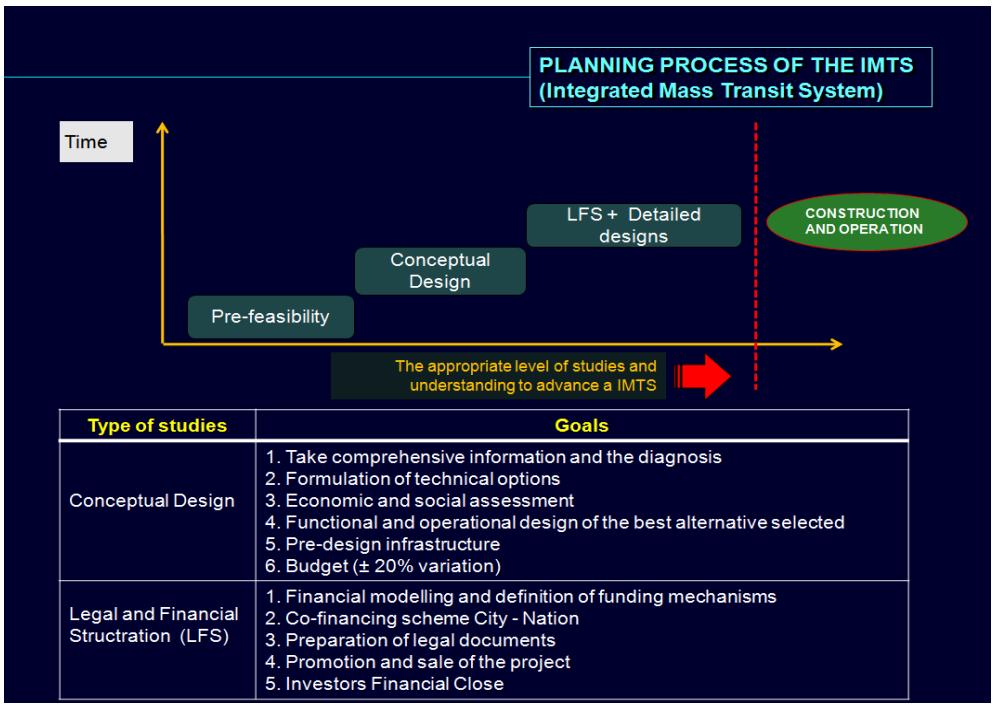
Under this definition, the main goals of a BRT are:

- Eliminate the "penny war". This marks a radical change in the remuneration system through the transformation from bus rental company to bus owner companies.

- Integrate physically and operationally most of the routes of the city, taking into account the technical and financial criteria. The Integration may include different modes of operating the buses. It also includes the integration of the tariffs.
- Reorder and coordinate the routes of existing public transport services and the new BRT routes.
- Build and / or adapt the infrastructure required in the main corridors of the BRT.
- Use new high-capacity vehicles with low-pollution technology which are able to fulfil the demand.
- Increase the average speed on trunk corridors to levels approaching 25 km/h, reducing travel times for users.
- Coordinate the implementation of BRT with the existing public transport which is still operating and maintain the conditions for mobility and accessibility appropriate.
- Remove old buses that pollute too much ("chatarrización").
- Apply marketing schemes and the collection of tickets flexible and economical.
- Promote a comprehensive urban development, improving public space.
- Strengthen and improve coordination between local authorities (Mass Transit Authorities, Ministries of Transport and Traffic and Metropolitan Areas, etc.) to ensure a better and more efficient management.
- Monitor service delivery through management companies, to ensure the sustainability of the system, the quality of customer service and minimum efficiency standards.

5.2 Planning Process of the IMTS (Integrated Mass Transit System)

The planning process for the design of the IMTS includes studies covering all the relevant aspects of a project of this nature. These studies are based upon a feasibility analysis to clarify the project's concept. This defines the possibility of implementation where the size of the city and the urban collective transport market are key factors. The next step is the conceptual design of the IMTS, based on the city's detailed mobility information surveys from which the technological and operational needs are taken to define the system itself (see Figure 4). IMTS is supported with national resources.



Type of studies	Goals
Conceptual Design	1. Take comprehensive information and the diagnosis 2. Formulation of technical options 3. Economic and social assessment 4. Functional and operational design of the best alternative selected 5. Pre-design infrastructure 6. Budget (± 20% variation)
Legal and Financial Structration (LFS)	1. Financial modelling and definition of funding mechanisms 2. Co-financing scheme City - Nation 3. Preparation of legal documents 4. Promotion and sale of the project 5. Investors Financial Close

Source: Departamento Nacional de Planeación, CONPES 3260. Bogotá.2003

Figure 4: Planning process of the IMTS (Integrated Mass Transit System)

5.3 TransMilenio System Elements

5.3.1 Overview

The system consists of the rapid and organized transit of high capacity articulated buses, throughout exclusive busways with fixed stops. Users get access to these stops in an organized way. Some of the stations are fed with feeder buses that bring the users from remote areas far from the network.

5.3.2 Infrastructure

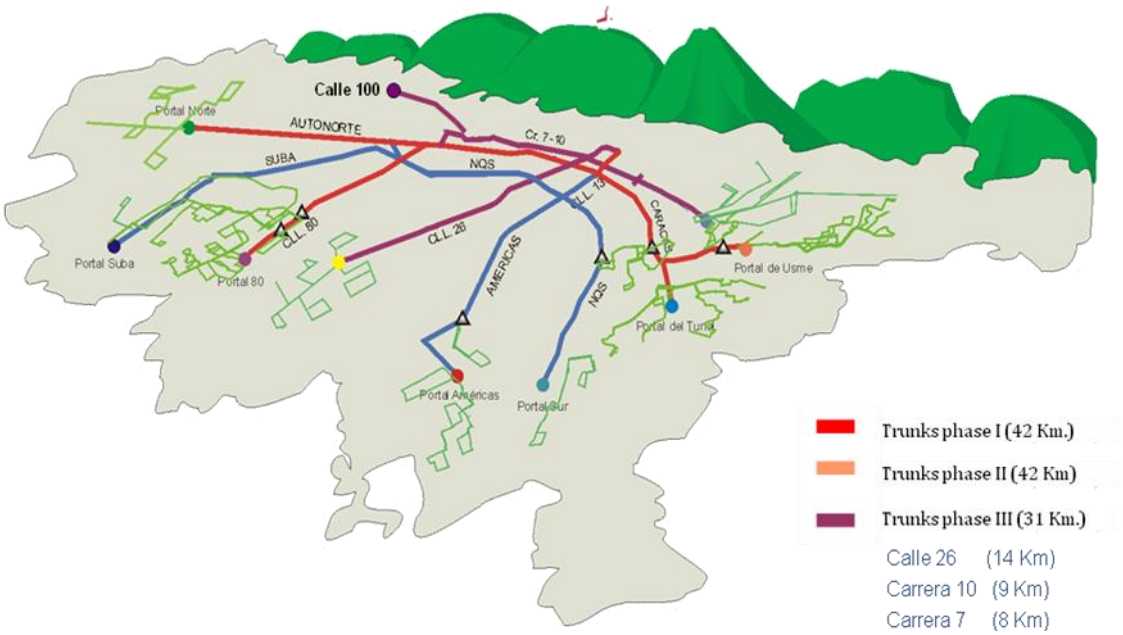
The system infrastructure consists of the combination of the network's trunk corridors and the different types of stations.

Photo 17: North Corridor

Photo 18: Elevated Station

5.3.3 Network of Trunk Corridors

Nowadays, the system has 9 main trunk lines as shown on Map 3. These were gradually incorporated in the first two phases of the service. These first two phases are those of the three initial phases planned for the initial development of the system. In the year 2000, when TransMilenio started its operation, The “Avenida Caracas” and “Calle 80” corridors came into operation. In year 2001 it was the “Autopista Norte” corridor and in year 2002 the corridor “Avenida Jiménez”. In year 2003 the “Avenida de las Americas” corridor was incorporated and in the year 2005 it was the time for the central sector of the NQS (Norte - Quito - Sur) corridor. In the year 2006 it was the “Suba” and the South bit of the NQS corridor. All these corridors are part of the system’s phases I and II.



Source: TRANSMILENIO S.A.

Map 3: Current Trunks Network

5.3.4 Stations

The TransMilenio system uses five types of stations:

- **Simple stations**. Correspond to stopping points on the trunk lines where users access the system and where they can buy their tickets, they are separated approximately 500 and 700 meters from each other.

Source: TRANSMILENIO S.A.

Photo 19: Simple station

- **Transfer Stations**. These allow the exchange between two different trunk lines through an underground passage, examples of these are found in the Avenida Jimenez, which connects the Avenida Caracas and the Avenida de Las Americas lines, and the Ricaurte station, connecting the Avenida de las Americas to the NQS corridor.
- **No-exchange stations**. These stations banned the exchange between the north-southbound and south-northbound. Such type of stations are located on the Autopista Norte and Tunal corridor. Their placement on these sectors is due to space conditions on the road.
- **Intermediate Stations** These are interexchange points on the trunk lines, where users can transfer between the network buses and the feeder buses. As it happens on the gateway stations, there is no need to make extra payments. Example of these stations are Avenida ciudad de Cali, Carrera 77, Calle 40 Sur, Molinos, Banderas and General Santander stations.

Source: TRANSMILENIO S.A.

Photo 20: Intermediate station

- **Main Stations**. These are the starting and ending points of the trunk line routes, and they are the transfer stations between trunk buses, the feeders, and regional transportation routes. They have other services as well as cycle parking, complementing the cycle path's network. Other services provided are telephones and

restrooms areas. Examples of these are found on these hubs: North, Suba, Calle 80, Las Americas, South and Usme Tunal.

Source: TRANSMILENIO S.A

Photo 21: Main Station

5.3.5 Vehicles

5.3.5.1 Overview

The system is operated by two types of vehicles: high-capacity buses (articulated buses) along the trunk lines passengers and feeder buses.

5.3.5.2 Articulated Buses

The service is provided by two types of articulated buses, mono- and bi-articulated, according to the number of articulations they have. The majority of the service is provided by mono-articulated buses. These are 18 meters long and 2.60 meter wide and have four 1.10 meter wide doors, placed at the left side of the bus. They have a capacity of 160 passengers, 48 of them are seated. These vehicles operate on diesel fuel. To show that they are operating along the trunk roads they are painted in red colour (see Photo 22).

Currently, there are circulating 5 bi-articulated buses with two articulations. These buses are 27.2 meters long and 2.60 meters wide They have seven doors of 1.10 meters width and a capacity of 260 passengers. These buses will start operations once Phase III of the system is terminated. They are distinguished by their yellow and red colour (see Photo 23).

Photo 22: Articulated bus

Photo 23: Bi-Articulated bus

5.3.5.3 Feeder Vehicles

Feeder buses are used to carry passengers to and from the main and intermediate stations. They are single buses with three doors on the right side and a capacity of 80 passengers. The green colour indicates that they are operating on feeder lines (see Photos 24 and 25).

Photo 24: Frontal view Feeder vehicle

Photo 25: Side view Feeder vehicle

5.4 TransMilenio System Operation

5.4.1 Overview

The system operation is done through a public-private model, where all - organization, planning, control and monitoring system as well as the infrastructure construction - is the City's responsibility. The operation is carried out by the private sector, which is obliged to bus purchasing, bus maintenance and as well as the hiring and education of drivers.

The system provides four types of services – the express service, the super express service and the "easyroute" service along the trunk lines and the feeder services.

5.4.2 Trunk Lines

The trunk lines are defined by exclusive corridors starting and ending at the portals or gateway stations ("main stations"). The buses stop only to pick up passengers at stations, according to a rigorous pre-planning and real-time control. Along the trunk lines only TransMilenio mass transit operates. The parallel circulation of the former public transport along these corridors is prohibited.

5.4.3 Express Services

The express services are designed to serve as fast as possible origin and destination areas previously identified. For this purpose, the exclusive express service does not stop at all stations but only in those of higher importance. These services have a higher commercial speed than that of the services that stop at all the stations.

5.4.4 Super Express Services

Super express services stop only at some stations and travel between origin-destination pairs with greater demand for travel, giving an extra advantage to the users who make long journeys within the system due to its lower number of stops.

Express and super express services provide a better user experience and allow a better use of the fleet. Users are not forced to stop at all stations along the route, reducing hence their travel time. It's also possible to make more cycles with the same number of buses.

5.4.5 "Easy Route" Services

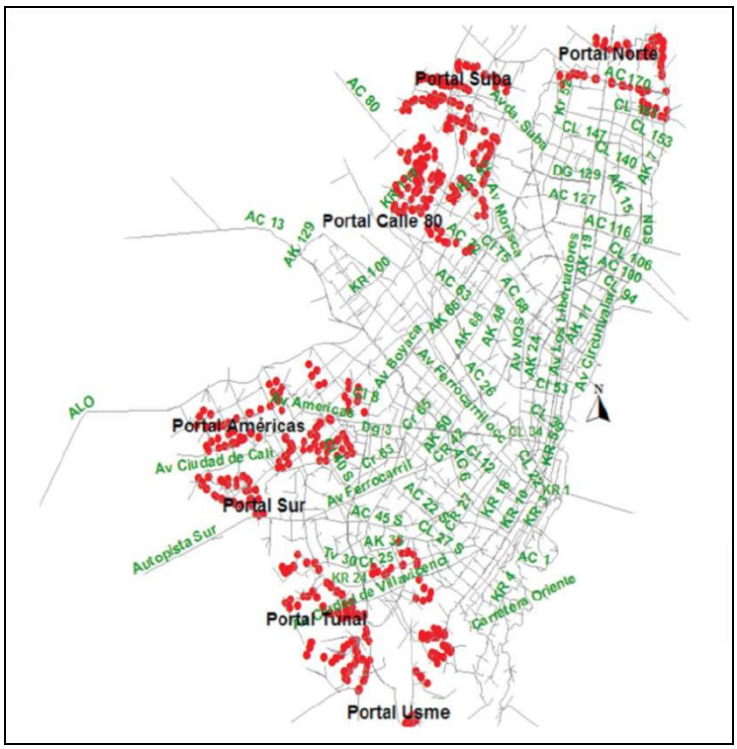
"Easy route" services stop at all stations along the route giving users an alternative and quicker travel experience with shorter waiting times. This is possible due to the frequency of the schedule.

5.4.6 Feeder Services

The feeder services are routes attracting passengers from some given areas in the city, connecting them to the TransMilenio system. They join the trunk lines at the main and the intermediate stations. The buses used for this operation are of medium capacity, appropriate to the normal road and traffic conditions. The feeder system gives access from the surrounding neighborhoods to the TransMilenio system without extra payment.

The operation of these services is performed through local and non-exclusive roads. This facilitates the integration of mainly residential areas of low and middle income with the trunk lines. The average distance between the stops along the feeder routes is approximately 400 meters. These stops have signs, and areas suitable for loading and unloading of passengers and passenger waiting.

Map 4 indicates the location of the stops of the 74 feeder routes of the system. These routes serve 515 kilometers, and are operated with 476 vehicles, attending 302 neighborhoods.



Source: Universidad de los Andes. "*Observatorio de TransMilenio - 2008".* Cámara de Comercio de Bogotá. Bogotá, 2009

Map 4: Stop points of feeder routes

5.4.7 Operating Companies

Seven companies perform TransMilenio's operation. These were created just for that purpose, and they reunite 98 % of the private bus operators in the city. These companies are chosen through a bidding process where legal, technical and financial requirements are requested upon completion.

The winners of the bidding process are responsible for the vehicle purchasing and the hiring of drivers, mechanics, administrative staff and extra personnel. The granting of the operation includes the administration and maintenance of garages and parking. These are provided by the local authority. The Operators are paid based on the mileage.

5.5 Fare Collection System

The fare collection system is carried out by two private companies. They were chosen through public bidding. They provide smart cards and the equipment forming the technological system platform, including tickets machines (smart cards), control gates, communication equipment and other necessary equipment. The logistics to assure the system's operation during the operating hours is also a responsibility of the private companies. This includes services like ticketing, security, equipment maintenance and money's bank deposit.

The following elements form the fare collection system:

- Ticket selling at the stations: There are points of sale located at the entrances of the stations, where the user can recharge the enabled cards.

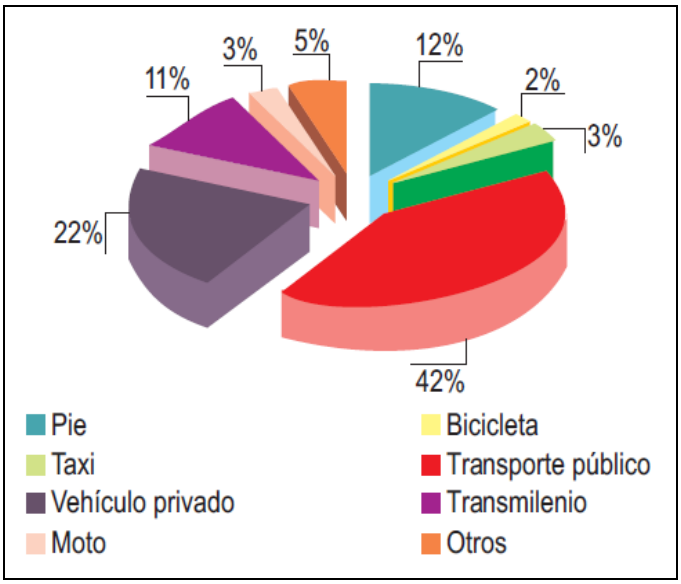
- External sales outlets: They are located in establishments and shopping centers and have personalized attention for reloading all enabled cards.
- Smart Cards automatic loading terminals (SCLT): These devices allow users to recharge frequent traveller cards or student cards automatically.
- Mobile recharge terminals: They are portable devices served by a box office operator where the user can top-up the enabled cards.
- Control gates and cash registers: These are the access control mechanisms, located at the entrances of the stations for the card's validation.

5.6 TransMilenio Operational Indicators

5.6.1 Demand

5.6.1.1 Overview

In 2008, The TransMilenio system served 11 % of the daily trips, whilst the traditional public transport served 42 % of them and 22 % were private transport trips (see Figure 5).

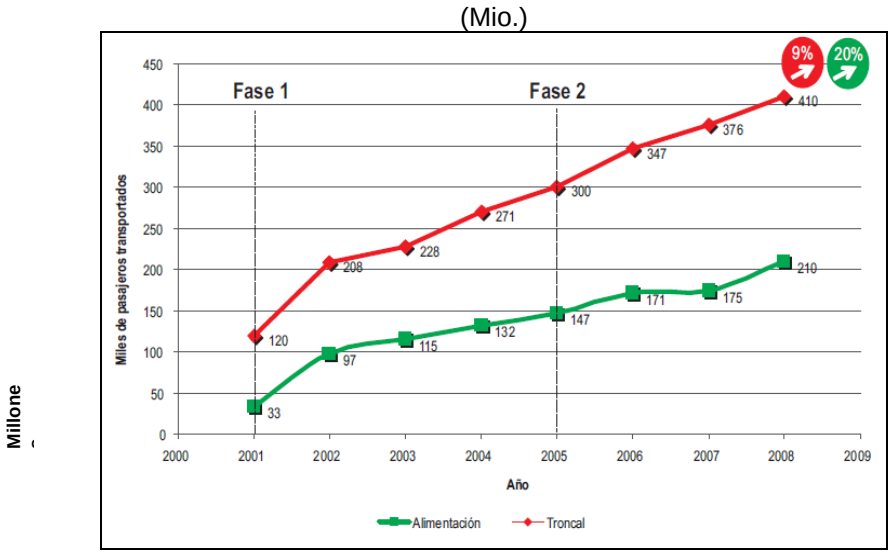


Source: Universidad de los Andes. "*Observatorio de TransMilenio - 2008".* Cámara de Comercio de Bogotá. Bogotá, 2009.

Figure 5: Modal share - Bogotá, 2008

5.6.1.2 Passengers Mobilized by TransMilenio 2001 - 2008

In 2008, the TransMilenio system carried on the trunk lines 410 million passengers, representing a 9 % increase compared to the previous year (see Figure 6). The feeder system moved in the same year 210 million passengers, a fairly significant increase of 20 % in comparison to the year 2007 (see also Figure 6).

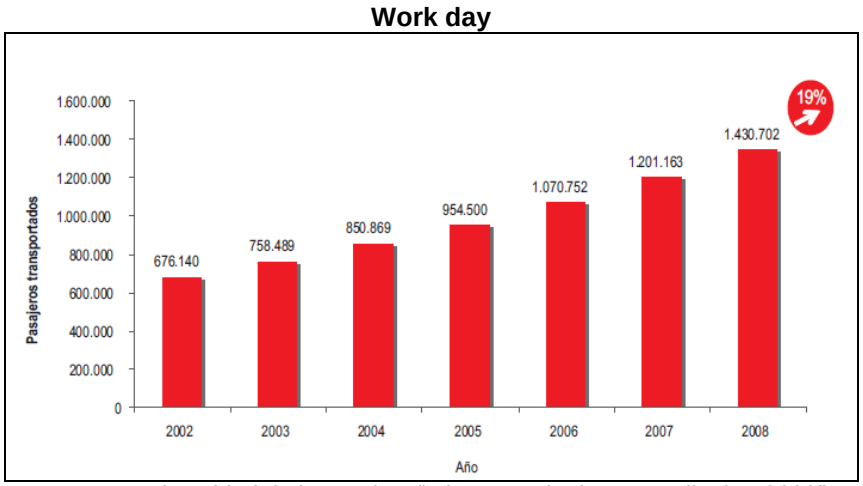


Source: Universidad de los Andes. "*Observatorio de TransMilenio - 2008".* Cámara de Comercio de Bogotá. Bogotá, 2009.

Figure 6: Passengers mobilized 2001 - 2008

5.6.1.3 Daily Passengers Mobilized by TransMilenio 2002 - 2008

On working days in the year 2008, the average number of passengers carried on a daily basis, was 1,430,702. This marks an increase of 19 % compared to 2007 (see Figure 7).

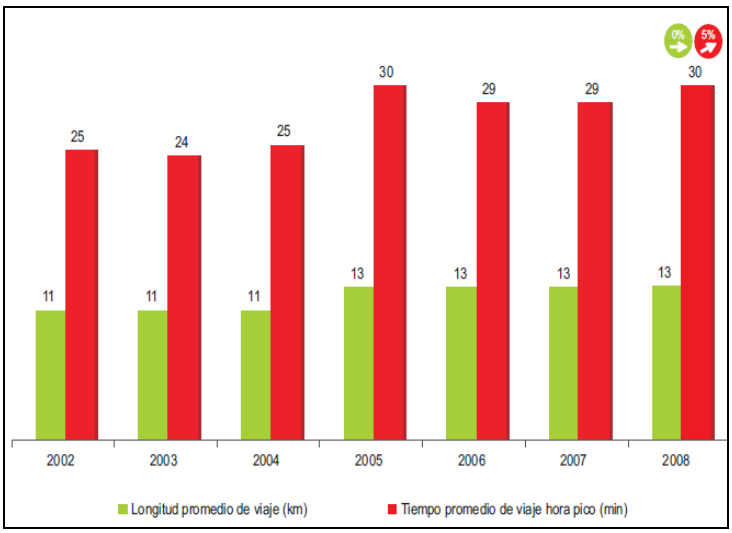


Source: Universidad de los Andes. "*Observatorio de TransMilenio - 2008".* Cámara de Comercio de Bogotá. Bogotá, 2009.

Figure 7: Average daily passengers mobilized

5.6.1.4 Average Trip Length and Travel Time of Passengers

In 2008, the passengers average trip length was 13 km and the average travel time was 30 minutes (see Figure 8). The first remained constant over the last four years while the latter increased by 5 % compared to 2007.

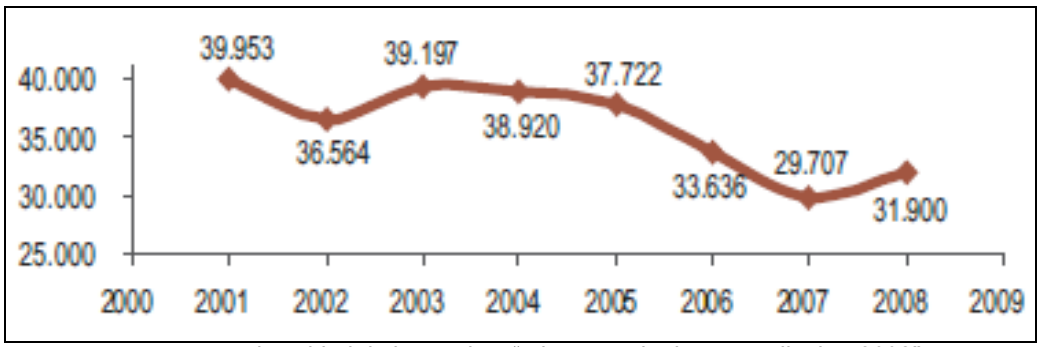


Source: Universidad de los Andes. "*Observatorio de TransMilenio - 2008".* Cámara de Comercio de Bogotá. Bogotá, 2009.

Figure 8: Average length and travel time in peak hour 2002 – 2008

5.6.1.5 Number of Passengers Carried per Year and by Trunk Line Bus

In 2008, each trunk line bus carried 31,900 passengers on average. This marks an increase of 7 % compared to 2007. However, as shown in Figure 9, the total number of passengers carried per bus had a downward trend between 2003 and 2007, going from 39,197 to 29,707 passengers.



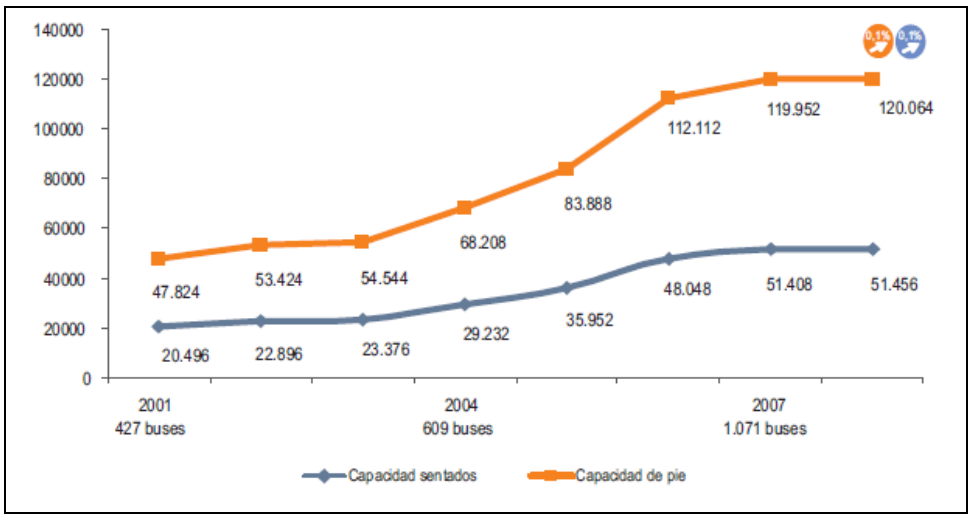
Source: Universidad de los Andes. "*Observatorio de TransMilenio - 2008".* Cámara de Comercio de Bogotá. Bogotá, 2009.

Figure 9: Total annual passengers transported per trunk bus 2001 - 2008

5.6.2 Supply

5.6.2.1 Capacity (Buses)

The capacity in the TransMilenio system in 2008 was represented by 51.546 seats and 120.064 standing passengers with a slight increase of 0.1 % compared to the year 2007. Figure 10 shows the evolution of the offered capacity, from 427 buses in 2002 to 609 in 2004 and 1,071 in 2007.



Source: Universidad de los Andes. "*Observatorio de TransMilenio - 2008".* Cámara de Comercio de Bogotá. Bogotá, 2009.

Figure 10: Evolution of system's installed capacity 2001 - 2008

5.6.2.2 Number of Buses Running in the System (Daily Average)

On a working day (2009), the daily average of buses running in the morning peak hours is 1,055 buses, while in the evening peak hours this number is reduced to 1,027 buses (see Figure 11). In other hours, the average is 520 buses running in the system. Peak hours accumulate 47 % of total daily bus trips.

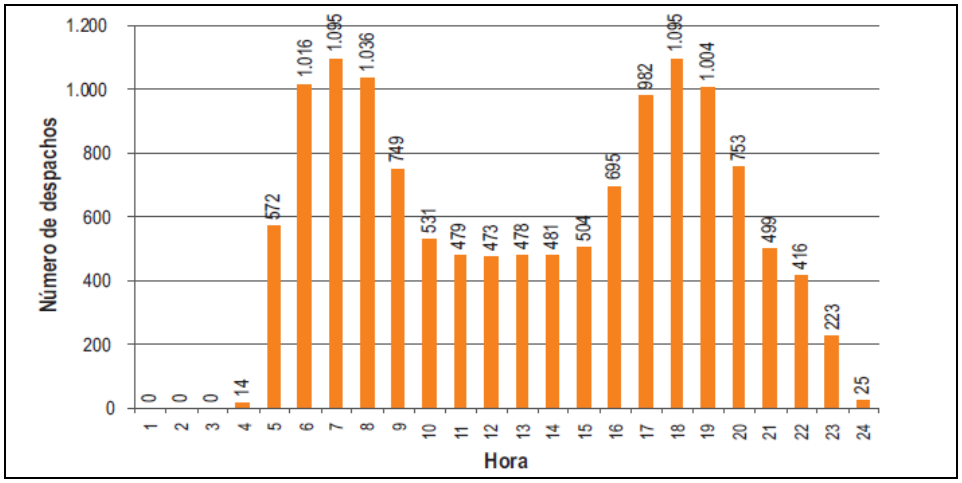
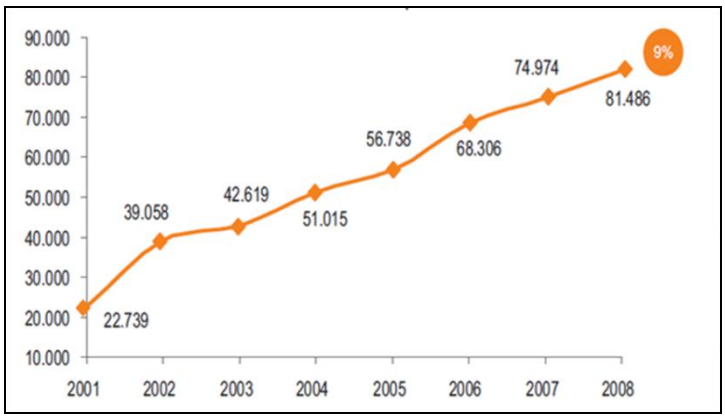


Figure 11: Average number of buses running in the system - work day 2009

5.6.2.3 Yearly Mileage of the Vehicle Fleet

In 2008, the vehicle fleet travelled 81.4 million km along the trunk lines with a 9 % increase compared to 2007. Figure 12 shows a year-to-year increase in the number of miles driven.



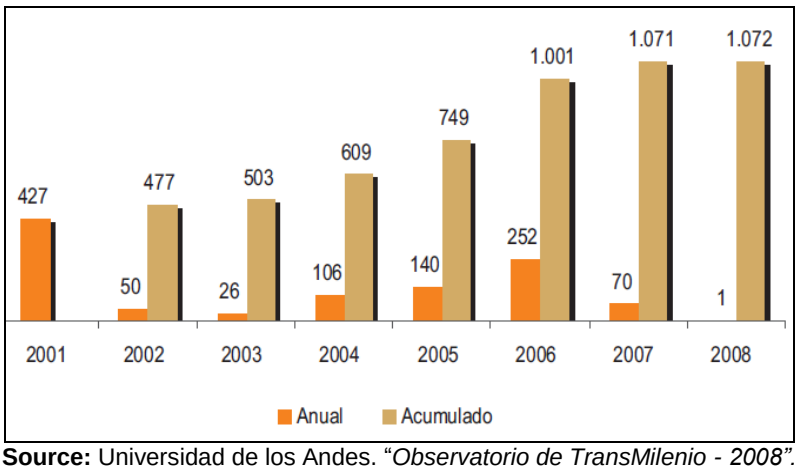
Source: Universidad de los Andes. "*Observatorio de TransMilenio - 2008".* Cámara de Comercio de Bogotá. Bogotá, 2009.

Figure 12: Total annual travelled kilometres along the trunk lines 2001 - 2008

The daily average mileage for year 2008 peaked to 226,000 km from 208,000 km in the year 2007, representing an increase of 8 %.

5.6.2.4 Fleet Linked to the Trunk Lines and to the Feeder System

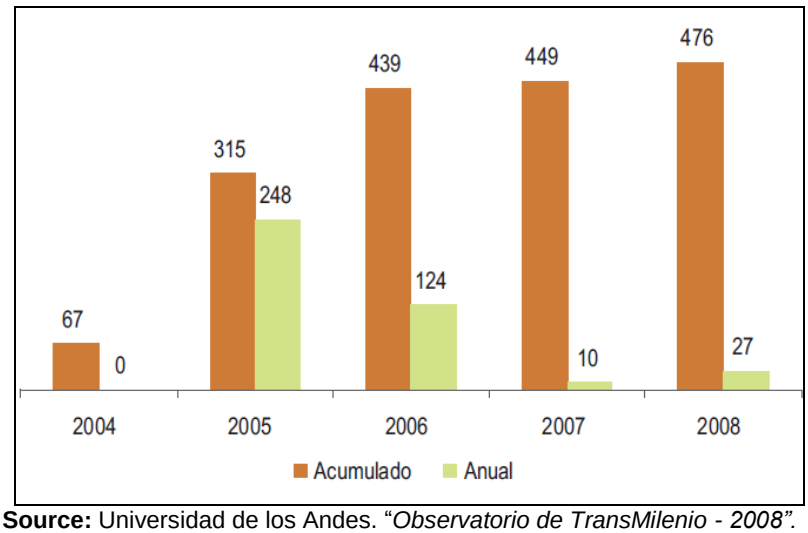
In the past eight years, the trunk lines bus fleet grew by 2.5 times, from 427 buses in 2001 to 1,072 in 2008 (see Figure 13).



Source: Universidad de los Andes. "*Observatorio de TransMilenio - 2008".* Cámara de Comercio de Bogotá. Bogotá, 2009

Figure 13: Trunk lines fleets 2001 - 2008

The feeder bus fleet consists in 2008 out of 476 buses. The main increases were in 2005 and 2008, with 248 and 124 units (see Figure 14).



Source: Universidad de los Andes. "*Observatorio de TransMilenio - 2008".* Cámara de Comercio de Bogotá. Bogotá, 2009

Figure 14: Feeder bus fleet 2004 - 2008

6 Integrated Public Transport System (SITP - Sistema Integrado de Transporte Publico)

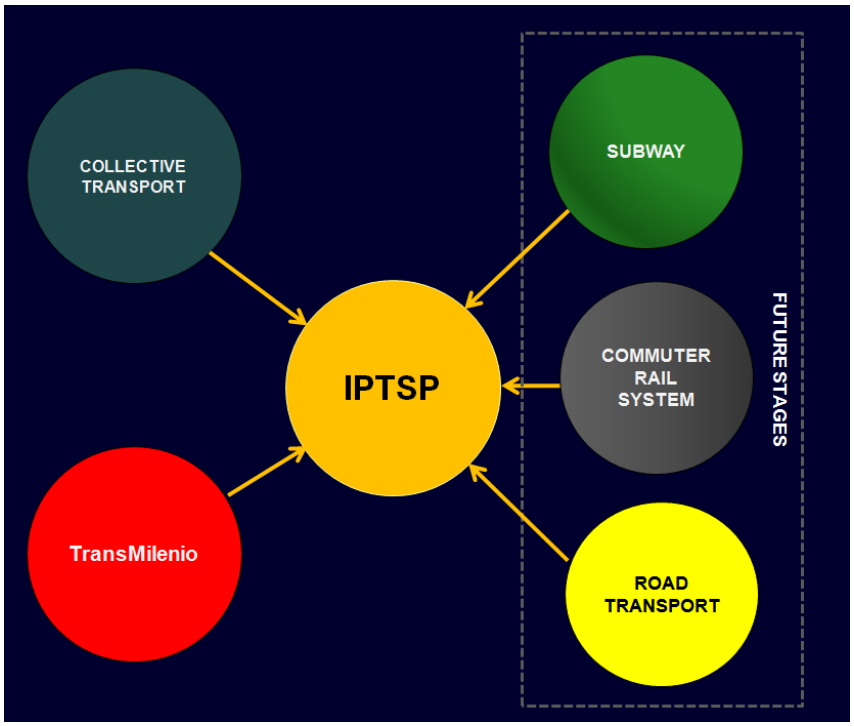
6.1 Introduction

The current city administration has launched an ambitious program to create a new business and operational scheme of public passenger transport, which has been called the Integrated Public Transport System - SITP. SITP will eliminate the current structure provided by buses, small buses and minibuses and integrate this traditional public transport with the massive transit system. This implies a special infrastructure for the functionality of the systems, transport equipment specifications based on technical standards and a management scheme that combines the previous two items under a single system with the purpose of carrying 100 % of travel demand of the citizens of Bogotá DC.

The SITP will consist of the two transport systems that operate in the city independently: the system TransMilenio and the traditional public transport. One is a high-capacity system that operates in high demand corridors and the second is a route system that operates at low capacity corridors handling nearly 80 % of the daily trips in the city.

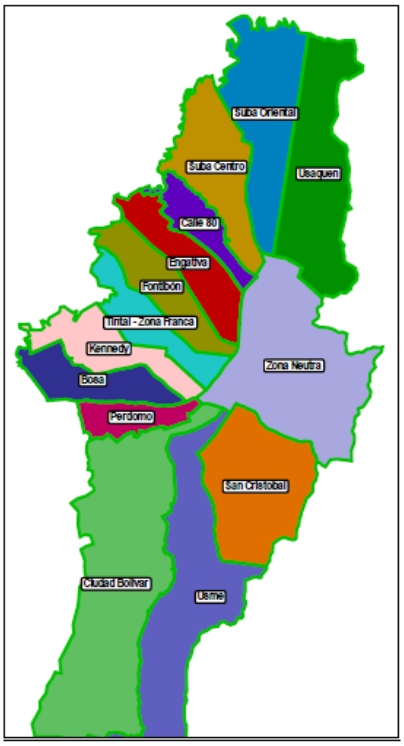
The SITP divides the city into 13 zones (see Map 5). Each will be headed by an operating company selected through competitive bidding. This system will provide routes to all parts of the city. The selection process will take into account with a high priority to rank small owners of buses, small buses and minibuses, public transport companies, and massive transit companies in Bogotá. The SITP will be given in concession for 24 years.

These companies provide the service directly and will become therefore responsible for all items included in the system. The service requires them to hire the drivers of vehicles who will have a fixed salary and benefits.



Source: TRANSMILENIO S.A.

Figure 15: Sub-systems of the Integrated Transport System - SITP (IPTSP)



Source: TRANSMILENIO S.A.

Map 5: Operation zones SITP

It will create an integrated fare collection and fleet management, and payment of the fee will be done with a smart card that can be used in different types of transport: traditional buses, Metro and TransMilenio. There will be an integrated tariff, which

means the user pays for a bus ticket or TransMilenio and if they require a second trip to reach their final destination, you need to pay only a small additional amount and not another passage. The additional payments will be lower than the first transfer fee and the coresponing trip can be done within a given period of time.

The buses have fixed stops with information about route frequency and timetable of bus lines. New terminals will be built, as well as stations and stops. The maintenance of the road infrastructure will be provided by the city.

The fleet of buses will be modernized, with high quality and less pollution. From 2010, no public transport vehicle will be more than ten years old, and lifetime may not exceed twelve years.

6.2 Stages of Implementation of SITP

It is envisaged that the SITP be developed in four phases namely:

- **Phase 1** SITP: Preparation for implementation of the SITP.

  Phase 1 includes the selection process for the operators and the integrated zonal fare collection and control - (SIRCI).

- **Phase 2** SITP: Gradual implementation of the operation. Upon completion of Phase 1.

  The tenders for the operation and for the SIRCI zonal operation will be awarded. The new scheme to provide customer service will gradually start aiming to complete the full integration step by step.
  In this phase, which initiates the operation, in areas the current TransMilenio system is already operating the traditional public transport will be integrated to the TransMilenio system. In other areas, the service of the current public transport system shall be maintained until SITP operators start providing the service.

- **Phase 3** SITP: Integrated operation of SITP.

  Once Phase 2 will have terminated the fare integration and the integration of all existing means of public transport will make improvements to the infrastructure of the road system to generate operational efficiencies and will continue both the ongoing
  process of adjustment of the supply to the demand and the replacement of vehicles. This will be done under the Medium Term Fiscal Framework.

- **Phase 4** SITP: Integration with rail modes.

  This phase corresponds to the system integration of the other means of transport provided in the Mobility Master Plan as part of the SITP, including the Metro. It will start when the rail bound systems are ready to operate. At this stage, as part of the SITP the system and all other modes will be integrated with respect of operation and fares to the Metro. This will be done under the conditions to which the transport authorities and the private operators of the service agree. All the above will be developed within a framework of financial sustainability, to preserve the economic equilibrium of the integrated components and the benefits to the user of the transport service.

6.3 Proposed Route Types

The routes planned for the SITP are classified into the following four groups:

- Trunk Routes
  - Features: Shaft structuring, long distance, high demand.
  - Fare Collection Type: On Station.
  - Operation: Exclusive lane left with or without bypass.
- Auxiliary Routes
  - Features: Support for trunk routes in corridors of intermediate demands. Transmission and distribution function of demand.
  - Fare Collection Type: On the bus by means of electronic payment.
  - Operation: Mixed traffic.
- Feeders and Complementary Routes
  - Features: Power trunk routes in doorways, simple stations and intermediate stations.
  - Fare Collection Type: On the bus by means of electronic payment or backbone station.
  - Operation: Mixed traffic.
- Special Routes (Urban and Rural)
  - Characteristics: Attention to areas of difficult access or very low demand.
  - Collection Type: On the bus by means of electronic payment.
  - Operation: Mixed traffic.

The implementation of the routing architecture is a gradual process which must start from the current situation and move towards the future, to have implemented the type of routes aforesaid.

7 The Metro System

7.1 Introduction

It has been sixty years (it was in 1950), since the first talks, regarding the need of building the underground system for the city, occurred. This started off when the previous tram system disappeared. The underground project has been subject to numerous studies and countless technical and political debates.

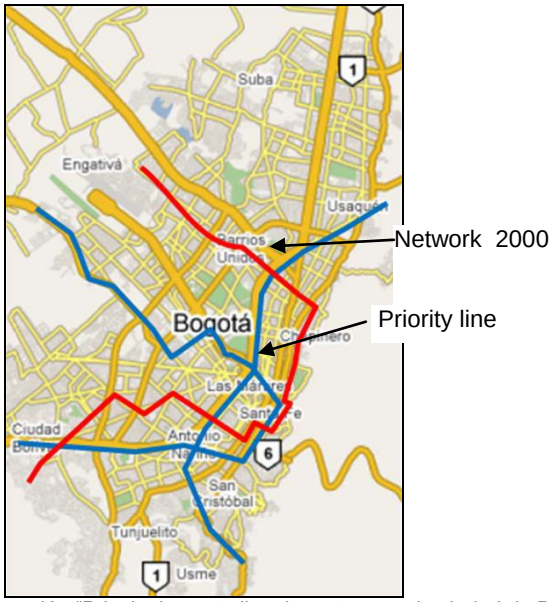
Today, Bogotá is closer to the possibility of having this mass transit system, given the City's Mayor position regarding this subject. Besides this was one of his campaign promises. He has the support of the national government, although this is subject to technical studies and the funding of the feasibility studies by the World Bank. The studies carried out in 2009 have had serious critiques and have been validated by major Colombian universities such as the "Universidad Nacional de Colombia" and the "Universidad de Los Andes" with a great support from the University of Illinois.

7.2 Studies Chronology

In the past 30 years, a total of four studies analyzing the construction of the underground system in Bogotá have been carried out. However, a decision on whether to proceed hasn't been taken. These four studies are summarized below.

7.3 Metro Project INECO - SOFRETU-CS, 1981

In 1981, the city hired the consortium SOFRETU-INECO-CS for the first underground route design. This study proposed the construction of three lines with a total length of 75.8 km, plus 17 km in peripheral lines. It proposed 88 stations and lead to total costs of U$ 2,956 million (in 1981) (see Map 6). The first line was designed with a length of 23.6 km, with 23 stations and costs of U$ 797 million (in 1981).



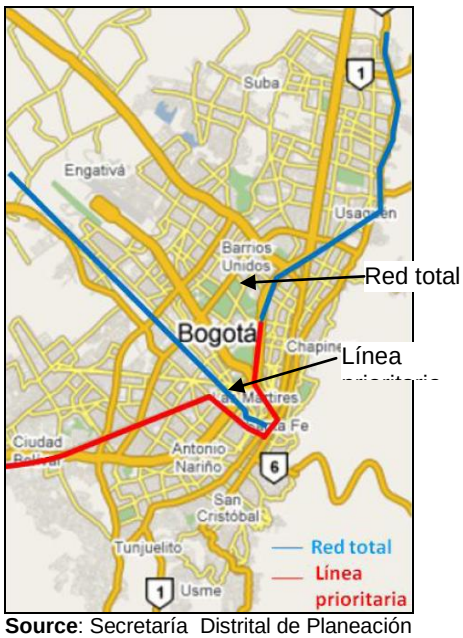
Source: Secretaría Distrital de Planeación "Principales estudios de metro para la ciudad de Bogotá". Bogotá 2008

Map 6: Proposed lines 1981

In the opinion of the District Department of Planning, there were important gaps in the study. E.g., it envisioned for the year 2000 a population of 7.5 million inhabitants, which is now expected for 2011, and it was based on a development pattern leading towards the West of the city, while actually the city grows not to the West but strongly towards the South. The project was not implemented since finally priority was given to the underground system in the City of Medellin.

7.4 Metro System along the Existing Railway Network, 1986 - 1990

In 1987, the National government proposed the development of a Metro system using the existing railway corridors, through the construction of three lines and with a total length of 46.4 km, 29 stations and costs of U$ 1,360 million (1990) (see Map 7). The first line was designed with a length of 23 km, 10 stations and costs of U$ 858 million (1990).



Source: Secretaría Distrital de Planeación "Principales estudios de metro para la ciudad de Bogotá". Bogotá 2008

Map 7: Proposed lines over railway tracks 1987

To implement the project in terms of "Turnkey" the Italian company InterMetro SPA was picked out of eight international bidders. The Planning authority considered that the proposal, submitted by the Italian consortium, was not clear in technical terms nor financially and the forecasted costs were far below the international standards. Furthermore, the system was proposed in areas of low demand.

7.5 Underground system propose in the Transportation Master Plan by JICA, 1996

In 1996, the Japanese Cooperation Agency, JICA, prepared the Transportation Master Plan for the city. In it, a comprehensive development scheme for the city with an integrated transport system with trunk lines was proposed. The project included as well a public railway transportation system plus the layout of an underground corridor that would be connected to the other subsystems (see Map 8). This line was designed with a length of 32 km. The costs were estimated to U$ 2,275 million (1996). The construction was planned to begin in 2006 and the start of operation was scheduled in 2016.

Source: Secretaría Distrital de Planeación "Principales estudios de metro para la ciudad de Bogotá". Bogotá 2008

Map 8: Line proposed in 1996

The study was based on a future city developing towards the North, but the Bogotá District in its Land Management Plan ("POT"), contrary to this study, limited the development in that sector of the city. These decisions show a clear lack of coherence in urban planning.

7.6 Integrated Mass Transport System - SITM (Sistema Integrado de Transporte Massivo), 1997

In 1997, the consortium SYSTRA-BECHTEL-INGETEC was commissioned to develop the "Integrated Mass Transit System Conceptual Design for the Savannah of Bogotá-MITS". Within this study, an underground system with three lines was proposed (see Map 9). Including a total length of 78.8 km and costs of U$ 4,171 million (1996), the system should be supplemented by a trunk line network of 48.4 km length.

The first metro line was designed with a length of 29.3 km, including 23 stations. The total costs were estimated to U$ 2,450 million (1996). It included the simultaneous implementation of a bus corridor system with a length of 29 km and costs of U$ 174 million (1996).

As with the previous study, there wasn't any correlation between the study on the integrated mass transport and the city's urban development. While the proposed integrated system suggested a development to the West of the city, the city's own development is from the North to the South.

Source: Secretaría Distrital de Planeación "Principales estudios de metro para la ciudad de Bogotá". Bogotá 2008

Map 9: Lines proposed for integrated mass transit system - 1997

7.7 Comparison of Proposals

7.7.1 "UFL" (Underground´s First Line)

Table 3 shows the main "UFL" (Underground's First Line) features, suggested in the studies presented.

Study	Year	Starting Year	Length km	Capacity Pas/hour/direction	Design speed KPH	Cost US$ Millions (1)
INECO-SOFRETU	1981	1986	23.0	44.000	28	2.200
INTERMETRO SPA	1987	1995	23.0	22.000 (2)	44	1.928
JICA	1996	2016	32.0	42.000		3.057
SYSTRA-BECHTEL-INGETEC	1997	2006	29.3	56.000	40	3.293

Sources: Secretaría Distrital de Planeación "Principales estudios de metro para la ciudad de Bogotá". Bogotá 2008

Notes: (1) Costs of 2007
(2) Capacity recalculated

Table 3: Main features of the "UFL" (Underground´s First Line), proposed between 1981 and 1997

7.7.2 Studies Most Frequent Preferable Corridors

Map 10 shows the corridors that have been frequently chosen in the various mass transport studies made in Bogotá between 1981 and 1994, according to the research carried out by the Japanese Agency for Cooperation and within the Transportation Master Plan of 1996.

Sources: Secretaría Distrital de Planeación "Principales estudios de metro para la ciudad de Bogotá". Bogotá 2008, con base en la investigación hecha por JICA- 1996.

Map 10: Most frequently chosen corridors in previous studies

8 Comprehensive Program of Mobility of the Capital Region - CPMCR

8.1 Introduction

As a result of the debate which arose in the technical evaluation study of the subway system conceptualization, it was concluded that the system should be part of a comprehensive scheme of local and regional mobility, linking Bogotá with the Department of Cundinamarca and a big area which is called the Capital Region, through the integration of the urban transport system in the city with the long distance commuter system.

8.2 Expected Developments

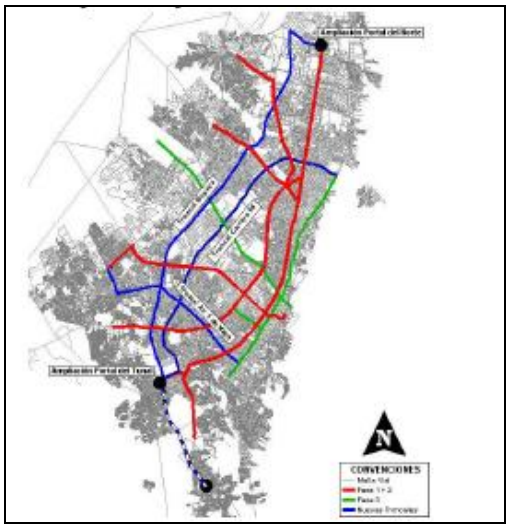
To meet the goal of the Comprehensive Program of Mobility of the Capital Region should the following developments in the urban and regional transport system been undertaken:

- **Collective Urban Transport Integration through Integrated Public Transport System (ITPS)**

  Develop the steps envisaged for the ITPS, which is in the process of award of companies to provide service to different areas.

- **TransMilenio System Expansion**

  It is necessary to expand and consolidate the TransMilenio system for which the following corridors are prioritized, as shown in Map 11: Carrera 68, Avenida Boyacá, Avenida Primero de Mayo, Calle 13 - Calle 19 and Avenida Ciudad de Cali.



Source: TRANSMILENIO S.A.

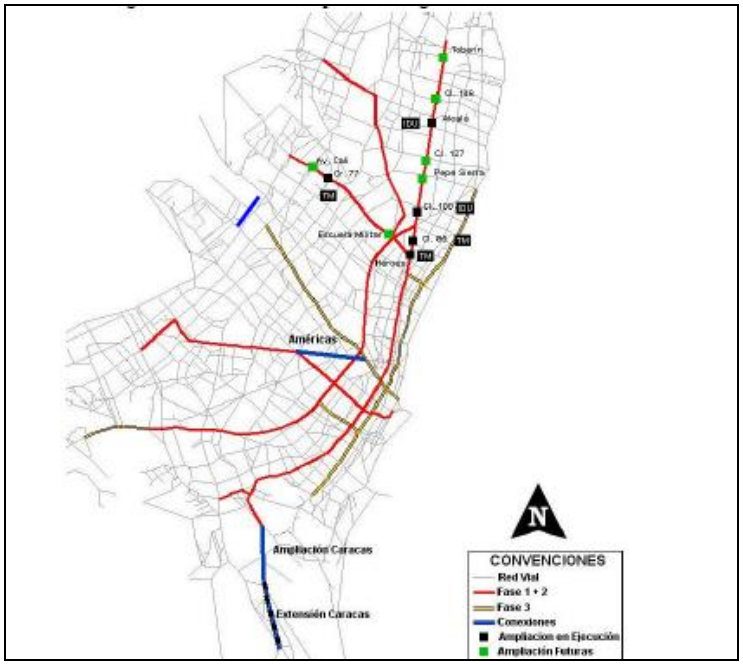
Map 11: Corridors established for the priority of TransMilenio

- **Adapting Existing Infrastructure to Integrate with the ITPS**

  Complementarily it is necessary to adapt the existing infrastructure to obtain an optimal integration of TransMilenio with the rest of the system, for which it has been anticipated:

  a) Extension of capacity of simple stations of Phase I and II.

  b) Extension of the corridors with Americas, Caracas, North, Tunal and connect the corridors Tunal and NQS (see Map 12).



Source: TRANSMILENIO S.A

Map 12: Adequacy of TransMilenio infrastructure for integration with ITPS

- **Operation of the First Subway Line (FSL)**

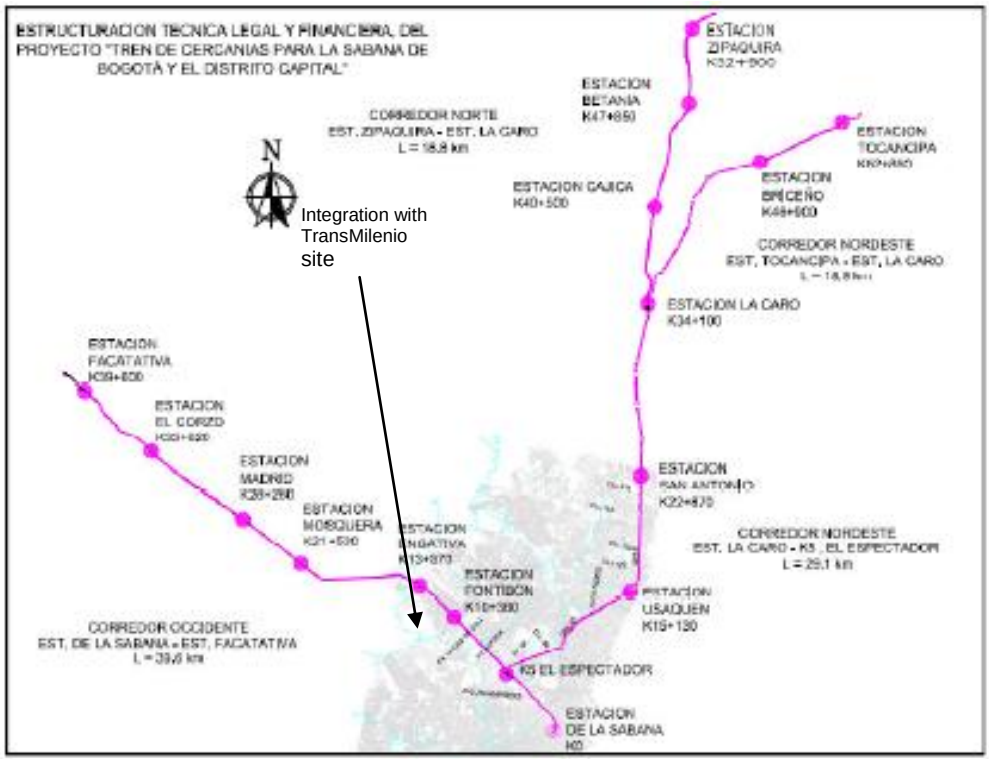
  The first subway line must start operation as subway has been anticipated in the last study contracted for the conceptual design of the network as previously mentioned.

- **Operation of the Cable Network**

  The cable network for public transport will be part of ITPS in the peripheral sectors of the district with difficult topography and limited accessibility, which will allow the integration of the public transport system and the urban planning.

- **Operation of the Commuter Rail System**

  The integration of the Capital Region comprises the City of Bogotá, the Cundinamarca Department and other local authorities to operate a commuter rail system. In the Sabana de Bogotá there are currently two main railway lines, the line North and the line West with a total length of 111 km and 15 stations, as shown in Map 13.



Source: Estudio Estructuración Técnica, Legal y Financiera del Tren de Cercanías de la Sabana de Bogotá y el Distrito Capital. Ministerio de Transporte

Map 13: The existing railway corridors

The Western Railway system is connected with the TransMilenio at the intersection with Avenida Ciudad de Cali.

9 The Future of Mobility in Bogotá

As it has already been mentioned, the future of mobility in Bogotá begun developing during the last fifteen years in which several studies have been conducted, important actions like the development of the massive transport system TransMilenio have been implemented, political, normative, technical, enterprise, environmental, social, physical, and landscape changes took place and budget was provided to build the basis to realize a structural change in favor of the public transport service of the city and the Capital Region.

For the current administration, the challenge of mobility planning in Bogotá has focused on the following projects:

- Beginning of the operation of Phase III of the TransMilenio System, including the design and implementation of the village Soacha´s corridor.
- The studies and designs for Public Transport System - PTS.
- The coordination with Cundinamarca for the implementation and articulation of the subway and the commuter rail system.

Linked to the above, a series of complementary projects have been developed focusing on public space management, coordination and integration of intermodal disincentives to automobile use in order to build a high quality mobility, which is well connected, more secure, accessible, efficient productive, organized, and friendly to the

environment. In conclusion the City of Bogotá and th Capitol Region are directing their efforts towards the future mobility of a more humane and sustainable city.

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Sustainable Infrastructure Planning in Post-Oil Cities - Lessons from Masdar (Abu-Dhabi) and Port Harcourt (Nigeria) for Tema (Ghana)

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Abstract: In the advent of oil discovery, the boom of infrastructure development in the country is always phenomenal and if it's sustainably planned and properly implemented can change the socio-economic fortunes of the country. The case varies for various countries due to some action and inactions of its policy makers and this become evident in the spatial disposition of its infrastructure as well as the growth of the city as a whole. The euphoria and excitement surrounding Ghana's oil discovery have reach a state which calls for policy makers to take a break from the jubilation and plan for its infrastructure development in the next few decades. The type of plans instituted would determine whether important cities like Tema would develop to be like Port Harcourt of Nigeria or Masdar of Abu-Dhabi. As the treasures base of the nation, and the fact that it is the centre of the oil and gas industry-technology in Nigeria and the West Africa sub-region; Port Harcourt holds the largest accumulation of heavy and light industry-technology in Nigeria and the West African sub-region. As a city which was original founded and planned by the colonial masters to export coal to England is also nicknamed the Garden City. It has a vibrant oil economy; offering myriad opportunities for business, investment and tourism but also have its own infrastructural and physical development challenges that do not reflect the apparent wealth accrued from the oil.
Masdar City on the other hand is a young city which was master planned by the British Architectural firm Norman Forster and Partners in 2008 and is also growing fast due to the revenues from the 1971 oil discovery in United Arab Emirates. Abu-Dhabi, the capital state of the UAE sprang from a fishermen and hunters community by applying the latest principles of sustainability, explore renewable resources of energy that has transform it to an open, industrious, progressive and tourist capital. Masdar City a part of Abu-Dhabi urban utopia (as described by some urban and development planners) represent a new type of urban setting and lifestyles that blend innovation, technology and sustainability in the harsh desert climatic condition. Just as C.A. Doxiadis planned Tema (the industrial city and largest port in Ghana) in the 1960's with the Garden-City concept, the construction of Masdar City is also being heralded as "the world's first carbon-neutral, zero-waste city". It is therefore prudent to critically interrogate the underlying issues and principles that informed the infrastructure development and planning of the two cities (Masdar and Port Harcourt) which have dictated the final disposition of the urban fabric.
In this paper, the current trends of sustainable infrastructure planning and development in Post-Oil Cities with reference to Port Harcourt and Masdar City would be discussed. The issue of relevance of Masdar City Infrastructure Development and Port

Harcourt Current state of Infrastructure would be critically analysed as well. Finally, recommendations from lessons gleaned from both Masdar City and Port Harcourt would be made for the future infrastructure planning and development of Tema Metropolitan area when the oil revenues in Ghana start to manifest in Ghana's economy.

Key Words: Sustainable, Infrastructure Planning, Development

1 Sustainable Infrastructure planning

Infrastructure is the basic physical and organizational structures needed for the operation of a society or enterprise,[1] or the services and facilities necessary for an economy to function.[2] The term typically refers to the technical structures that support a society, such as roads, water supply, sewers, power grids, telecommunications, and so forth. Viewed functionally, infrastructure *facilitates* the production of goods and services; for example, roads enable the transport of raw materials to a factory, and also for the distribution of finished products to markets. Infrastructure can be classified as 'Hard' or 'Soft' , 'Material' or 'Institutional' depending on its form of application.

"Hard" infrastructure refers to the large physical networks necessary for the functioning of a modern industrial nation, whereas "soft" infrastructure refers to all the institutions which are required to maintain the economic, health, cultural and social standards of a country, such as the financial system, the education system, the health care system, the system of government and law enforcement, as well as emergency services[3].

Thus a more systematic definition of the term „infrastructure „was undertaken by Jochimsen[4] two decades ago. He defined it as the sum of all basic material structures, institutional conditions and human resources available to society, needed for functioning of the economic sector. "Material infrastructure" was defined as comprising all buildings and physical networks (such as roads pipelines, water ways, sewerage systems etc.) which are directly or Para –governmental) agencies. "Institutional infrastructure" constituted the basis for the functioning of social and economic activities and included all written and unwritten laws, regulations, administrative and planning systems, traditions and other behavioural patterns. Personal Infrastructure ("Human Capital") was comprised of the quantity of human resources available to a society.

Infrastructure also comprehends such goods and services that cannot be marketed because their use cannot be precluded to any individual. The exclusion principle is not applicable. (E.g. roads). Hence it would be appropriate to say that **Sustainable urban infrastructure[5]** is a term used to describe infrastructure that facilitates a place

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[5] http://en.wikipedia.org/wiki/Infrastructure (accessed June 20,2010)

or regions progress towards the goal of sustainable living. The criteria for what can be included in this kind of urban environment varies from place to place, given differences in existing infrastructure and built form, climate and availability of local resources or talents. These infrastructures are therefore the basic facilities, services, installations, institutions and physical networks that cannot be marketed because their use cannot be precluded to any individual but are needed for the functioning of a community or society.

Consequently, the following could be considered as vital component or aspect of sustainable urban infrastructure:

- public transport networks
- Distributed generation and integrated energy demand management initiatives and programs
- High efficiency buildings and other development constraints such as only permitting the construction of green buildings and sustainable habitats with energy-efficient landscaping.
- connected green spaces and wildlife corridors
- Low impact development practices to protect water resources.
- Macro and Micro-Level Policies that have sustainability as its fundamental Pillars.

1.1 Characteristics of Cities with Infrastructure planned with sustainability concept as a basis

The infrastructure in many cities with great attractivity for business and tourism as well as being liveable due to its form, function and disposition having varying underlying principles that govern them. The City's image is largely dependent upon the type of infrastructure that have been provided and how its supporting the society and the local economy.

Sustainable Infrastructure should therefore:

a. Minimise resource use and ecological impacts throughout its lifecycle

b. Preserve ecosystem integrity

c. Not aggravate adverse global phenomena as climate change and ozone depletion

d. Deliver economically viable goods and services

e. Maximise long-run economic growth for the entire community

f. Be financially viable

g. Be managed and operated in a sustainable way

h. Be socially inclusive

i. Contribute to meeting the Millennium Development Goals (MDG)

j. Be accepted and supported by the general population

1.2 How critical is sustainability to Post-Oil Cities

A Post-Oil City is a relatively large and permanent urban settlement which generally have advanced or complex infrastructural systems which has evolved or been developed after the discovery of oil in the country of location. These cities manifest itself by the type of investment and infrastructure that follow the city's development. Due to the hysteria that follows oil find and economy, a lot of basic fundamental process that are considered the building block of sustainability are overlooked or side-track. A vision for the city that considers the entire country as well as the welfare of the current and future populace is critical. This is usually accompanied by a pragmatic action plan that is built on consensus building but not necessarily democratic principles (illiteracy level is critical for a successful democracy). This is really important because after the oil economy becomes a focal issue in national discourse, the people must take ownership of this vision and implement it for the lifting up of the living standard of the entire country. Oil and gas which is termed as black gold has also been described as a blessing in many Arabian countries whilst turning out to be a source of a 'curse' in many African countries. The difference is the approach of utilization and distribution of wealth and infrastructure that accompany the Post-Oil Cities. Whereas some cities were built for the selfish interest of the colonial Masters who never thought of any Post Independent states, others were developed for the people by Patriotic citizens who thought about the future of their country.

For example:

I. **Masdar, Abu-Dhabi have enjoyed oil income since 1971**

II. **Port Harcourt, Nigeria have benefited from oil since 1956**

III. **Doha, Qatar enjoyed oil income since 1949.**

However one cannot say that all these cities have benefited from the presence of any Post-Oil economy at one point in the country's history. Whereas Abu Dhabi and Qatar stand out due to the tremendous infrastructure improvement that has been built since the discovery of oil, Nigeria cannot boast of such. The basic difference is the sustainability principle in planning and development of Infrastructure in Post-Oil Cities. Thus it is important to emphasise that sustainability concept is crucial for the for the rapid development of the infrastructure that affects lives in the communities with post-oil economy. These involve strategies and their associated action plan which involves the community strategies and that is necessary to identify infrastructure requirements that are support development opportunities and growth. The fabric of the city contains paths, landmarks, nodes, districts and edges form the skeleton of the city as well. (McGraw-Hill Companies, 2004; Speiregen, 1965, pg 4:3, 5). The close interaction of this fabric with routes, open spaces and buildings form geometrical, regular or irregular urban pattern in the city. Thus the Urban fabric which is under consideration include the physical aspect of urbanism, emphasizing building types, thoroughfares, vistas, open spaces, frontages, plazas, and streetscapes but excluding environmental, functional and socio-cultural aspects(American Planning Association).

The influence and impacts of the POST-OIL Economy (POE) on the Urban Fabric differ from region to region as well as Country to Country and are at times influence

by the geo-political scenario of the area. The POE can positively translate an area which under normal circumstances could have suffered from urban gentrification to become a cosmopolitan precinct. The city becomes multi-cultural and provides an enhanced socio-economic infrastructure system that supports diverse groups of people. More so, the POE has adequate resources to experiment various types of infrastructure that can be synchronised with the current high technological communication systems. However, this is usually accompanied with the proliferation of Foreign Urban style, Architectonic features and principles that do not fit in the local authentic tic fabric that expresses the spirit and ethos of the community. In an event where here is not adequate or proper urban management system in place, the urban fabric becomes a distorted impression of struggle that depicts the profile-economic inequality that pertains in the city.

The choice of Masdar and Port Harcourt as focal case study was base on the underlisted issues

- Both Cities' infrastructure development depended heavily upon the Oil Income
- They were all master planned by British Planners with Green city Concept
- Port Harcourt has similar geo-physical and socio-cultural characteristics like Tema.
- Port Harcourt represent infrastructure planning with a moderate vision but without "Soft" systems in place
- Masdar represent an attractive utopian state without any major geophysical or socio-cultural similarities
- Masdar also represent also a futuristic case with adequate planning for the "Soft" System.

2 Masdar, Abu-Dhabi as A Post-Oil City

The capital of United Arab Emirates, Abu Dhabi, sprang up half-way through the eighteenth century as a fishermen and hunters' village. It was transformed when petroleum was discovered there in the mid twentieth century and the United Arab Emirates came into existence in 1971 (Larsen,2009). Abu Dhabi's economy is heavily dependent on its vast reserves of oil and gas. According to the CIA country report 2008,the UAE is the 11the largest oil producing country in the world and nearly about 40% of the country's output is based on oil and gas output.

2.1 Urban Fabric and Infrastructure Development

Masdar, a roughly six-square kilometre, 50,000-person city, is touted as being the first carbon-neutral, zero-waste, car-free city (Basantani 2008). One major advantage to building an entirely new city is the ability to selectively employ the latest technologies and materials in order to build a city that has as little impact on the natural environment as possible. The residential density is expected to be about140 inhabitants / hectare but the daily density would be 245 people per hectare. The city according to Larsen (2009) was also planned after the traditional Islamic city approach. Thus it has narrow streets which is naturally shady due to the mutual shading effects of the high density low rise block of buildings, and also possesses diverse open and public

spaces. In the case of Masdar, Larsen (2009) explains that the environmental sustainability and impact of virtually every aspect of the city was carefully considered, from the initial planning and construction stages to the eventual daily functions of the city.

2.2 Characteristic of Infrastructure Planning and Development in Masdar

As indicated in figure 1, the infrastructure provision of which had been planned for Masdar are in layers of Transportation, Energy, Waste Management Water provision and management. In the area Transportation, Masdar would be one f the world's first car-free scities (Biello, 2008; Stilwell et al, 2008). The master plan outlines three primary means of transportation: walking, a light rail system, and an elevated personal rapid transit (PRT) system (Figure 1). This integrated system intends to provide a public transit stop within two-hundred meters of any given point in the city (Basantani 2008). There would be about three thousand of the PRT Vehicles with about 85 to 100 station generation about 135,000 trips per day. Due to Masdar's pedestrian-friendly design, walking and bicycling are expected to be the city's most popular forms of transit (Masdar Initiative, 2008). As previously discussed, streets in Masdar are narrow and shaded to provide a comfortable walking environment that encourages humaninteraction (Masdar Initiative, 2008). Pedestrian networks in the city are also supplemented by two electric transportation systems designed to efficiently convey people further distances (McGrath, 2008; Stilwell et al,2008). The first system is a light rail which will connect Masdar to Abu Dhabi City, the adjacent international airport as well as other surrounding communities (Masdar Initiative, 2008). The second transport system developed for use in Masdar is an underground personal rapid transit system (PRT) which relies on compact podcars to shuttle people around the city (Biello, 2008; Stilwell et al,2008). These podcars will run on a series of magnetic tracks using electricity and will be fully automated, directly shuttling riders to a multitude of stations throughout the city (Biello, 2008; Stilwell et al,2008). Convenience was made a priority for each of these electric transport systems, with stations available within a 200 meter radius from any location in the city (Masdar Initiative, 2008). As a city located in a harsh desert climate, a highly efficient water system is a key element of Masdar's sustainability plan. Masdar will derive all of its water from a desalinization plant located just outside the city which will run solely on solar power (ENN, 2008). Masdar's planners took great strides to lower the city's net water demand, achieving a 60% reduction in overall water consumption (McGrath, 2008).

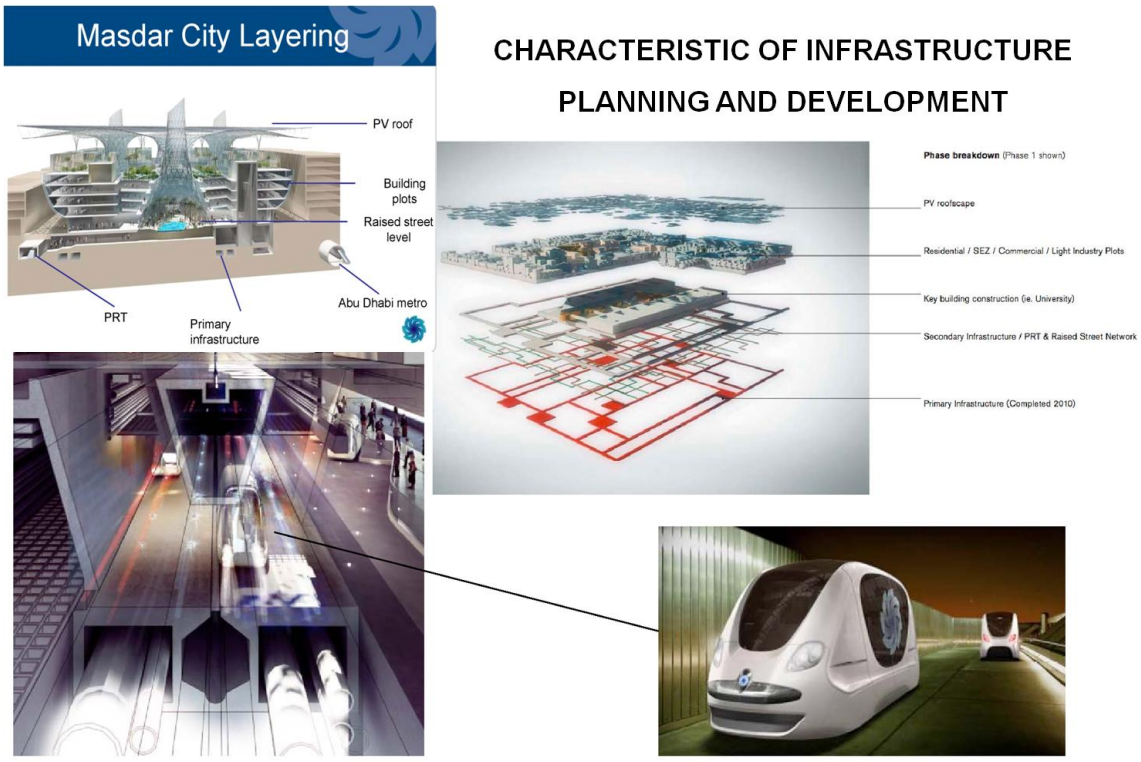

Figure 1: Infrastructure Development in Masdar. Source: Masdar Initiative, 2008

In addition, 80% of all water in Masdar will be repurified and recycled back for household and irrigation purposes (McGrath, 2008). Masdar will also apply some of the world's most advanced water recapture technologies to catch and reuse water diverted for landscaping. (Sullivan, 2008; Stilwell et al,2008). Masdar City' power infrastructure features a range of renewable energy technologies; including a range of photovoltaic plants(PV), a concentrating solar thermal power plant (CSP), evacuated thermal tube collectors, and a waste-to energy plant. Each technology has certain characteristics that determine how and when the energy produced will be used, its advantages, and disadvantages, and not least, its cost. (Nader/Energy Procedia, 2009, p.3953).

Masdar City will rely on intelligent design and innovative urban planning in order to cut energy consumption by about 70% from that needed for a conventional city under Abu Dhabi's current conditions(Nader/ Energy Procedia,2009, p.3953).The specifications for the façades of all buildings within Masdar City are extremely high. In a very warm climate such as Abu Dhabi, the loss of cooled air entails significant energy cost. By specifying high quality façades and shading them from the worst of the day's heat, the need for cooling and for power can be greatly reduced. All Masdar City buildings would be intelligent buildings, incorporating monitoring and control systems, which would facilitate the most efficient possible use of resources.(Nader/ Energy Procedia,2009, p.3953).Through a combination of careful control of materials brought onto the site and intensive recycling and waste-to-energy technologies, Masdar City would aim for net zero waste. Physical waste would be managed through an inte-

grated, user-friendly and odorless system and biodegradable materials would be composted. (Nader/ Energy Procedia, 2009, p.3954).

3 PORT HARCOURT, NIGERIA AS A POST OIL CITY

The cities that make up the region derived the name (Niger Delta) from being situated at the mouth of the River Niger, which could be traced back to early 15th century. Comprising the people of the region are the Ijaws (who form the largest ethnic group in the area), the Itsekiris, Urohobos, Efiks, Ibibios and other smaller ethnic groups (IHRHL, 2000, p.1). The colonial era gave birth to Nigeria with the Niger Delta situated at the Southern-Eastern part of the country. As at 1975, three states were under the region namely Rivers, Bendel and Cross River States, with two Ibo States, Anambra and Imo as the hinterland. Following the creation of more states and a redefinition of which areas should be included in the Niger Delta, 9 states were included. They are Abia, Akwa Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Ondo and Rivers States. (IHRHL, 2000, p.1).

Port Harcout, the capital of River State is the second larget Port of Nigeria. This Port was developed on a bend of the Bonny river, Where a bluff of solid land lay close to deep water.It was laid out for the colonial government of Nigeria for effective control of the hinterland. Apart fron that, Port Harcourt was also developed to tap the vast oil palm resources of the south–eastern Nigeria and to facilitate marketing of the coal which had been discovered in the udi hill near Enugu in 1912 (http://en.wikipedia.org/wiki). Its therefore not surprising that with this vision for the city of Port Harcourt, the resultant urban development that followed after the oil discovery was notthing to near a sustainable city

3.1 Urban Fabric and Infrastructure Development

There are three significant events which directly affected the growth of Port Harcourt btween 1946 to 1966 (http://en.wikipedia.org/wiki). These were:

a. The launching of the 10 year Colonial Development Plan in 1946, which provided for Town planning and Village Reconstruction in Nigeria of which Port Harcourt was a Part;
b. Political developments in Nigeria and their effect on the local adminstration of Port Harcourt
c. The expansion of the Nigerian petroleum economy

As per these developments and influence, Port Harcourt was laid out into two residential nuclei- an African location and the European reservation which were separated by a neutral zone (predominantly green infrastructure). Each of these residential nuclei developed different housing standards and general planning standards, reflecting the double standards of the British Town planning Practice of the Colonial Africa. The European reservation on one hand had golf courses, country club (Port Harcourt Club) and a Hospital. Where as the African locan or zone was characterised by crowded housing, unpaved grid-iron streets and a few green Open spaces. This development apparently did not reflect the wealth that comes with the oil economy but another mega-pseudo-slum in the region.

3.2 Characteristic of Infrastructure Planning and Development in Port Harcourt

The accompanying infrastructure was also characterized by inadequate maintenance and lack of pragmatic planning with the future growth of the city in mind. The infrastructure apparently became inadequate for the bustling population. Unlike Masdar, Port Harcourt was characterized with a high illiterate population adding to the problem of soft infrastructure gap in the city. Rampant civil unrest which usually becomes violent protest is also an order of the day in the city. The activities of violent militias has almost become like a political party fighting for the course of the people. This consequently affects the project delivery timelines as well as the project funding as most donors consider the area as unstable and risky to do business. As if that was not bad enough, the old age anti-developmental problem called corruption was also almost accepted as part of the norms and cultural practice. Every major infrastructure project ends up being affected by corruption and hence the quality becomes affected as well. However, in the past few years a new master plan has been drafted to salvage the almost worst situation and example of a pot-oil city in the sub Saharan African region.

Figure 2: Aerial view of portion of the City of Port Harcourt. Source: Googlemap,2010

4 Tema, Ghana as A Post Oil City

Tema is a coastal city, situated about 25km East of Accra, Ghana and it has a land area of 368.3 sq.km and an estimated population of 0.7 million people. From the 1960s through 1980s. Tema has been transformed rapidly from a small fishing village into an industrial nerve center of Ghana's economy. With a deep seaport, Tema

handles about 70% of all shipment to Ghana and some land locked countries in the West African Sub-Region. Tema accommodates over 200 small, Medium and large industries include an aluminium smelter,an oil refinery, and food processing plants.Unlike Masdar or Port Harcourt, Tema was developed after independence and was planned before the discovery of oil. It however has the fishing community like both Masdar and port Harcourt prior to the oil economy and have geo-physical features almost like that of Port Harcourt (*http://www.pseau.org)*.

4.1 Urban Fabric and Infrastructure Development in Tema

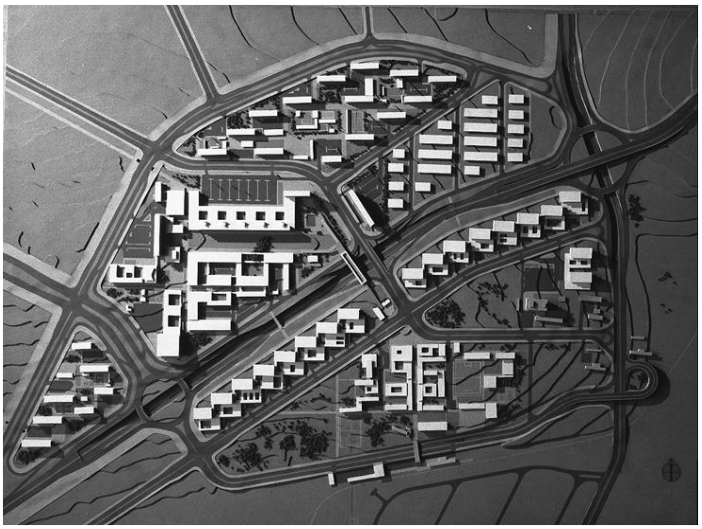

Figure 3:Model of the Urban Structure of Tema as planned in the 1960's. Source: Doxiadis,1968

Tema is the largest man-made harbor in Africa, and is linked to Accra by both a railway & highway. Tema which was planned by the Greek Town planner C.A.Doxiadis was conceptualised after the Ebenezar Howard's Garden city concept and has out grown its planned capacity. As a township, Tema is made up of several sprawling districts, known as a 'Communities', with the centre of Tema referred to as 'Community 1'. Tema is separated from Accra by Sakumono and eastern suburbs of Accra such as Teshie and Nungua, and the districts of Sakumono and Tema are themselves kept separated by the Sakumono Lagoon. Tema's communities are home to several major financial institutions, government departments, retailers, restaurants, and hotels & guesthouses(http://www.ghanapedia.org). As shown in figure 4 the structure has metamophose into something entirely different from the original. It now contain areas which are well organised with adequate green infrastructure and as well as areas which has defy all the planning regulations and sprawled. A Mixture of the classical grid iron concept with the organic cul-de-sac street system makes Tema one of the few areas where the House numbering and identification is properly done.The streetscape is however littered withunplanned commercial kiosk serving as convenient shops.All planned garages along the street have been turned to a commercial activity. On the advent of the oil economy the

direction of urban development trend has become very crucial whether to follow the path of Masdar or by default would tow the path of Port Harcourt.

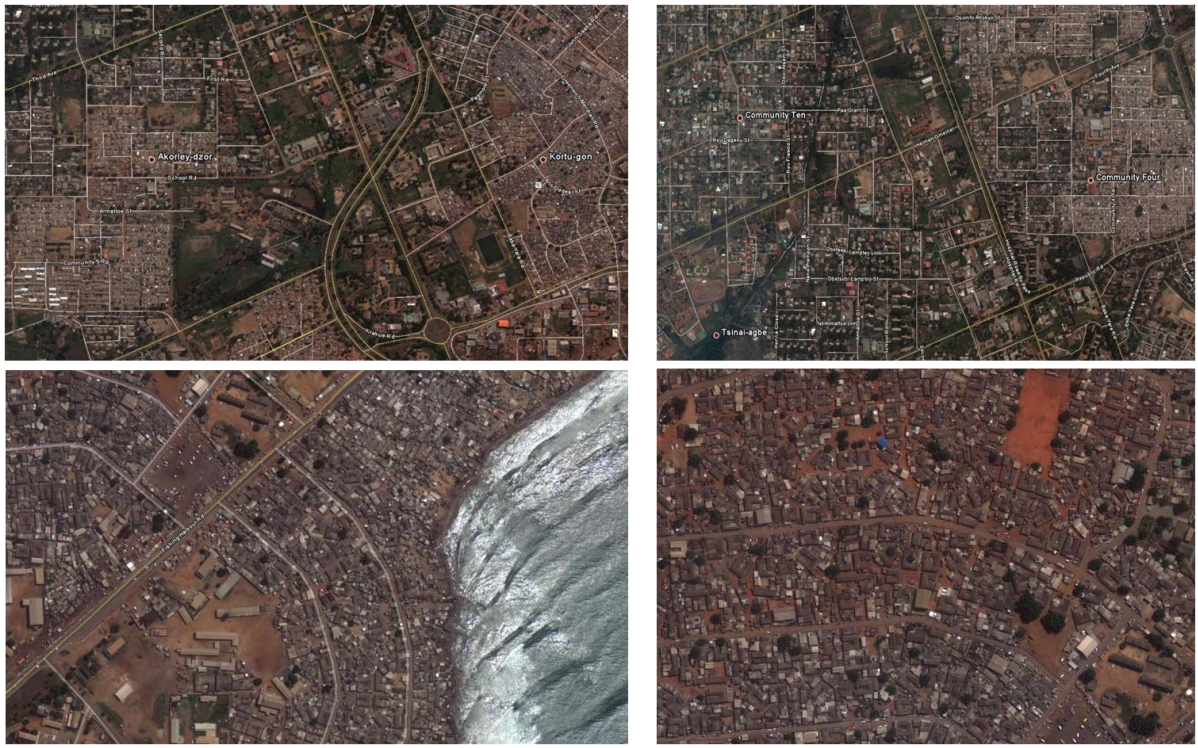

Figure 4: Urban Structure of Tema in 2010. Source:Google earth,2010

4.2 Characteristic of the Trend of Infrastructure Planning and Development in Tema

Tema is the city with the most planned infrastructure system in Ghana but due to lack of maintenance culture, almost every infrastructure network is found wanton. attempts are being made recently by the Tema Development company to salvage the situation but it require more than just money but a paradigm shift in the attitude of the inhabitants toward the usage of the basic infrastructure system is required. The breakdown of the solid waste management system is a typical example as many drains have been turned into the dumping grounds in the various communities. The electricity and Water system is quite functional apart from the national problem of unannounced intermittent blackouts. The road network is also quite good apart from the few bottlenecks that exist in the capital, community 1.

4.3 Lessons from Masdar

There are quite a few lessons that can be gleaned from the the Masdar City development as information and advice for Tema as it gets to the cross-roads of development. The Masdar city's $22 billion budget served as a catalyst for additional innovation, which can also be considered as benefit to the economy(Todonova 2008).When huge sums of money are allocated to a given course that is an incentive for all major stakeholders to be part of it.. According to Rosenthal (2008), Aluminum companies responded to the incentive by developing a more competitive product with significant-

ly reduced carbon emissions to prevent their product from being excluded from the project.

Thus with adequate government policies and budget support for Tema as a post oil city, there is a possibility of new innovations of traditional materials being enhanced to meet the international standards for usage and promotion in the African sub region. The Aluminum Factory which has collapsed could be revived. The zero waste strategy can be adopted and applied locally from the grassroots. Reduce Reuse and Recycle as well as composting and waste-to energy strategy can be researched and implemented with appropriate technology that is suitable for the Ghanaian economy. This would also call for the central Government policy and budget support as new recycling plant and waster trucks and companies would have to be supported with subsidies.

Though a zero car city may be difficult, is a pragmatic green infrastructure network is planned and implement with the necessary support, it would be pleasant for people to ride from the origin to their destinations without suffering from the scotching sun. The Bus Rapid Transit system may also be introduced as well as the Light Rail System in the Long-term. Re-usage of the waste water system can also be explored and decentralized photovoltaic power also encouraged with the proper policy backing it. Masdar City was developed on a solid vision and objective backed by the requisite policy and political will to propel its execution into reality. Tema as a Post oil city would need just that with the Research back-bone as Masdar institute provided for Masdar City. Research into the new Technologies, Systems and Policies at Graduate level is relevant to help maintain any new system that would be introduced into Tema.

However, Tema should be planned with such budgets as it would promote inequality in development in the country and foster rural-urban migration. After the oil, what will Masdar use to sustain its bloated population desert metropolis? Tema ought to be planned in tandem with the other adjoining cities to curtail the temptation of creating a haven and expensive city for only the rich. Looking at the policing system in the country, a case like Masdar in Tema would just increase the high-tech robbery and artificial lifestyle which would only support the rich, thus causing social segregation which was fought against during independence of Ghana. No one knows whether Masdar would be a success or not as it's just an experimental project yet to be sent through the rigorous test of time in a developing economy. Masdar development was not planned with the people but was planned for the people with the hope that it would satisfy the aspirations of the future inhabitants.

4.4 Lessons from Port Harcourt

Port Harcourt is a very good example of a failed city with so much of a resource which Tema can take it as a negative example to motivate its policy makers in doing the right thing. The militancy and rampant demonstrations just represent the results of inadequate consensus building and public consultation before developmental project is implemented. Tema is in a better position to avoid all the mistakes of Port Harcourt and provide adequate job opportunities for the youth and educate them which would become difficult for them to engage in violent demonstrations. Transparency in

the procurement process during the development implementation would go a long way the gain the trust of the would-have been demonstrators.

5 Conclusions

In conclusion, the way forward for Tema is to glean from the good practice of Masdar and adapting it to suit the local environment technologically, culturally and financially.

The whole process would only work if there is good governance in place at the Metropolitan and municipal level as well at the central government. Apart from that Patriotism on the part of the leaders and the professionals would play a key role since it would cause them to think about Ghanaians first before the foreigners or tourist. Peace and stability in the political environment is also very crucial for Tema to transit from its current state to the Post Oil city which would attract recommendation and cited as a best practice. Suffice it to say, Tema as a post oil city would need to plan and develop as an Afro-Green City which would be a city for the people by the people. This Afro-Green Community would be a sustainable or Green community with the African anthropogenic and socio-economic characteristics permeates through the housing, built environment, transportation and connectivity, socio-cultural, governance, environmental, economy and services (Marful,2005).

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Mysore: Challenges of Infrastructure Provision

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Abstract: Our urban areas are growing rapidly and require planning and adequate servicing to avoid problems associated with unplanned and ad-hoc growth. The study reflects the sudden spurt in Mysore's growth due to economic development within the region. Mysore is currently faced with a tremendous pressure on its resources such as land, urban infrastructure, affordable housing and better quality of life. Currently a master plan is being prepared for Mysore region encompassing an area of 509sq.km. The paper analyses the challenges and key issues relating to the existing situation and suggests the ways to mitigate through the process of master plan preparation maintaining the heritage, culture and environment of the city.

Key Words: Mysore, urban infrastructure, master plan, economic development, heritage, information technology (IT), Mysore City Corporation

1 Introduction

Large pressure of growing population, increased demand for basic infrastructural facilities combined with industrial activities have essentially led to rapid changes in land use patterns in many of the urban areas in India. Planning for infrastructural facilities, identification of residential and commercial areas without distressing the environment is a crucial issue. A successful city cannot operate efficiently in isolation from its environment and must offer investors security, efficiency in provision of infrastructure and should put the needs of its citizens at the forefront of all its planning activities. In Mysore urban planning and architectural conceptualization took place in the early nineteenth century. The concern for city aesthetics, spaces for public plazas, parks and gardens, well designed markets & boulevards were planned in the overall setting of which they formed a part. The city of Mysore has reasonably good urban infrastructure and a relatively clean and green environment. Furthermore, Mysore is less congested and land value is comparatively cheaper. The city has several culture, heritage and tourist attractions in and around Mysore; of which the Mysore Dasara[6] being the most prominent. The university and a range of other educational establishments are added attractions for efficient and skilled manpower required for the growth of local economic development.

[6] Mysore Dasara is the state-festival of Karnataka which lasts for 10 days. According to a legend, Dasara denotes the victory of truth over evil and the day when the Goddess Chamundeshwari killed the demon Mahishasura. Traditions of celebrating the Dasara festival are an elaborate affair & attract a large audience including foreigners.

2 Changing Face of Mysore

The Government of Karnataka is promoting Mysore as an alternative destination for Information Technology (IT) and Information Technology enabled Services (ITeS) industries and developing it as a counter magnet to the city of Bangalore. Mysore has become a new haven for the IT related services and is poised to play bigger role in the economy of the city. The South Western railway has their headquarters in Mysore and is one of the major employers in Mysore. Other factors that will change the face of Mysore are: the doubling of the railway line, completion of the Bangalore-Mysore Infrastructure Corridor project, operationalisation of a new airport and the up gradation of the state highway to four lanes.

Mysore district has the largest concentration of industrial enterprises in the state after Bangalore and has extensive areas under process of industrialization. There are five existing industrial areas within Mysore and Nanjangud. These areas house varied industries related to automobile, engineering, mechanical and knowledge based industries such as IT, ITeS and research centres. Mysore offers significant advantages in financial impact towards cost of living and real estate prices. As per a market survey, Mysore is emerging as one of the top-ten cites for investment in the country. However, today the need is to package and market it appropriately.

3 Project Brief

The Master Plan for Mysore Nanjangud Local Planning Area (LPA) covers an area of 509sq.km. The planning area includes two urban local bodies; Mysore City Corporation (128sq.km) and Nanjangud Town Municipal Council (11.6sq.km) along with 110 other villages. The last master plan was prepared in 1997 and is still in use today. However due to rapid urbanisation it is outdated and paralysed by the lack of regulations and policies within the existing development control regulations. An existing plan under preparation is for 2021. High resolution satellite imagery was used for preparation of maps.

Box 1: Statutory provision for the preparation of Master Plan in state of Karnataka, India

The Master Plan for Mysore is being prepared under the aegis of Karnataka Town & Country Planning Act, 1961. Mysore Urban Development Authority is responsible for the preparation of Master Plan and updating it at least every 10 years. The master plan preparation consists of a report explaining the provisions of plan, regulations for land use zones and regulations for conservation of heritage precincts. The plan is finalised after a series of public consultations and approval from the government

4 Objectives of the Master Plan proposals

- To promote Mysore city as the destination for investment in nonpolluting economic activities like IT, Bio-Technology and tourism related activities.
- To promote and conserve the cultural heritage, preserve the natural characteristics of the city and its environs through planned development.
- To plan for an emerging metropolis with options for efficient public transport system, good road network and access to state of the art urban infrastructure.

- Suitable Planning measures to prevent the misuse of natural landscapes like reserved forest, water bodies, natural valleys and hills.

5 Provision of Urban Infrastructure

For a city to function smoothly it is critical to evaluate the condition of its existing service delivery capacities. Generally cities within Asia expand in an ad-hoc manner primarily due to creation of job opportunities or an economically viable environment. These cities grow but the urban local body do not have the service delivery spread to its entire areas. This creates a serious threat to the citizens staying in such areas without basic amenities thus decreasing their quality of life. Discussed below are selected urban infrastructure services.

5.1 Water Supply

Existing Situation

Mysore has a perennial source of water supply in the form of river Cauvery. There are currently three operational water supply schemes using water from this river. The first water supply system was commissioned in 1896 at Belagola which is downstream of the Krishnaraja Sagar dam on river Cauvery. The treated water is supplied to various balancing reservoirs through a well defined network of various sized pipes which the topography of Mysore supports. As of today 85 percentage of household are covered within the water supply network and 80 percentage of households registered with Mysore City Corporation have water meters installed.

Challenges and Key Issues of existing Water Supply System

There is a lot of unaccounted for water loss due to unauthorised connections and poorly functioning water meters. The O&M of the WTP and the water supply network has not been sufficient primarily due to the lack of funds with MCC assigned for the maintenance of the water supply system. Tapping the sources of unaccounted loss of water is a mammoth but necessary task for the city. Today, there is a need for modernisation and up-gradation of network for the distribution of the water supply, provision of more over head tanks and other water distribution elements which are lacking. There is no augmentation of resources today which has become a major concern for the city's water supply system. The water loss is further magnified due to the use of water stand posts within the slum areas. There is also a strong dependency on the municipal finances for the maintenance of these systems. A proposal for privatisation of water supply system has been initiated. However, as all things new, there is resistance by some citizens, due to assumptions of higher water charges to be paid by the users, control on illegal water usage, etc.

Mitigation through Master Plan Process

The master plan emphasis is on enhancement and provision of infrastructure services like water supply, sewerage, storm water and solid waste management. Due care has been taken to integrate these urban services within the process of preparation of master plan. The bulk water sources have been identified to mitigate the is-

sues of provision of water supply. Within the housing layouts the provision of piped water supply has been provided. Mysore is one of the first cities in India which will have 24x7 privatised water supply systems under the Jawaharlal Nehru National Urban Renewal Mission[7] program to cater to the increased capacity of the utility services. JUSCO (a private water utility company) has been given the contract for this 24x7 water supply system on performance based management for the next six years on behalf of MCC. However with the privatisation; the water supply will eventually result in restricting and minimising illegal connections, collection of water taxes and regularisation of water to end users.

5.2 Sewerage

Existing Situation

Mysore was one of the early cities in India to have an underground drainage system dating back to 1904. There are three treatment plants which are functional covering the entire city's operations with 57 percent of households connected to the underground sewerage. The STPs have a capacity to treat the sewage greater than the existing population but the total sewage going into the outfalls is less than 50% of the sewage generated in the city. Hence the system is not being utilized to its fullest. There is no maintenance of the sewerage lines as some of these are damaged and need urgent repairs because of which the sewage is being dumped into the open storm water drains along the roads. Also due to heavy maintenance costs the O&M of this system is not carried out appropriately.

Challenges and key issues of existing Sewer System

There is a need to have new sewerage distribution system to cater to the needs of the existing population along with 100 percent coverage. With the development of new knowledge based industries and increase in the population the requirement for the sewerage network is ever increasing along with a need to upgraded sewerage network and install new pipelines. If this is not done than the issues of systematic disposal of sewage is a concerned for the urban local bodies. Within the existing housing layouts the piped sewerage network is constructed but there is a need for trunk sewers to be laid within some areas of the city.

Mitigation through Master Plan Process

The master plan proposal addresses the issues of sewage by emphasizing on redistribution and augmentation of the existing system. The proposals deal with the issues of O&M of the network lines and repairing or replacing them with new ones wherever required. The construction, rehabilitation and expansion of the underground drainage

[7] The Government of India; recognising the challenge of an acute urban crisis initiated a process of urban renewal through the launch of the Jawaharlal Nehru National Urban Renewal Mission. The aim is to encourage reforms and fast track planned development of identified cities. Focus is to be on efficiency in urban infrastructure and service delivery mechanisms, community participation & accountability of urban local bodies towards citizens.

system include the service connections to all households within the city area in the first phase and later to be extended to outer areas.

5.3 Storm Water Drains

Existing Situation

The storm water drains within the city of Mysore and its out growth follow well defined valleys, which the city's topography supports. Within the Mysore city area the existing roads have been provided with primary drains which are then connected to a network of secondary drains. There are about twelve catchment areas within the city which are responsible for the water runoff for these drains from where the water is collected and discharged into river Cauvery through a series of tanks and canals.

Challenges of existing Storm Water Drains

The lack of inspection mechanism for monitoring the cleanliness of storm water drains and silt deposition causes overflowing of drains which has become a major issue. The topography of the city is such that the storm water drains into three tanks viz., Kesare tank in north, Dalvai tank and Malalavadi tank in south. At present the sewerage from areas without sewerage network is let into the storm water drains and natural valleys. At many places encroachments have been made over these drains disconnecting and blocking them. Initially the tanks were interlinked but as some of these have been blocked; the overflow of one tank does not reach the others connected to it.

Mitigation through Master Plan Process

The project includes remodeling of storm water drains, increasing the coverage of storm water drainage network, delinking the sewerage system from the storm water drainage system, completing the missing and blocked sewer links and desilting to clean up the storm water drains.

5.4 Education

Existing Situation

Mysore state was a pioneer in setting up of educational institutions and a fore runner in providing quality education with one of the oldest universities in the state. Modern education system was set up in 1833 with establishment of the free English schools for masses. Various colleges and technical institutions were established followed by the formation of the University of Mysore. Currently the city has five engineering colleges, medical institution comprising of medical studies, dental studies and Pharmacy College. Most of these educational institutions are equally distributed so as to provide access to education for the citizens of Mysore.

Challenges and Key issues of Existing Education System

As the Indian economy is growing at a rapid pace there is a need for skilled manpower to support the continuous process of economic development. This need is fulfilled through the promotion and imparting of quality education. To increase the en-

rollment rate, provision for better and more dedicated teachers along with setting of better class infrastructure needs to be carried out within these institutions. There is also requirement of funds for research and to create tie ups and interaction between the industries and educational institutions.

Mitigation through Master Plan Process

Mysore as a city has the ingredients to develop itself as an educational hub of South India. The necessary parcels of land for primary and high schools for each neighbourhood have been provided. To promote the private sector participation; higher education and research institutions are being provided with required land for development of world class campuses and universities within the city of Mysore.

5.5 Traffic and Transport

Existing Situation

Networks of national and state highway pass through Mysore connecting it to various parts of the state and country. Mysore city has an airport facility under civil aviation network of the country. The Mysore city railway station is a major junction providing for transportation towards Bangalore, Mumbai and Chamrajnagar. The existing urban road network can be grouped into a system of ring roads, include various radial roads which emanate from Mysore towards other urban centers in the region. Large numbers of commercial vehicles catering to industries have now been made to use the outer ring road which in turn has eased the traffic in inner city area and lowered the pollution content. The parking areas within the city's commercial district and public area is not sufficient and unable to cater to the growing number of vehicles in the city. There are on-street parking facilities within some of the commercial areas. Mysore has a city bus transportation facility, managed by state transport corporation connecting many places in and around Mysore. Approximately 0.18 million passengers travel by buses that make around 4,384 trips per day.

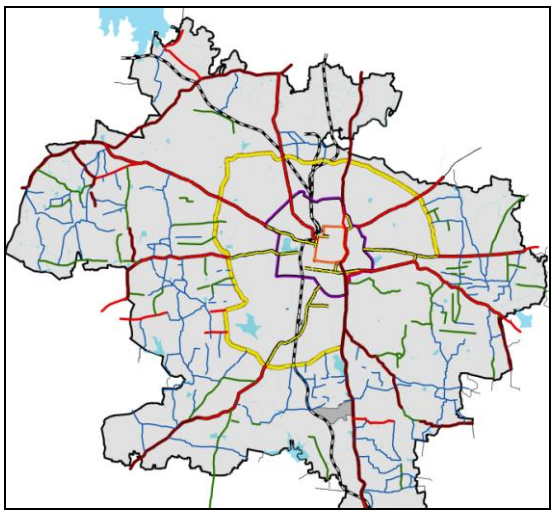
Challenges and Key issues of existing Traffic and Transport

Some of the important roads within the city that are major traffic generators have non uniform widths and need to be widened to ease the traffic movement. Some of the roads passing through the newly developed housing layouts have not yet been finished and these missing links need to be completed. There is an additional need for parking within the CBD areas which is already congested due to heavy traffic along with off-street parking facility. However, the existing ring road has not been completed and a link is still missing which needs to be constructed.

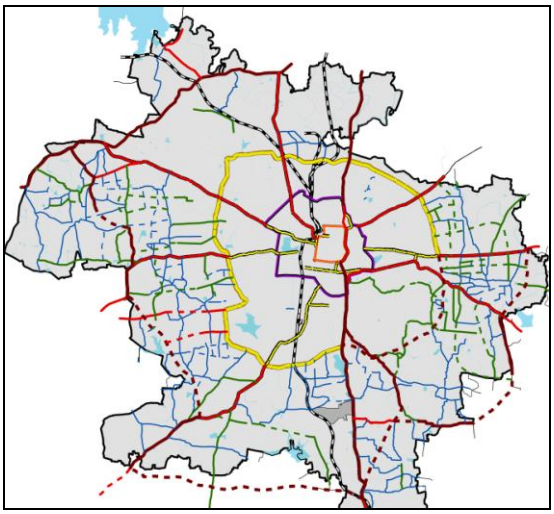
Mitigation through Master Plan Process

It is proposed to have a peripheral road of 45m width and is suitably aligned in the outskirts of the planning area along some of the existing rural road network. The important regional roads and the village roads are proposed to be widened to either 24m or 18m. Suitable deviations of the existing roads are worked out to develop bypass links treating the rural habitats as urban villages in the plan period. The pro-

posed major road network outside the existing built up area have been worked out, taking into consideration the various private housing schemes developed by the authority and private sector. Multi level car parking has been proposed at various places. These include the up-gradation of existing parking facilities and the proposals for new parcels of land. The master plan proposes new widths for the buildings lines which will enable to have clear building lines along the given stretches of the roads through the provisions made within the land use and zoning regulations.



Existing Circulation Pattern



Proposed Circulation Pattern

6 Housing

Existing Situation

The existing housing scenario in Mysore is being governed by many factors one of which is the high cost of land due to increase in demand for housing. The general trend is to construct one's own house within the layouts formed by the planning authority or by private developers. These plots within each housing layouts vary in size with larger one's measuring 80mx100m to smaller one's going at 20mx40m. The individual houses are designed by the owners and the building permission and house plans are to be authorized by the local body as per the development control regulations. The housing layouts at large do not address the needs of the people within the middle and lower income groups. There has been no survey either by the housing board within the state or the authority for the housing demand and land requirements. This will highlight a real picture of the housing needs and will be easy to release the land for residential areas as required. Today due to the rapid economic growth there is a lot of speculation about increased housing demand. But the existing studies suggest that there are housing layouts with serviced lands which have not yet being occupied fully. Mysore is also one of the few cities in India that do not have a large slum dwelling population.

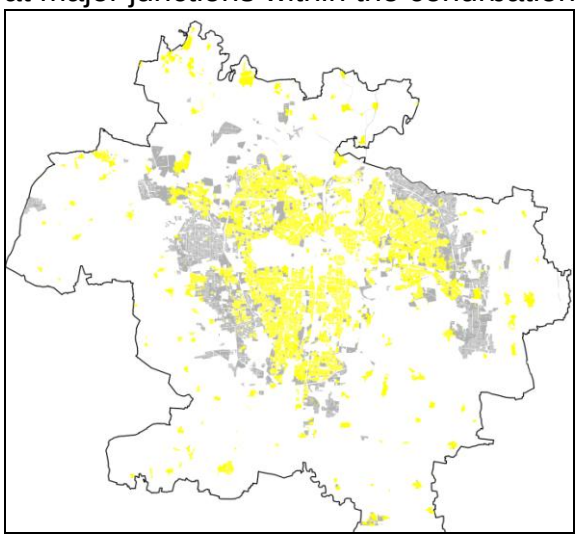
Challenges and Key Issues in Housing

There is a need to address the key issue of affordable housing for the masses and provision of housing for the economically weaker section. Mysore under the JnNURM project is trying to be "slum free city". To ensure this there is an urgent need of af-

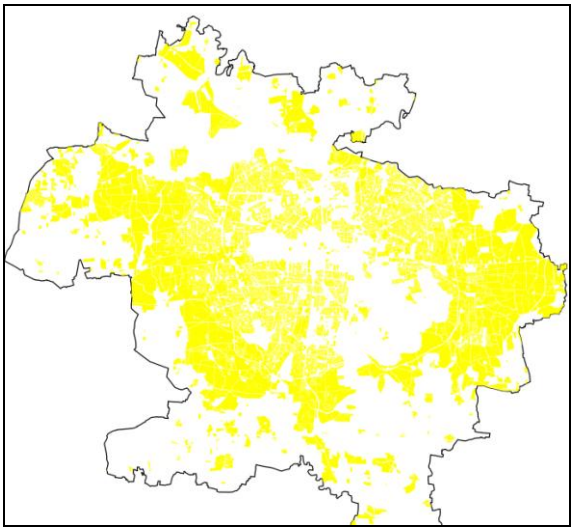
fordable mass housing for various sections of the society. The biggest issue that then arises is the provision of land within the city where there is serviced land available for such development. If these houses are provided in far off places then the issues of urban infrastructure and transportation will be consistent; increasing the cost of travel and non availability of basic necessities. There have also been issues with the change of land uses from industrial to residential. These changes affect the existing infrastructure provision and reduce the efficiency of the existing system. There is a growing trend in more construction of apartment buildings. Thus instead of a single family house it is now converted into a multi-family housing.

Mitigation through Master Plan Process

As the city has developed over the past 150 years Mysore comprises of a diversity of housing styles and residential environments. Consideration for housing issues within the master plan incorporates urban growth, urban consolidation, neighborhood character and opportunities to facilitate new development within the existing urban fabric. There has been focus on housing needs of the lower and the increasing middle income group. The consumer preference of housing has shifted from plotted land development to residential apartments. There are provisions for residential apartments as part of the mixed zone development. Residential land market is very active and the cost of land has increased fivefold. There is also provision for housing within the existing infill areas. The new plan has a major focus on creation of neighbourhood development through area plans focusing on providing serviced land to housing layouts and its surroundings. Due care has been taken to have neighbourhood centres at major junctions within the conurbation area.



Existing Residential areas (grey shows the unoccupied serviced housing layouts)



Proposed Residential areas

7 Landuse Proposals

Challenges and Key issues in Landuse

The previous master plan comprised of regulations that did not support the proposed plan fully. The proposed land use in the existing plan was only for an area of 164 sq.km. The land use zoning was based entirely on the assumptions and estimates of

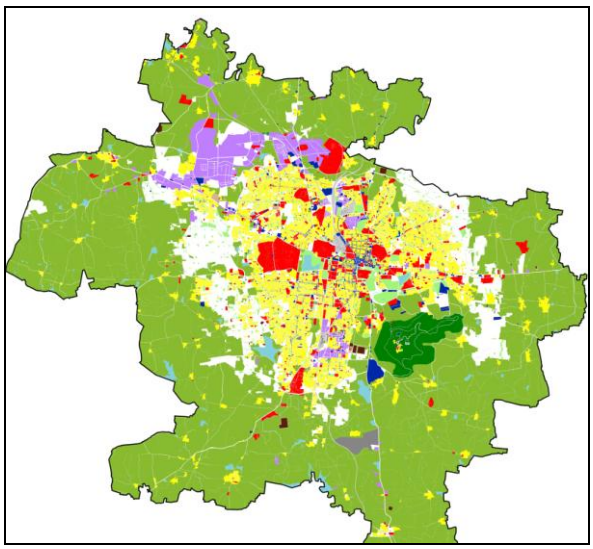
population for the plan period and there was no mention of compact development and provision of integrated urban infrastructure.

In absence of the land use plan, for outgrowth areas; there was ad-hoc release of land. The main factor for this type of development was due to the release of land by state revenue department[8] for residential and commercial uses. Hence no master plan proposals are followed, since they are not backed by implementation of stringent rules and provisions within the development control regulations. Due to this there was stress on the urban development authority to extend the existing provision of urban infrastructure facilities and hence huge capital investments.

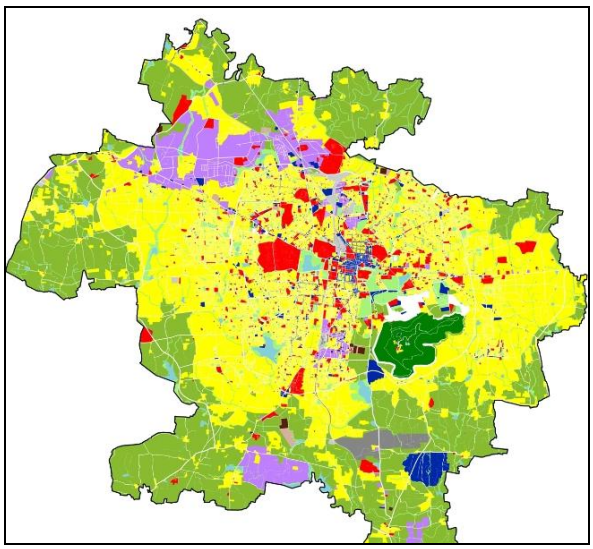
Mitigation through Landuse Proposals

1. The old master plan of 1997 had 30 planning districts (micro level plans) while the master plan proposals for 2021 have made provision for reorganizing some planning district and creation 45 planning districts.
2. As Mysore is a tourist destination the demand for tourism related activities are bound to grow. Therefore the tourism related activities like international convention centers, exhibition grounds & hotels are proposed near the airport. In order to accommodate various demands, land has been released for activities like golf course, crafts village and theme parks; generating employment opportunities and promotion of economic development.
3. No new area has been proposed for industrial use, as the authority has already acquired land within Mysore urban and peri-urban areas. It is seen that some industrial plots are still vacant and future demand for industries could be met. The plan also envisages retaining the defunct industrial land for the future.
4. For compact development and optimum utilization of land, no additional land is required for residential purposes. The existing vacant lands, and permissions given for change of land use, for residential use in urban areas, will take care of these requirements even beyond the planning period of 2021. This shall easy the O&M of infrastructure and lower the costs of provision of services to the authority.
5. From the point of view of spatial distribution of amenities, services and public utility, land has been allocated for health facilities; play grounds, sports ground, fire station, truck terminals and bus depots.
6. The radial corridors and main arteries linking the city outside the existing built up area have been identified as Mutation Corridor Zones, for which, separate regulations are framed in Development Control Regulations.

[8] In India the land is released for non agricultural purpose by the State Revenue Department. The Urban Development Authority who is preparing the master plan does not have any control for release of these lands. There is no coordination within the two government departments during the process of granting permission for the conversion of this land use. Hence release of urbanisable land is independent of the process of master plan.



Existing Landuse Plan (2010)



Proposed Landuse Plan (2021)

8 Development Control Regulations (DCR)

Key Issues with Development Control Regulations

There were no regulations for heritage precincts, building line controls or proposed road widths. The regulations for parking, physically handicapped persons, residential and non residential development, fire protection and natural disaster mitigation were missing within the previous DCR. There was a serious need to redefine the land use zoning and incorporate various provisions within the existing DCR.

Box 2: Development Control Regulations

DCR is a tool for guiding and promoting development in an area in order to improve the quality of life of its citizens. Development regulations include land use zoning for master plans, regulations regarding land use, usage of buildings, plot coverage, Floor Area Ratio, setbacks, open spaces, height, number of storey, parking requirements, etc; for various developments on land, and for various categories of buildings.

Mitigation through Development Control Regulations

A new set of Development Control Regulations were proposed. DCR was tailored to meet the needs keeping in mind the character and essence of Mysore.

1. The DCRs deal with the intensively, moderately and sparsely developed areas separately and have complete separate sets of regulations for each.
2. Special Development Control Regulations have been drafted for the protection of ancient monuments, heritage precincts and areas of heritage importance. The regulation areas have been defined around each such identified monument, heritage building and defined urban area.
3. There is a clearly defined set of provisions for various land use zones for setbacks, road widths, floor area ratio, ground coverage, building lines for important and through roads and parking regulations.
4. There have been very clear provisions made in case of changes of land uses which are permissible and the land uses for which they are permissible.

5. Regulations for parking, physically handicapped persons, residential and non residential development, fire protection, provisions of signages and safety measures against natural disaster are all clearly defined.
6. The DCRs have been drafted so as to have these transparent and that it should promote development and be user centric. This will encourage people to comply with the planning regulations laid within the premise of the master plan document which will help use of land optimally thus ensuring maximum resource allocation.

9 Highlights of the Master Plan Proposals

Preparation of Master plan for a city is a long drawn exercise. City planning has economic, social and physical dimensions. The master plan proposal for Mysore takes into consideration the aspects of physical and economic development for the future land uses. The city is to be developed in physical terms through the allocation and organsiation of the land uses through proposals on a macro and micro level planning. These proposals take into consideration the strengthening of the economic base for sustainable development and make people happy through the social approach. The plan also proposes the compact development in the interest of optimum utilization of urban infrastructure. The challenge today is with the horizontal expansion and urban sprawl. The master plan also focuses on controlling the existing change of land uses by the government outside the developed area to minimize the housing speculation and control the land prices. Finally the need to maintain the culture and heritage of Mysore city is being addressed within this master plan in a holistic way. The development control regulations and land use zoning regulations are prepared to control development while have development promotion within new areas to make it an attractive business destination.

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Ways of Infrastructure Redevelopment in Cyclone Nargis Hit Area, Myanmar

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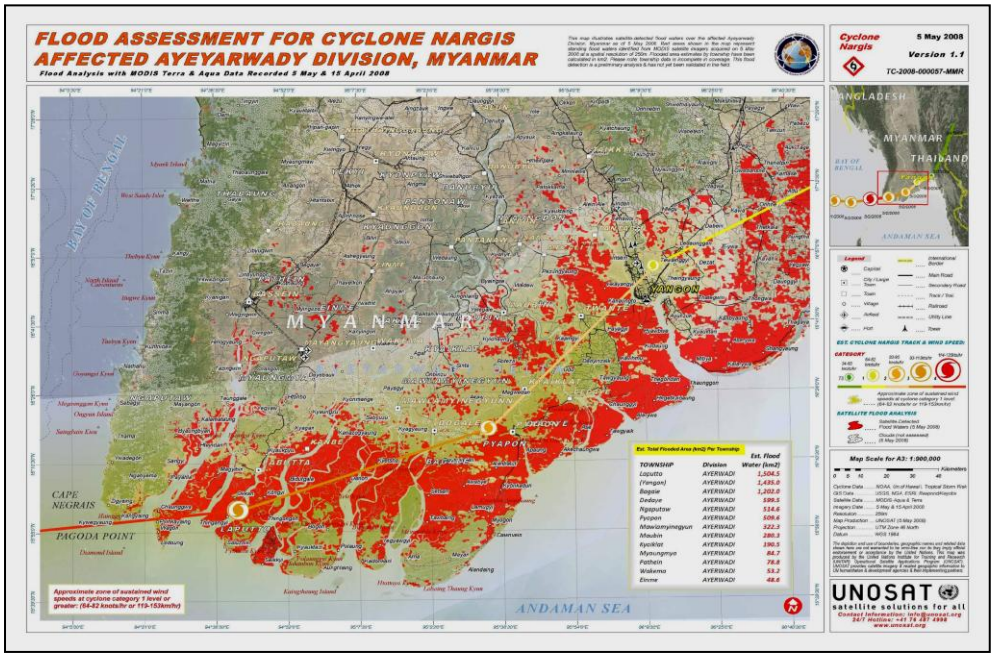
Abstract: This paper is about the ways of infrastructure redevelopment in Cyclone Nargis hit area.

Key Words: Infrastructure Redevelopment

1 Impacts of Cyclone Nargis Hit Area

Cyclone Nargis badly hit Myanmar delta area, Ayeyarwady division and Yangon division, at unprecedented scale on 2-3 May in 2008. The estimated death was more than 130, 000 people, number of affected persons were as high as 2.4 million and estimated losses were US$ 4 billion. It was totally destroyed by 450,000 units of houses, water sources, embankments, their main livelihoods, communication and social amenities. The consequences of impacts such as health problems (trauma and injury, fever, diarrhea, respiratory, etc.,) suspension of education, unemployment generation, market disruption and environmental degradation problems became emerged. The impacts of flood assessment detailed areas are shown on Map (1).

Map 1: Flood Assessment for Cyclone Nargis Affected Area



Source: UNOSAT, satellite solutions for all

1.1 Post-Nargis Joint Assessment (PONJIA)

In the aftermath of the cyclone, United Nations (UN), the Association of South East Asian Nations (ASEAN) and the Myanmar Government set up to coordinate the Tripartite Core Group (TCG) for relief efforts. Post Nargis Joint Assessment (PONJA) was conducted to determine the full scale of the impacts of the cyclone and requirements for immediate, short and long term recovery.

1.2 Emergency Response, Recovery and Rehabilitation Committee

ASEAN, the Government of Myanmar, the United Nations, the local and international NGO community, small community-based organizations and thousands of civic-minded individuals made intense efforts to provide for the relief and recovery needs of the affected population. The Government's disaster-related policy and decision making authority which called National Natural Disaster Preparedness Central Committee issued **"**the Program for Reconstruction of Cyclone Nargis Affected Areas and Implementation Plans for Preparedness and Protection from Future Natural Disasters" on 15th August 2008. The program includes three phases: the completion of emergency and relief measures; recovery, reconstruction and development measures and the measures for long term preparedness and protection from natural disasters. Under the National Natural Disaster Preparedness Central Committee and working committee, the government has also urgently formed response actions for 10 sub-committees; news and information, assessment and emergency relief, security, confirmation of loss and damage, transportation and route clearance, natural disaster reduction and emergency shelter provision, emergency communication, search and rescue, health care and towns/villages rehabilitation and reconstruction.

2 Regional Redevelopment Action Plans

The main issues to be considered as regional redevelopment action plan takes into account the economic based development for productive lives, community based development for healthy and upgrading lives and environmental based quality development for their protected lives.

2.1 Economic Based Development for Productive Lives

Livelihoods in the delta are mainly paddy rice cultivation, fishing and processing, livestock raising, horticulture (mostly fruit trees), small and medium scale of agro based industries and small scale forestry activities (firewood, charcoal and timber) and salt production. This is a fact of life for the 50% of the households work in agriculture, 20% of population who derived their main income from fishing and remaining 30% of landless labors which called causal labors. After the storm surge about 63% of paddy land (783,000 ha) was salinization, 85% of improper operating rice mills, 75% of fishing gear losses and 50% of live stocks damage were key issues to be redeveloped. Myanmar Government, the large companies of Myanmar and international community are re-establishing the livelihoods of farming communities and demand for causal agricultural labor by restoring and improving (such as technical transfer, equipments,

seeds and fertilizers are subsidized as quantitatively and qualitatively) sustainable cropping on the basis of environment. These redevelopments reach in certain limits. Both government and NGOs have strengthened livelihoods opportunities through improved access to credit and provided micro finance loans to 120,000 households.

The activities included to restore the fisheries and aquaculture sectors, the expanded provision of safer and improved boats, fishing gear and adapted credit system for the needs of fishermen. Beneficiaries would be small and medium inland and shore fishers, including household-based aquaculture however there was limited scale for larger scale fishers. Moreover, the rehabilitation of ice plants, cold storage facilities and processing equipment will definitely increased labors for processing and marketing.

Mangroves play an essential role for using as roofing materials for houses and charcoal production on the other hand these are mainly in coastal area protection for wind break and flood retards. The delta area was suffered major impacts of Cyclone Nargis due to the human activities; harvesting of timber for firewood and charcoal for home consumption as well as income generation. Therefore, the areas have replantation program and conservation programs started in the coastal zone management program. (See article 2.3)

2.2 Community Based Development for Healthy and Upgrading Lives

2.2.1 New Regional Networks

The delta region is mostly rely on the water way. The Ministry of Construction has started to rebuild damage or destroyed roads, bridges and to implement 10 new regional road network projects to connect from the frontier regions to the inland areas as a strong and safe regional network, as well as supporting routes for relief and recovery projects and easy flow for goods commodities (Map-2). These main networks are started to develop as only 2 lanes and inside the townships as the safety bunds.

Map 2: New Regional Road Networks in Ayeyarwady Division

Source: Road Department, Ministry of Construction

2.2.2 Resettlement Planning and Housing Sector

The National Natural Disaster Preparedness Central Committee has planned for the new settlements in order to minimize the disaster risk for the future. For the reloca-

tion of survivors the necessary support to either return to their native villages or to integrate fully at their new location. The relocation of new settlements plan were taken into account by scenarios considered as to meet the needs of the development and achieve the balance of social economic and physical infrastructure, to promote cost effective provision for infrastructure services and to provide the concept of sustainable development. New settlements areas are planned for long term sustainable development; these are located on elevated land, near the regional road network, favorable conditions for finding their livelihoods and the availability of water sources. For instance, Labutta three miles new town, Ywa Thit village, Oat Twim village and Aung Khaing village were planned from the Department of Human Settlement and Housing Development.

Based on the data from the UN Habitat, 59,618 houses were newly constructed, 30,217 houses were repaired, 79,502 houses were provided by materials and granted by cash, therefore totally 169,337 houses were developed. Towns/Villages Rehabilitation and Reconstruction Committee have constructed 10,117 houses. In addition, it is planned to construct 38,000 houses and to repair 268,000 houses in 2010-2011. Therefore, currently about 55% of shelter sector was recovered in the affected areas. The provision of safer housings minimum floor area is from 160 square feet to 200 square feet and which can be expandable to 320 square feet. The rehabilitation and reconstruction of household shelters are safer and durable which incorporation of Disaster Risk Reduction construction techniques. Rebuilding effort was carried out by villages themselves to get the advantages of knowledge and good skill of safe construction methods. However, some buildings are main of a temporary nature and have not been able integrate with Disaster Risk Reduction techniques.

New Shelters in Ayeyarwady Division

2.2.3 Redevelopment of Social and Physical Infrastructure

The provisions of sufficient basic social infrastructure within the affected areas such as schools, hospitals, primary health care centers are rebuilt some are expanded and upgraded. The core objective is to ensure restoration and appropriately enhanced provision of access to quality basic primary health care services, availability and the use of services by the affected population. According to the requirements, 16 bedded hospitals are provided the settlement which has more than 20,000 inhabitants and primary health care centers are mostly facilitated for 10,000 inhabitants. The Government plans to upgrade and expand a number of hospitals: Labutta General Hospi-

tal from 25 bedded to 200 bedded, Pyapon General Hospital from 50 bedded to 100 bedded, Bogale General Hospital from 50 bedded to 100 bedded and Mawlamyine Kyun General Hospital from 50 bedded to 100 bedded. In addition, 16 bedded hospitals have been implemented in five townships within the areas.

Regarding the education sector, Cyclone Nargis destroyed 1,736 schools (a total of 29 high schools, 67 middle schools and 1,640 primary schools) in the Ayeyarwady Division. Close collaboration between the Ministry of Education and international organizations have implemented rebuilding of schools and improving the quality of learning environment. The Government plans to make them storm resistant as appropriate and necessary, depending on the specific conditions prevailed in each village. An extensive education program, 610 schools are repaired and upgraded, 1,175 schools are newly constructed in Ayeyarwady Division.

Newly Constructed Schools in Ayeyarwady Division

2.2.4 Access to Safe Drinking Water

The main source of water for rural communities in the delta is rainwater and surface water. There were more than 5,000 ponds in the affected villages. According to the PONJA report more than 2,000 ponds were damaged. The Government is carrying out extensive program of rehabilitating village ponds, lakes and wells normally used by villagers as a source of drinking water and which were flooded with sea water during the storm. In the six month period following the cyclone, ponds and hand-dug wells have been cleaned in 2,000 villages, aiming to restore at least one pond and well per village. Continuously, existing water sources were improved and protected of water ponds programs in each township. The Government and UNDP (United Nations Development Program) plan to introduce new well digging program and more effective water purification systems through out the affected region to have access to adequate safe water.

2.2.5 Sanitation and Hygiene

Most of the households were practicing unsanitary defecation almost 40 percent in the immediate aftermath of the cyclone, creating additional risks of communicable disease. The provision of latrine sets is extended to households. Sanitation has been improved by supporting local authorities and communities in tackling the problem of solid waste and drainage disposal. To promote greater coordination, efficiency and transparency in relation to the implementation of public health related sectoral activi-

ties including health, water, sanitation, hygiene (WASH) and nutrition, consideration should be given to the setting up of Public Health Organization and Review Board for functioning, approval of health plans and major decisions on the allocation and real relocation of funds based on the program performance.

The WASH implementation needed to draw on all the capacities available in INGOs, LNGOs and UN system well coordinated with on going government program. WASH activities incorporated monitoring and evaluation mechanism through the relevant Township Community Committee.

2.3 Environmental Based Quality Development for Protected Lives

There will be no protective lives environmental development and awareness exists in the community. As a result of increasing vulnerability areas in delta which caused to natural disasters and suffered many losses of human lives, livelihoods, damage of natural resources and demolish of infrastructure. Therefore, communities should be at the center of restoring and preserving their environment practices (biodiversity, land use) and sound natural resource base (water, forest) for protective lives.

Regenerating natural mangrove forests and mangrove plantations along river banks and around villages, as well as replanting village woodlots will both contribute to livelihoods and reduce future disaster risks. Village organizations are main partners for implementing projects that promote sustainable natural resource management practice and environmental management (Pilot Projects, training awareness e.g. Community Forestry and Coastal Zone Management). While such a community based approach to mangrove rehabilitation (encourage people's participation in planting activities) implement 5 years plan to restore more than 12,592 ha of damaged mangrove, comprising 2,023 ha of gap planting, 8,555 ha for natural regeneration and 2,013 ha of plantation establishment. International Tropical Timber Organization, Japan International Cooperation Agency (JICA) and FREDA also support for the rehabilitation and replanting community-owned in the delta also combined with sustainable exploitation of inshore and inland fisheries.

2.3.1 Provision of Cyclone Shelters

Cyclone shelters or storm shelters are critical components of a comprehensive DRR strategy and can save many lives in the event of the disaster. These shelters are not only protecting against high winds but also against suddenly rising water. The Government, International Organizations, INGOs, LNGOs and local donors have implemented cyclone shelters for different number of population sizes designed by the Public Works, Ministry of Construction and the Ministry of Science and Technology and provided technical assistants from Myanmar Engineering Society. In the year of 2010, 66 cyclone shelters are constructed completely and 110 cyclone shelters are under construction and 9 are proposed for the construction. Cyclone shelters can include designated as public building (schools, health centers, monasteries and other multi purposes buildings).

Cyclone shelters in Ayeyarwady Division


2.3.1 Disaster Risk Reduction (DRR)

Disaster impact is greater in countries where prevention, preparedness, mitigation and response capacities are inadequate. Disaster Risk must focus not only implemented on preparedness and response, but also on prevention and mitigation and this includes issues of community awareness, early warning systems (from national level to community level) and capacity to manage disaster risks (for the inclusion of DRR in public education).

Asian Disaster Preparedness Centre (ADPC) supports for Myanmar Action Plan for Disaster Risk Reduction (MAPDRR) program for future disaster risk reduction projects (2009-2015). The objectives of MAPDRR are as follows:

- To build a more resilient and safer community through conceptualization, development and implementation of appropriate disaster risk reduction programs;
- To provide a framework for implementing Myanmar's DRR commitments at the global and regional levels, under Hyogo Framework for Action (HFA) and ASEAN Agreement on Disaster Management and Emergency Response (AADMER)
- To provide a mechanism where the disaster risk reduction initiatives of all Government Ministries and Departments, supported by UN organizations and other stakeholders, can be coordinated and monitored;
- To provide a conducive environment for mainstreaming DRR into development plans, and programs at National, State, Division, Township and Village Tract levels; and
- To support mutually beneficial partnerships between the Myanmar Government and their development cooperation partners in DRR programs.

The MAPDRR has seven components each component has 4 to 13 sub-components/projects and total number of 64 priority projects have been identified. The followings are seven themes of MAPDRR components:

- Policy, institutional arrangements and further institutional development
- Hazard, vulnerability and risk assessments
- Multi hazard early warning system
- Preparedness and response program at National/ States/ Divisions and Township Level
- Mainstreaming of DRR into development and mitigation
- Community base disaster preparedness and risk reduction and
- Public awareness education and training.

For the MAPDRR task force partners includes, 17 departments from 12 ministries, in association with local and international NGOs, UNDP and UNOCHA (United Nations Office for Coordination of Humanitarian Affairs) and professional associations,

academic institutions, Myanmar Red Cross and ASEAN which are a driving number of disaster risk management activities in the affected areas.

Therefore, it needs disaster network which allows and encourages promoting effective coordination and communication as well developing knowledge management with its all stakeholders in Myanmar. DRR institutions are working as the central government coordination body as is the National Natural Disaster Preparedness Central Committee and regional administrative level as States and Divisions level.

3 Assessment of Vulnerability and Improvements of Disaster Risk Management System in the Affected Regions

The Department of Human Settlement and Housing Development has evaluated the redevelopments of the most affected area of Bogalay, Labutta and Phyar Pon townships, in order to assess for the hierarchy of risks taking into account 12 main elements with three dimensional aspects; physical, economic and social. There are specified by 5 ranks and from rank 1 to rank 5 goes more critical stage of the settlement. Regarding to assess, between the rank 2 and 3 express as the relative safety stage for the settlement therefore the assessment takes the average rank as 2.5 and for 12 ranking items. Evaluation of the result of the assessment can be defined as three categories of risks: high (total rank>30), medium (total rank range 25 to 30) and low (total rank <25) risk areas. The following table shows the relation of main elements and the ranking system of settlement assessment.

Table 1: Vulnerability Assessment of Settlement

Main Elements	Rank 1	Rank2	Rank 3	Rank 4	Rank 5
Population size	<1000	1000-2500	2500-5000	5000-10000	>10000
Location of settlement	dispersed	along the highway	along the safety bunds	along the village road	along the river
Mode of transport	by bike	by cycle	by cart	on foot	by water way
Walking time to cyclone shelter	10 min	20 min	30 min	45 min	>1hour
Topography	elevated land	flat land	-low lying land	-mouth of river	- frontier to sea water
Type of housing	-brick Noggin	-wood (good)	-wood (poor)	-Hut (good)	-Hut (poor)
Information dissemination	internet access	-TV/radio announcement	communication centre	instrumentation method	difficult to have information
Infrastructure services	80% can be protected	60% can be protected	40% can be protected	20% can be protected	can be destroyed
Main Livelihood	80% can be protected	60% can be protected	40% can be protected	20% can be protected	can be destroyed
Natural Environment	80% can be protected	60% can be protected	40% can be protected	20% can be protected	can be destroyed
Education Awareness	Well trained	Good response	Understanding	Weak response	No response
Natural Protection	80% can be protected	60% can be protected	40% can be protected	20% can be protected	can be destroyed

The vulnerable assessment result indicates the hierarchy level of vulnerable risk in each township. The summary also provides a snapshot of system condition as a baseline for future improvements in local level and comprehensive for regional investment strategy. However, the risk level can be changed depending on the progressive developments occurring in corresponding areas.

To improve the Disaster Risk Management System, the items of settlements mitigation measures, preparedness planning, advocacy issues and next steps of task force must be identified by the related disaster impacts. Table (2) shows the improvement of Disaster Risk Management System for the affected areas.

Table 2: Improvement of Disaster Risk Management System

Impacts	Mitigation Measures	Preparedness Planning	Advocacy Issues	Next Steps
Losses of human lives,	-relocation of safer settlement and housing -minimum evacuation route to cyclone shelter -awareness of cyclone warning system	-develop early warning system -mangrove plantation for protection	-demonstration for cyclone safety (the Department of Relief and Resettlement) - store food for after cyclone - movement for old people, disable and children (emergency team)	-need to construct more safety infrastructure cyclone shelter, safety bunds
Damages of Infrastructure Roads	-Permanent road network from frontier region to inland region	-sub-base of the road for long term use -more alignments for frontier to inland access	-check road specification under construction and regular maintenance (Ministry of Construction)	-Study for future alignment
Losses of houses	-construct DRR techniques of houses - plantation for wind break	-on job DRR construction training for long term	-maintenance work for safety (involvement of communities)	- upgrade types of housing and cyclone resistance housing
Crop losses	-strengthen river banks, improve irrigation canals, install better water management system	- supervise and monitor weak points for river banks, preposition sand bags and tools coordinate and share information with other NGOs and communities	- common temporary safety storage for agriculture products (warehouse) encourage community participation	- better and more detailed assessments needed of canals and rivers in order to prepare projects for funding
Fishing facilities losses	-weather forecast from radio/TV/ other access -inform departure/ arrival at local port	-permission of traveling by cyclone weather announcement	-identification of safety location for fisher men by local authorities	-education for water way safety
Disease outbreak	- raise awareness of sanitation issues and environmental hygiene	- monitor health statistics and preposition hand tools	- encourage the involvement of NGOs - emergency medical treatment team	- more assessments and provision of hand tools
Losses of water resources	-water storage tanks for drinking water	-regular maintenance -training for cyclone awareness	-store rain water as emergency by communities	- establish new water sources
Schools/ Hospitals	-safety location -safety structure	-use more durable materials	-regular maintenance for safety communities by the concerned Departments	-upgrade and expand the facilities
Environmental degradation	-reduce human activities of forest and mangrove -substitute roofing material of housing and charcoal use	-re-plantation and raise forest and mangrove	-Coastal zone management by the dept of forest	-Conservation for forest and mangrove

4 Conclusions

According to the vulnerability assessments, infrastructure redevelopment are still needed to fulfill in the high risk settlements areas as the first priority and continuous process of development should be implemented in the medium risk areas. In Nargis affected areas, the main environment development outcomes will be more engaged in Disaster Risk Reduction measures, understanding of early warning system, mitigation measures in vulnerable areas, disaster mitigation is better integrated into current recovery and reconstruction efforts, national and local institutions developments improved preparedness and mitigation policies and response mechanisms due to the economic base, community base and environmental base of continuous infrastructure redevelopment activities.

Therefore, Disaster Risk Reduction will be covered a wide range of intervention undertaken before, during and after a disaster to prevent or minimize loss of life and property, minimize human suffering and hasten recovery in future.

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Numerical Modelling as A Key Tool in the Decision-Making Process for Water Resources Management

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Abstract: Once our ancestors decided to settle close to rivers, natural streams, oceans and lakes; these water bodies have been playing a crucial role in the activities of human-societies. Since life depends on this vital liquid, to manage the water resources properly and in a sustainable way is transcendental for finding the harmony between the water resources and the man-made constructions. In order to reach this aim; the people involved in the decision-making process for water resources management have to be supported not only by well-done directives or guidelines; but also by experts in the field of hydro-engineering.

Nowadays, the water specialists use numerical models to understand better the natural phenomena that involve water dynamics. Thanks to the rapid evolution of the computer facilities; numerical modelling is becoming a rapid, efficient and "cheap" solution to predict the hazards provoked by water flow and to manage our water resources. The present paper takes a glance on how numerical modelling can help the hydro-engineers not only in predicting water flow, but also to analyze the interaction between water and the man-made infrastructure. Once a numerical model is set-up; the water specialist can modify it relatively easy in order to forecast different scenarios and consequently to facilitate the work of decision-makers to choose the most convenient option from the technical point of view.

Key Words: Computer Facilities, Water Dynamics, Global And/Or Project Scale.

1 Introduction

Several of the most relevant civilizations of our history decided to settle along rivers, close to water bodies or not far away from the coastal shoreline. Once they decided to build their villages, towns or cities; water became an element that not only have been enhancing the beauty of the landscape, but also it became a "witness" of the culture, customs and history of these civilizations [4]. It is possible to mention some examples if we remember the settlements close to the Nile in Egypt, the Rhine, the Elbe, the Thames or the Danube in Europe without forgetting the Vistula or the Odra in Poland. Looking outside the Euro-Afro-Asian continent; the ancient Mexicans migrated from the Pacific coast, (where the mythical *Aztlán* was supposed to be located) to the central plateau of the country founding the Great *Tenochtitlan* (nowadays Mexico City) in the middle of a lake following the order of their God *Huitzilopochtli*. Therefore, our ancestors modified the water bodies without thinking about the consequences that these changes could provoke (in those times, there

were not water specialists, who could advise them about the consequences of their decisions). The majority of the negative effects that arose after modifying the natural water conditions are because the water is constantly in motion; e.g. the changes in the water table still represents a problem for maintaining the floor level in the centre of Mexico City. Nevertheless, it is a matter of fact that centuries ago the decision-making process was completely different than in the actuality. But not everything is fault of these historical decisions, water motion is as well the reason of many ecological problems that are not related to any human influence, on the contrary, human interference had mitigated the hazards that water brings with [4].

In water resources management; numerical models are actually applied to a wide range of problems in hydrology, flood flow, groundwater flow and recently in sediment transport. The present paper highlights the importance of considering numerical modelling as a tool that facilitates the decision-making process for water resources management. The use of models as decision making tools often has greater value in sensitivity analysis and in building and analyzing different scenarios [5]. Let's not forget that all models consider plenty of assumptions that in real life can not be neglected. Nevertheless, these assumptions facilitate the performance of these approximations. The advantage of numerical modelling is that, once the model is set up and established, a range of scenarios can be built and analyzed with relatively little effort. Nevertheless, numerical models should be viewed with caution because not understanding them becomes a 'black box' which may promote errors of judgment in their application. Hence, before choosing a model, its applicability to a specific problem must be questioned in depth.

The aim of this paper is to introduce "hydraulic modelling" to the infrastructure planner and to express the author's point of view on choosing the most appropriate model to facilitate the decision-making process depending on the problem's characteristics, on its complexity as well as on the hydrodynamic conditions that characterize the involved water resources.

2 Flow modelling

Nowadays; the scientists are able to analyze the natural phenomena thanks to the usage of models; namely physical or/and numerical. This section presents briefly the general description of both kinds of models as tools that are used by water specialists to analyze hydro-engineering problems, such as flood protection, irrigation, sediment transport or water quality. In order to make these descriptions clearer, two examples concerning flood risk are mentioned. The first example illustrates the usage of physical modelling (a sluice in the Odra river in Poland) in order to perform a flood risk assessment; and the second shows a flood forecasting system of a tropical river system in Mexico [2] built with 1-dimensional numerical modelling.

2.1 Physical modelling

Physical modelling allows the water specialists to visualize water dynamics in well-established scaled constructions at the laboratory. These models are a feasible and reliable choice to analyze the interaction between hydraulic structures (built or planned to be built) and the water bodies in case of normal and catastrophic scenarios, such as flood waves or dam failures.

Flood risk year by year threatens countries where intense rainfall (and not only) occurs in small periods of time and where human interference could play a positive role to mitigate the arising hazards. In the open-air hydraulic laboratory of the Wrocław University of Technology, some experimental works were carried out in order to test the functionality of the barrage and sluice “Bartoszowicki” for the regulation of the river Odra at the entrance of the city of Wrocław.

Fig. 1 Overview of the barrage and sluice “Bartoszowicki” in Wrocław (from google earth)

The figure 1 depicts an aerial view (taken from google earth) of those hydraulic structures. In case of flood wave events, the sluice is open in order to address most of the Odra’s river flow to the tributary Widawa (that works as a flood alleviation channel) in order to flood the non-urbanized areas that surround the northern part of Wrocław.

Fig. 2 View of the barrage from its downstream side at the entrance of the city

Fig. 3 Physical model of the barrage and sluice at the Wrocław University of Technology

A physical model was built at the laboratory to reproduce catastrophic scenarios and to check the reliability of these structures. The figure 2 depicts the view of the barrage from its downstream side and the figure 3 shows how the physical model looked like. The laboratorial works demonstrated that for small and medium flood wave events; the sluice should work properly. Probe of this fact is that in May 2010 (see fig. 4), these structures were used to alleviate the flooding problems of the city and the consequences were not chaotic. The water in the city centre was pretty close to the river banks, but fortunately, the river only overflew in one neighbourhood (Kozanów) without regretting tragic damages.

Fig. 4 Flood wave downstream the barrage “Bartoszowicki” near the city center (May 2010)

The experienced engineers are convinced that complex hydraulic problems cannot be solved analytically or by computer modelling and in some cases it is truth. Nevertheless, to carry out physical models adequately depends on the experience of the work team and the instrumentation of the laboratory. But, is it possible to build physical models of entire river basins to forecasts long-lasting flood waves? or to create an adequate physical model of the man-made world islands of Dubai? Or to analyze the changes in regional morphodynamics of the Persian Gulf because of these islands?

2.2 Numerical modelling

Numerical modelling is the process of approximating the solution of equations that describe physical processes using a step-wise approximation. In the early 1970's, the majority of the present numerical algorithms were invented. Nevertheless in those times, the computers were slow and not accessible to analyze hydro-engineering problems. Therefore, water projects had been analyzed mainly by physical modelling. This fact drastically changed because actually there are a large number of programs, which are capable to model hydrodynamics. These models are categorized according to their aim, number of dimensions or to the applied numerical methods. In this section, another example concerning flood risk is presented to describe how numerical modelling can be applied to real-world cases.

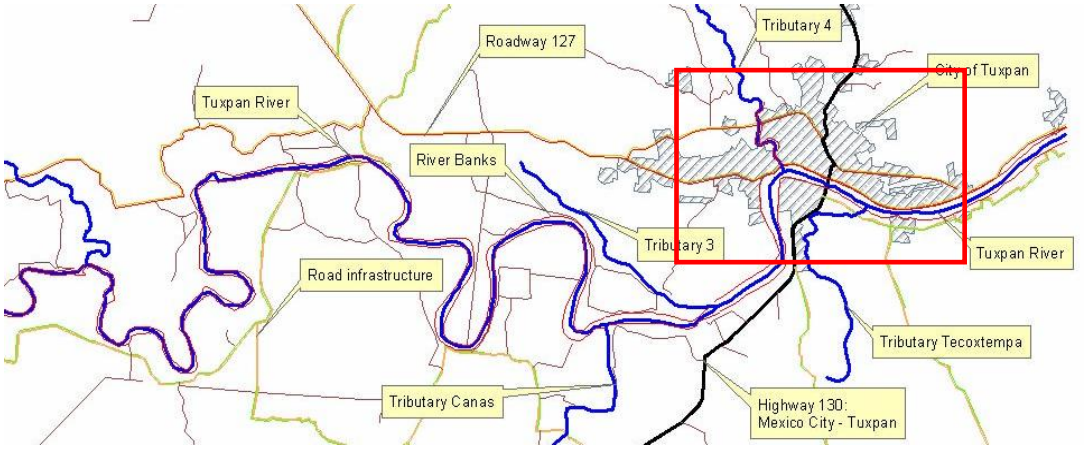

Fig. 5 Road infrastructure and tributaries in the nearby area of the city of Tuxpan

The Tuxpan River as one of the 17 main rivers that flow into the Gulf of Mexico within the Mexican territory. The population who lives in this basin had experienced many flood events along the history; the last two took place in October 1999 and seven years later in October 2006 affecting mainly the major cities located within this basin: The City of *Tuxpan* and *El Alamo*. A flood forecastng system were done in order to predict the flood extension for a probability of 2% (T=50 years). This forecasting system consist in two models: one hydrologycal [6] and one hydraulic [2]. The figure 5 depicts the GIS data base of the forecasting system close to the largest city within the basin (Tuxpan), the tributaries and the major road infrastructure.

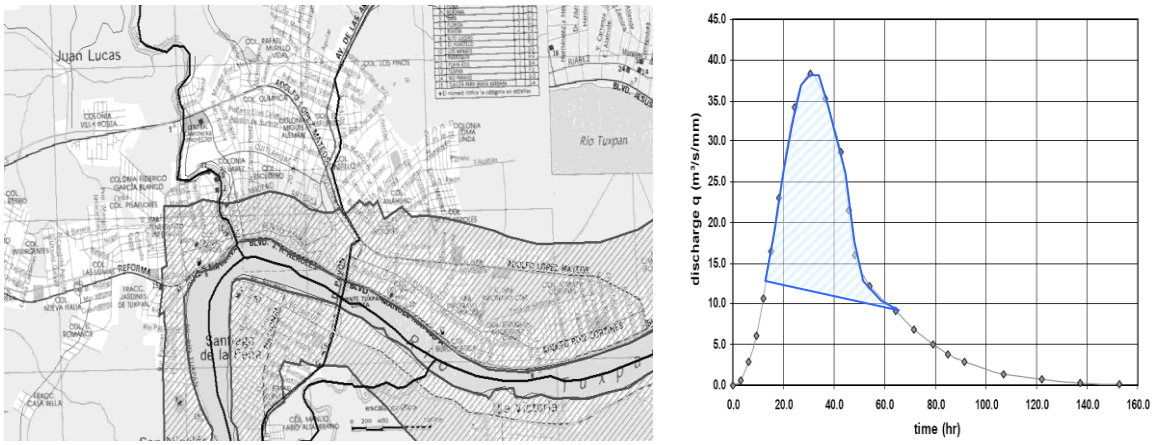

Fig. 6 Output of the forecasting system – inundation map and total flooding time

The figure 6 depicts the output of the forecasting system. On the left side, the map shows the forecasted flood extension in the city of Tuxpan. On the right side, the unitary hydrograph is depicted [6] that can be adapted depending in the rainfall intensity of the flood event. The dashed area of the hydrograph represents the total amount of water that should be retained in order to avoid flooding [2]. Once the hydro-engineer analyze the output of the model; special structures, such as polders or retention dams can be proposed to prevent or reduce flooding in the city.

The advantage of numerical modelling is that once the model is set up and the hydrodynamics conditions established, a wide range of scenarios can be investigated with relatively little effort; e.g. it is possible to construct flood extension maps for many flood waves with different probabilities of occurrence, to modify the hydrological conditions to test the functionality of the proposed retention areas or to perform sensitivity analyses to check the influence of land use of the watershed in the output of the model. The hydraulic module of flood forecasting system was built using a 1D model because its main objective was only to estimate the flood extension as well as the duration of the flood in the city. Nevertheless, there are cases where the applicability of 1D modelling is limited. The interaction between the water and the material from the bed or sea floor derives in sediment transport that causes many problems whose solutions are commonly non-sustainable. Regardless there are programs that use 1D modelling to treat sediment transport problems; the existence of secondary currents and non-coherent structures within the water flow can not be analyze with this kind of approaches. This is the case of structures such as groynes (see fig. 7) and breakwaters for river sediment management or to control the littoral drift of the shorelines. Hence, 2D or 3D modelling are more adequate techniques to analyze this kind of processes.

In the early 1980's, a new science was born: the Computational Fluid Dynamics (CFD). The purpose of CFD is to deal with the characteristics of the motion of fluids described by fundamental equations, with the usage of numerical algorithms, numerical methods and computers [3]. Nevertheless, in those times this new science was reserved only for high technology engineering areas such as aeronautics or astronautics. Nowadays, we can use some of these techniques to analyze complex flow problems. The figure 8 depicts the output of a CFD model that analyzes the influence of lateral groynes on the hydrodynamics of a small straight creek.

Fig. 7 Groynes close to the delta of the River Rhine in the Netherlands

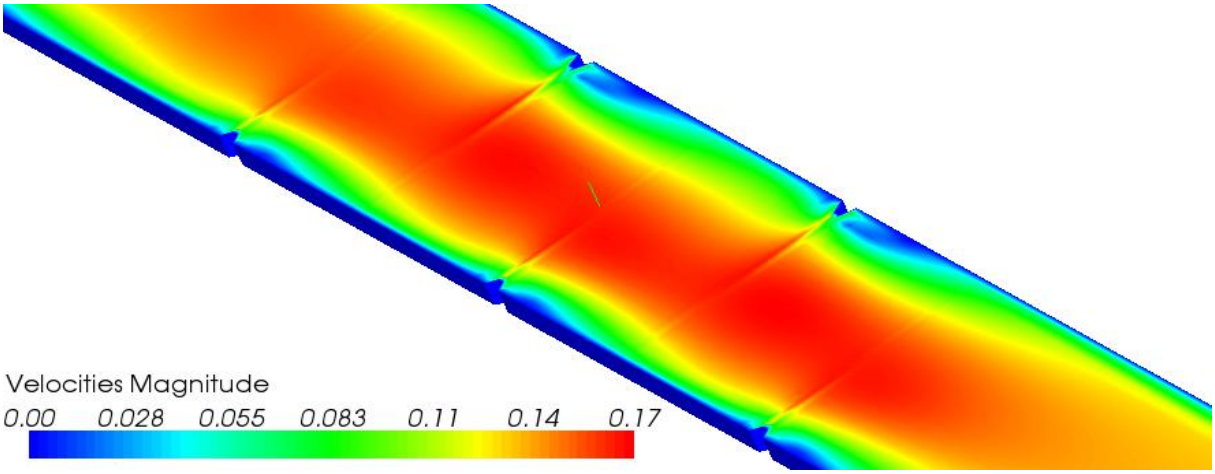

Fig. 8 Output of the CFD model – velocity field of a small straight creek with lateral groynes

Nevertheless, numerical models should be viewed with caution because not understanding them becomes a 'black box' which may promote errors of judgment in their usage. Additionally, the application of powerful models is subjected to the available computer facilities and to the model itself. For example, there are CFD programs that are not only expensive, but also required high-speed computers [5].

Physical modeling is directly visible and measurable quantitatively, but more expensive and time-consuming. Numerical modeling is less costly and requires less time to carry out. Hence, another alternative is hybrid modeling (use both numerical and physical models) as a help for the non-experienced teams to dominate the numerical techniques and to reduce the skepticism of the experienced water specialists who are still not convinced with the application of these new techniques [1].

3 Decision making for water resources management

It is a matter of fact that centuries ago the decision-making process was completely different than nowadays; in those times, the people involved in this process were not supported by the tools and knowledge that the actual engineers or urban planners have. Additionally, water is as well the reason of many disasters or ecological problems that are not related to any human influence, on the contrary, human interference could mitigate the hazards that water brings with (e.g. flood waves) to the population [3]. In today's society, environmental issues are an important concern in plan-

ning projects related to water resources; e.g. discharges of pollutants into rivers and lakes are not allowed, unless special permission is given by the appropriate authority.

3.1 Decision-making models and the Planning scale

New regulations and challenges for planning, construction and operation of hydraulic structures has increased demands for water usage. Therefore, appropriate decision-making processes and planning approaches are necessary to reach sustainable management for the water resources. In an appropriate decision-making process, there are key-points that conciliate the different interests of the people involved in this process; one of them is the interaction of specialists from different academic backgrounds in brainstorming exercises. Additionally and even though there are several decision-making models for water resources management; all of them should include public involvement as well as economic, social and environmental analysis.

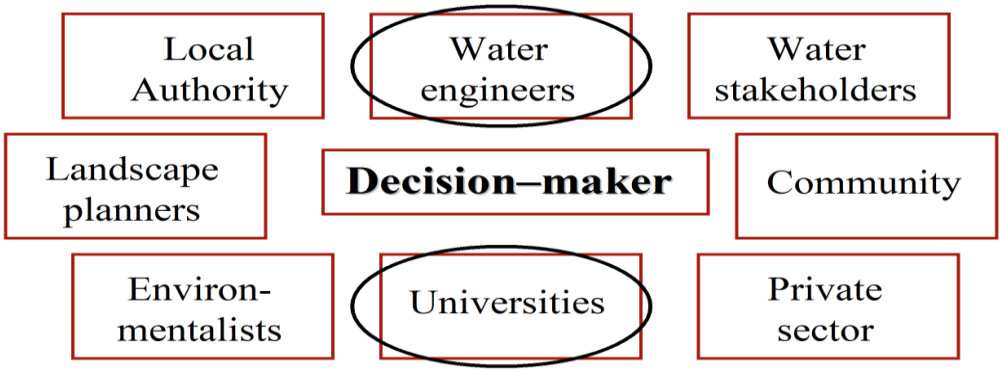

Fig. 9 Multi-disciplinary work in the decision-making process

The figure 9 depicts a simple scheme showing the people from different backgrounds and interests who participate in the decision-making process. In the same figure; water engineers and universities are emphasized because they are in charged of analyzing the plans, programs and alternatives from the technical point of view. They can use numerical modeling to fulfill this task. Looking at the traditional approach for planning and manage water resources in the US [8]; the decision-making has been relied on an iterative process which included the following steps:

1. Identifying problems and opportunities
2. Inventorying and forecasting conditions
3. Formulating alternative plans
4. Evaluating alternative plans
5. Comparing alternative plans
6. Selecting a plan

Numerical models represent a tool that can forecast conditions of the water resources and its interaction with the man-made infrastructure. It can help the water specialists not only to formulate plans and options, but also to evaluate and compare these different options (scenarios) to select the most convenient of them. Therefore, numerical models can be involved in five points of this traditional approach.

In planning, there are two important scales to be recognized: the *project* and the *global* scale. The *project scale* refers to a punctual problematic to be analyzed, e.g. planning the construction of a hydropower plant; while the global scale involves the whole river basin that will be altered by the construction of this punctual hydropower

plant. Hence, before choosing a model, the water specialist has to question in depth its applicability to a specific problem according to its planning scale.

At the project scale, physical models can be a good option for non-experienced CFD teams or to experienced water specialists who still don't trust the new computer technologies [5]. At the global scale, numerical models are a more suitable option to analyze water dynamics. Therefore, choosing the best *Computational Technique* is fundamental and depends on the characteristic of the flow and on the scale of the analyzed phenomenon. In one hand, it is extremely expensive to calculate flood extensions using CFD; therefore a convenient model could be 1D or 2D because the local turbulent structures are not of interest, just the flood duration and extension. On the other hand, analyzing the turbulent stresses in the bottom of a river downstream the mentioned hydropower plant can be done accurately only by using CFD.

3.2 Types of numerical models

Numerical models in hydro-engineering are categorized according to their aim, the number of dimensions to be resolved or to the applied numerical methods. The first programs that have been created were mainly 1D because the computational tools were still a constraint to develop more powerful approximations. Nevertheless, the actual water projects are more ambitious and more accurate models are required.

The Navier-Stokes set of equations or *NSE* (1) together with the continuity equation (2) describe the motion of incompressible fluids. These equations are the basis of all the hydrodynamic models. The NSE can be expressed as follows [3]:

$$\dot{u}_i + u_k u_{i,ki} = \upsilon u_{i,kk} - \frac{p_{,i}}{\rho} + g_i \tag{1}$$

$$u_{i,i} = 0 \tag{2}$$

where u is the velocity component in the i-direction, P is the pressure of the system; ρ is the density of the fluid in motion and υ is the fluid's kinematic viscosity. 1D and 2D models are simplifications of the NSE, while CFD techniques try to solve or approximate in different ways this set of equations. Due to the rapid development of the computer facilities over the past 20-30 years; CFD is becoming more popular among river engineers. Water specialists now are able to model in the computer complex phenomena that at the laboratory would be difficult to control with the scaled models.

A sub-classification of numerical models is according to the transition of the water flow. There are steady, unsteady or quasi-steady models. Steady models enormously facilitate the work of the water specialist; nevertheless the output of theses models losses accuracy. Unsteady models are very useful to analyze time-dependent phenomena, such as flood waves while quasi-steady models are useful to analyze complex phenomena that are time-dependent.

3.3 Choosing the most appropriate tool

This part of the paper presents some criteria on how the water specialist can choose the most appropriate numerical approach according to the characteristics of the phenomenon that has to be analyzed, the number of dimensions of the numerical model and the planning scale of the problem (global or project).

As mentioned in the previous sub-section, models can be classified according to the number of dimensions. In hydrodynamics, these dimensions are not related to the spatial geometry of the real world, but with the number of velocity components that are planned to be solved. 1D models are capable to estimate the water depth as well as the averaged velocity in one direction. These models are useful to analyze global scale problems, such as river flows through long reaches or long lasting flood waves.

3D numerical models (CFD) are powerful tools to investigate problems related to turbulent flows at the project scale; such as the flow through turbines or through hydropower houses; to analyze the functionality of hydraulic structures (spillway design) and to solve problems that involve complex physical phenomena such as sediment transport, hydraulic limnology, transport or dispersion of pollutants as well as coastal morphodynamics. It is necessary to point out that the *Reynolds number* is a parameter that allows us to choose the best CFD technique. It is necessary as well to highlight that there are 3D models that are still prohibitive for environmental and engineering purposes, such as *Direct Numerical Simulations* or DNS.

Model Type	***Governing Equations***	***Scale of the problems that can be analyzed***	***Available software (some examples)***
1-D	Bernoulli, 1D Saint Venant,	Global scale problems, such as river flow through a long quasi-straight reach; long lasting flood waves. Problems that involves kinematic waves and/or hydrologic routing.	HEC-RAS, HEC-2, FEQ, DAMBRK, DWOPER, FLDWAV, MIKE 11, SOBEK, SMS.
2-D	2D Saint-venant, Laplace equation together with the Darcy's Law.	Global scale problems of groundwater flow. Global scale problems of river flow through medium reaches with complex geometries. Watershed management and coastal morphodynamics.	FESWMS, RMA-2 RMA-4, RMA-6 RIVER2D, SMS MIKE 21, SOBEK MIKE FLOOD, SMS.
3-D	RANS, Vorticity and Helmholtz Equations, Navier-Stokes Equation, Laplace equation.	Project scale problems with not complicated geometries (water flow through turbines and hydropower houses). Problems that involves complex physical phenomena such as sediment transport, hydraulic limnology, water quality and transport of pollutants. Groundwater flow and coastal morphodynamics.	CH3D-SED, FLUENT STAR-CD, FLOW3D CFX, TELEMAC, PHOENICS, OPEN-FOAM, DELFT3D.

Table 1 Type of models according to their number of dimensions

2D models are probably a convenient option for specialists who work independently from universities or high education institutions. Global scale problems of groundwater flow; global scale problems of river flow through medium reaches with complex geometries are examples of phenomena that can be analyzed by 2D modelling with reliable outputs. Some project scale problems as well can be analyzed; nevertheless a CFD model is more recommendable.

The table 1 summarizes the previously mentioned criteria. This table depicts as well the governing equations according to the model type and some examples of the available software that can be used by the water-specialists.

4 Conclusions

In the decision-making process of projects, plans and programs that involve water resources; the role of the water specialist is fundamental in helping to choose most adequate decision. Therefore, models are useful tools that allow the water specialist to better analyze a wider range of scenarios of the water dynamics. Nowadays and thanks to the rapid evolution of the computer facilities, numerical models are becoming an efficient solution to forecast the hazards provoked by water motion, to study hydrodynamics and to predict the interaction between the water bodies and the man-made structures, which 30 years ago were only analyzed by physical modelling at the laboratory. Nevertheless, only few of the actual numerical models can be used for engineering or environmental purposes due to the scale of the hydro-engineering projects and due to the extreme computational costs of several of these techniques.

The usage of numerical models should be as well supervised by water specialists. It is a matter of fact that not experienced engineers easily apply computers to solve hydro-engineering problems with minimum knowledge of the theory [7]. An inexperienced user may produce convincing and impressive figures, but the accuracy of the result may still not be good enough to have a value in practical engineering if the calculation was not correctly carried out. Hybrid modelling can be a good option to convince the experienced engineers to use the new techniques and to help the young water specialists to enhance their knowledge about water dynamics thanks to the interaction with their experience colleagues [1].

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Private Sector Participation in Urban Water Supply in Developing Countries: The Ghana Experience

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Abstract: Inefficiency in urban water provision is quite widespread in the developing world. In Ghana, due to high level of losses and poor management of the water distribution system only about 25% of the urban population receive continues water supply. According to the multi-donor Africa MDG assessment (2008), access to an improved water sources in the country is only 56%. With the objective of injecting some efficiency into its water supply delivery system, Ghana in 2006 began a privatisation process under a 5-year management contract with two foreign water supply operators. The contract required the operator to, among other service standards; reduce non-revenue water (NRW) by at least 5% annually. NRW stood at 53% at the commencement of the contract. The operator will receive compensation for meeting these standards otherwise he pays a penalty to the Grantor. This paper discusses the contract so far in the mist of public oppositions, the absence of a clear legal and regulatory framework, and tariffs well below cost recovery levels. The paper concludes that whiles PSP can bring some efficiency gains in service delivery; accurate baseline information and clearly defined responsibilities for operator and grantor are necessary requirements for the success of any urban water supply management contract.

1 Introduction

Water is a basic necessity for human survival. It is a very critical element as far our goal to reduce poverty and improving on living standards are concern. Access to adequate safe water directly linked to all of the eight (8) Millennium Development Goals (MDGs). As a result of economic growth and stable political climate, Ghana is currently under-going rapid urbanization and industrialisation. It is estimated that nearly 44% of Ghanaians now live in urban areas, and almost half of urban residents live in the country's largest cities – Accra and Kumasi. Migration from rural areas to towns and cities is driving urban growth. With current growth rate, the urban population is projected to reach 14 million by 2015, at which point half of Ghana's population will be living in towns and cities.

The rate of urbanization outstrips current levels of urban water supply. The Ghana Water Company Limited (and its operator, AVRL) currently operates 82 urban systems with an average daily output of 572,012 m3/day as against a daily demand of 1,049,306 m3/day. Due to high level of losses and poor management of the water distribution system only about 25% of the urban population receive continues water supply. Water is rationed to many consumers with only a few customers able to get 24-hour supply. In the peri-urban areas and the densely populated poor urban areas customers receive supplies once a week or none at all. Among the urban poor, water can be a critical resource in short supply. Census (2000) found that only four out of

ten respondents (41.4%) living in urban areas had piped water in their homes and a similar number (42.6%) purchased water from a public tap or neighbour's residence. According to the multi-donor Africa MDG assessment (2008), access to an improved water sources in the country is only 56%. This is not too different from what was observed a year earlier by (Nyarko, Odai and Fosuhene, 2007) that access to urban water supply is 60% of the urban population. The Ghana Living Standards Survey, Round 4 (GLSS4) reported that approximately forty percent (40%) of urban families were relying on neighbours and vendors for their water. With rapid expansion of new housing developments, often ahead of utility services, more and more urban residents will depend on vendors and tanker services, at costs far in excess of utility rates. Additionally, the urban centres are the focus of Ghana's industrial and commercial activities many of which rely on adequate and reliable water supplies for efficient production (National Water Policy, 2007).

2 Non-revenue Water

Ghana has vast raw water resources which could sufficiently meet both domestic and industry needs of all Ghanaians. The main consumptive uses of water in Ghana are water supply, irrigation and livestock watering. On the basis of surface water resources alone, the consumptive water demand for 2020 has been projected to be 5 billion m3, which is equivalent to only some 12% of the total surface water resources. Notwithstanding the availability of water to meet water supply, there are deficits in coverage (National Water Policy, 2007). The deficits come from two main sources. First is the lack of financial resources to treat and distribute adequate water for all uses. The second reason is that much of the portable water produced and supplied either ends up as "Non-revenue water" or simply water which cannot be accounted for.

The International Water Association (IWA) has defined NRW in terms of a water balance: "NRW is the total of unbilled authorised consumption and apparent and physical losses against the total system input. The system input is measured by the outgoing flow in cubic metres of water treatment plants and boreholes. The billed authorised consumption is estimated based on the volume delivered to the customer. The total NRW in 2006 (prior to private sector participation) was 53%, of which 71% is on account of the Accra Tema Metropolitan Area (ATMA). Again, 25% of NRW came from physical losses alone. Nearly 20% of pipe connections were done illegally. Another challenge which the water sector faced was the low labour productivity of the Ghana Water Company Limited (GWCL). In 2006, labour productivity was 60 employees per 1000 connections compared to 4 employees per 1000 connections for more efficiently managed systems.

Another major challenge was the low tariffs which consumers paid for water. Tariff levels were not enough to recovery the life-cycle cost of water supply. Between 1990 and 1997 water tariff level was US$ 0.10 -0.15 per m3. This was increased to US$ 0.50 per m3 in 2004. In 2006, prior to private sector participation in the urban water sector, tariff was adjusted to US$ 0.55 per m3. This figure was still lower than the US$ 0.70 per m3 which was estimated to be the cost recovery tariff then.

In 2007, Ghana was identified as one of the countries which is off-track in meeting MDG target on access to portable water (see figure 1 below).

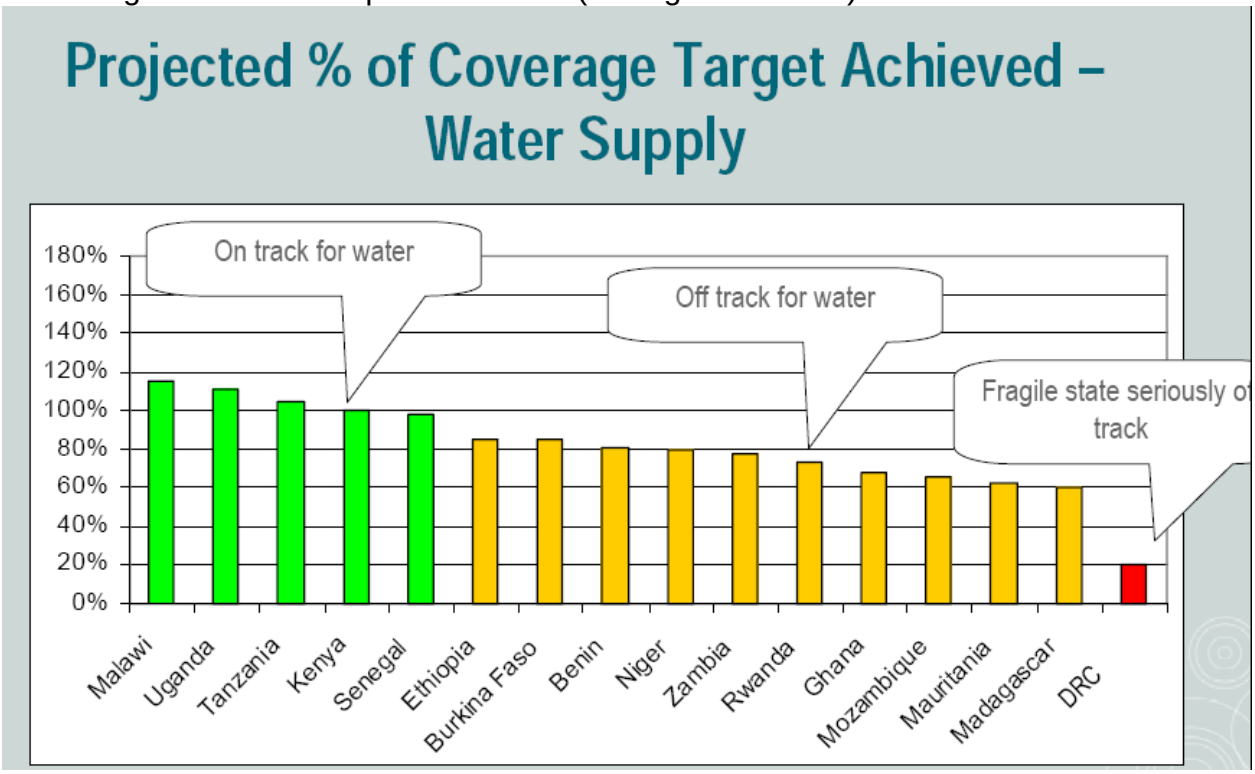

Figure 1: Water supply coverage by selected African countries

Source: Presentation at the World Water Week in Stockholm, 2007

The sector had suffered from severe lack of investments and maintenance of the existing infrastructure. As at 2006, about 96% of all water supply related investment had been funded by development partners. The figure below makes a comparison of the water sector preparedness among selected African country.

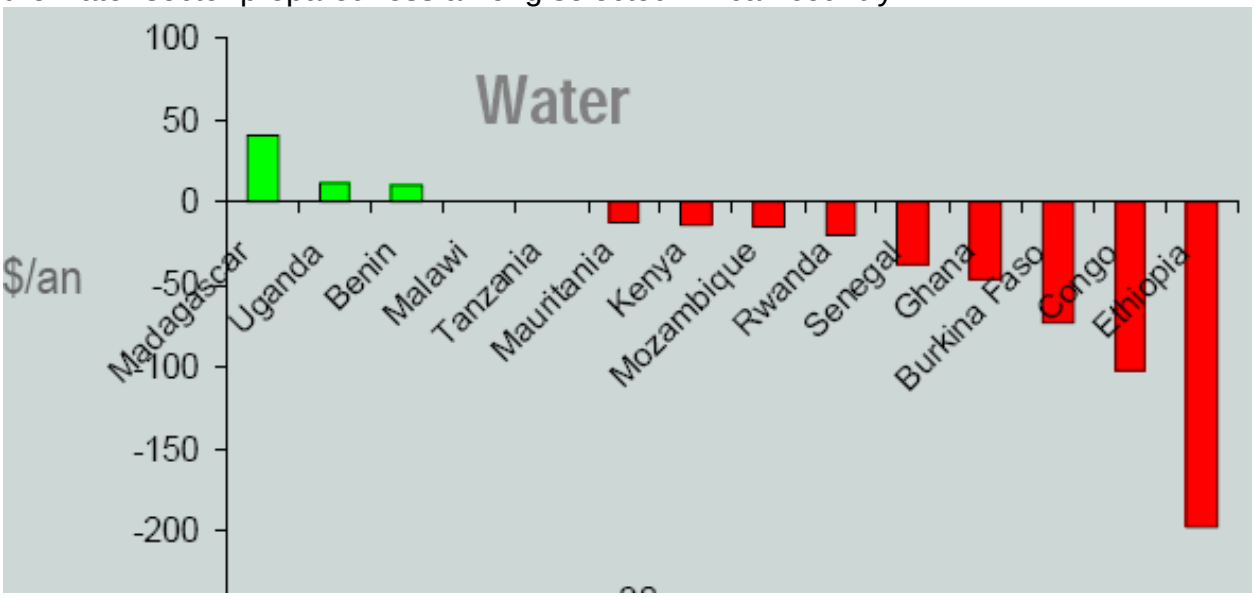

Figure 2: Annual investment in the water sector

Source: Presentation at the World Water Week in Stockholm, 2007

The above figure simply says that, in the case of Ghana, there is an annual backlog of about US$50 million investment which is not carried out. As with most infrastructure investments, when maintenance activities are not carried out when they are due, it costs much more to maintain in the future.

3 Establishment of Water Sector Restructuring Secretariat

The unsustainable situation of water supply in the country led Government to undertake a restructuring of the water sector. In 2004, with funds from World Bank, a Water Sector Restructuring Secretariat (WSRS) was established. Its objective was to design interventions which will increase urban water availability, extend distribution networks especially to low income consumers, and to assist the sector in establishing a sustainable financial basis. It also includes support to the introduction of PSP into management and operation of the systems under either a lease or a management contract (GLOWA-ZEP, n.d).

In response to poor service quality and low efficiency of the existing urban water utility Ghana Water Company Limited (GWCL), the WSRS examined various options of involving private sector in the urban water sector (see figure 3). The merits and demerits of each option were considered in the light of Ghana's economic and political situations.

Table 1: The Range of Options for PSP in Urban Water Supply

	Service contract	Management contract	Lease / affermage	Concession	BOT-type	Divestiture
Asset ownership	Public	Public	Public	Public	Private / public	Private
Capital investment	Public	Public	Public	Private	Private	Private
Commercial risk	Public	Public	Shared	Private	Private	Private
Operations/ maintenance	Private / public	Private	Private	Private	Private	Private
Contract duration	1–2 years	3–5 years	8–15 years	25–30 years	20–30 years	Indefinite

Source: ADB PPP Handbook, 2008

Originally a 10-year lease contract was envisaged. In 2000, a lease contract between GWCL and the US Company Azurix failed due to accusations of corruption and public opposition which led to the formation of the Coalition against Water Privatization.

4 Management Contract

In 2004, management contract option was chosen under a new scheme named Urban Water Project. The World Bank's Board approved a credit of US$103 million for the Urban Water Project, which was later turned into a grant. The Nordic Development Fund contributes another US$5 million, while the Government of Ghana

provides the remaining US$12 million of the US$120 million project.

Management contracts are most likely to be useful where the main objective is to rapidly enhance a water company's technical capacity and its efficiency in performing specific tasks, or to prepare for greater private involvement. Ghana, in 2006, began a privatisation process under a management contract with two foreign water supply operators –namely, Aqua Vitens Rand Limited (a South African-Dutch Consortium). AVRL will support GWCL under a five-year management contract to improve its performance and rehabilitate and extend the existing urban water infrastructure. The operator receives a base fixed fee for it services plus a compensation for achieving specified service standards in the contract. If the specified service standards are not met, operator received penalty deduction to the base fee.

The Project's two principal development objectives are to (World Bank, 2005):

(i) significantly increase access to the piped water system in Ghana's urban centers, with an emphasis on improving access, affordability and service reliability to the urban poor; and
(ii) Restoring long term financial stability, viability and sustainability of the Ghana Water Company Limited (GWCL).

Other specific objectives included the following:

- Extending reliable water supply especially to low-income areas
- Making potable water affordable for low-income consumers
- Increasing cost recovery
- Ensuring investments based on low-cost and concession financing
- Supporting further involvement of the private sector
- Reducing non-revenue water
- Increasing water treatment

Again, AVRL is responsible for the management of commercial services, such as:

- Commercial and administrative processes relating to meter reading, billing and collection.
- Applications for new connections, new subscriptions, customer files, customer disconnections and regularisation of illegal connections.

Under the terms of the management contract AVRL has access to funds for a training programme ($ 1.5 million) and a Repair, Replacement and Rehabilitation Fund ($ 5 million). The operator is expected to propose capital investments to GWCL each year.

The contract required the operator to achieve the following service standards (see table 2). The technical auditor to the contract monitors the activities of the operator and recommends appropriate compensations or penalties.

Table 2: Management contract service standards

Service Standard	Aspect to Monitor
1. Raw Water Quality	▪ Source of raw water ▪ Development of additional raw water sources
2. Treated Water Quality and Pressure	▪ Water quality, pressure levels and flow rates at headworks and distribution system meet defined standards
3. Reduction in Non-Revenue Water	▪ Plan for systematic reduction of non-revenue water in service areas by 5% annually ▪ Calculation of non-revenue water ▪ Reduction of leakages and illegal connection
4. Treatment Plant Operations	▪ Status of metering (specification and location) ▪ Average daily production ▪ Investment requirement to increase water production ▪ Adherence to PURC Regulatory Social Policy on low income customers ▪ Presence of snag items
5. Customer Response Plan	▪ Response to customer inquiry ▪ Average customer response time ▪ Plan to reduce average customer response time
6.Customer Accounts Receivable	▪ Non-public sector accounts receivables ▪ Non-public sector sales

5 Lessons

The management contract is currently in the final year of implementation with many of the targets yet to be achieved. Experience with the management contract in Ghana suggests that conferring higher degrees of management responsibility to an operator could bring about improvements.

Comparing Ghana's management contract experiences with other developing countries elicits some lessons to be learnt. A good management contract should exhibit the following characteristics:

1. Well defined roles of the Grantor and the Operator (parties of the contract);
2. Clear allocation of risks between the Grantor and the Operator;
3. Clearly defined baseline: in the case of Ghana, it appears baselines were not sufficiently established before the commencement of the contract. It was therefore difficult to measure achievement of certain service standards.
4. Achievable performance targets: without accurate baseline information realistic performance target cannot be set, and finally there is need for
5. Clear linkage between incentive fees and performance of the operator.

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Influence of Environmental Degradation on Future Water Supply Cost

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Abstract: Previous studies indicate that environmental conditions affect water supply cost. It was predicted that environmental degradation that occurred recently would increase water supply cost. The increase in the water supply cost is a challenge in the provision of water infrastructure. This challenge requires intervention and to undertake interventions, it is necessary to know the factors that influence water supply cost.

The goal of this study was prediction and intervention of future water supply cost related to environmental conditions, whereas the objectives are 1) environmental variables affecting water supply cost, 2) model of environmental condition and water supply cost. Relationship structure and intensity between water-supply-environment variables and water supply cost is observed by developing regression equations connecting water supply cost as dependent variable and quantity as well as water-supply- environment variables as independent variables. Influence of environmental degradation on water supply cost is analyzed by developing several scenarios of environmental changes, namely land conversion, population growth, and customer density. The results also show that in general the future water supply cost will increase.Based on the scenario of environmental changes, a number of recommendations are proposed to anticipate the increasing future water supply cost.

Keywords: Environmental, Water Supply Cost

1 Background

Previous studies (e.g. Husain, 1975; Clark, et.al., 1981; Meckler, 1983; Montgomery, 1985; Kawamura, 1991; Price, 1991) indicated that water supply cost is affected by a number of environmental variables, such as water quantity, water quality, topography, and customer density. This suggests that the decline in environmental conditions that occur at this time and likely will continue to decline in the future, will increase water supply cost.

Increased costs of water supply in the future due to changes in environmental conditions need to be known in order to provide strategic steps to intervene the cost, particularly related to environmental conditions. This intervention will certainly vary from one place to other places, because the cost study is casuistic. Therefore an empirical study is needed for a particular location. In Indonesia context, this kind of study is still very limited.The goal of this research was prediction and intervention of future water supply cost related to environmental conditions, whereas the objectives are 1) environmental variables affecting water supply cost, 2) model of environmental condition and water supply cost.

2 Research Method

Theoretically, water quantity, water quality, topography, and customer density was stated as variables affecting water supply cost. However, in practice a study have to be done to determine what variables from the variables mentioned above, which really affects water supply cost.Environmental variables affecting water supply cost in this study was identified by developing regression equations connecting water supply cost as dependent variable and water-supply-environment variables as independent variables. Cost in this study consisted of production and distribution cost. Water-supply-environment variables consist of water quantity, water quality, topography, and customer density. Quantity was measured as production and distribution volume per year (m^3/year). Water quality was measured as type of water source; spring, groundwater, and surface water. Water quality variable was stated as dummy variable groundwater and surface water. Topography was measured as type of distribution system. This variable was expressed as dummy variables pumping system. Customer density was measured as amount of customer/network length (HC/m). Production and distribution cost function can be stated as equation (1) and (2):

$$B_{pro(v)} = f(K_{pro(v),} \text{ SD, AP, Pom}) \quad (1)$$

$$B_{dis(v)} = f(K_{dis(v),} \text{ pdt, Pom}) \quad (2)$$

Where $B_{pro(v)}$ is production cost (Rp/year), $K_{pro(v)}$ is production volume (m^3/year), AP is surface water, SD is Deep Well, Pom is pumping system, $B_{dis(v)}$ is distribution cost (Rp/year), $K_{dis(v)}$ is production volume (m^3/year), pdt is customer density (SL/m).

Data for regression analysis was developed from 120 production systems and 53 distribution systems of PDAM in Kabupaten Bekasi, Kabupaten Subang, Kabupaten Cianjur, Kota Bandung, Kabupaten Bandung, Kabupaten Kuningan, and Kabupaten

Ciamis. Descriptive statistics of input data for production and distribution system is showed in Table 1 and 2.

Table 1: Descriptive Statistics of Production System

Variable	Minimum	Maximum	Average	Deviation Standard
$K_{pro(v)}$ (m^3/yr)	3,239	1.1E+07	863,042.3	1,529,040.79
AP	0	1		
SD	0	1		
Pom	0	1		
B_{pro} (Rp/yr)	5.0E+07	2.6E+09	2.9E+08	377,391,128.6

Table 2: Descriptive Statistics of Distribution System

Variable	Minimum	Maximum	Average	Deviation Standard
$K_{dis(v)}$ (l/sec)	26,946.77	1,727,849.57	432,012.70	373,864.98
Pdt (customer/m)	0.0034	0.098	0.0428	0.02289
Pom	0	1		
B_{dis} (Rp/yr)	130,000,000	2,800,000,000	480,000,000	438,832,352

Environmental variables that have been identified in the previous step, basically influenced by conditions of wider environment. Intervention towards water supply cost was done through intervention of this wider environmental condition. After environmental variables that affect water supply cost and their relationship with wider environmental conditions can be identified, system dynamic modeling was undertaken to determine the effect of environmental condition to water supply cost. This modeling used Banjaran in Kabupaten Bandung, Indonesia as case study.

3 Findings

Relationship between water supply cost and water supply environment variables are shown by equation (3) and (4). Equation (3) is for production system and equation (4) is for distribution system. Relationship structure between water-supply-environment variable based on equation 1 are best explained by linear regression form (R^2=0.95). The relationship structure is expressed by equation (3).

$$B_{pro(v)} = -2.0 \times 10^7 + 219.4\ K_{pro(v)} + 4.1 \times 10^7\ SD + 1.6 \times 10^8\ Pom \quad (3)$$

Equation (3) states that quantity, water quality and topography influence production cost positively.

Relationship structure between water-supply-environment variables and distribution cost based on equation (2) are best explained by log linear regression form (R^2=0.97). The relationship structure is:

$$\ln B_{dis(v)} = 8.02 + 0.78 \ln K_{dis(v)} - 0.55 \ln pdt + 0.21\ Pom \quad (4)$$

Equation (4) states that quantity and topography influence distribution cost positively, whereas customer density influences cost negatively.

This study showed that water quantity, customer density, topography, and water quality influence water supply cost. The results of this study corresponded with that stated in the theory. The quantity of raw water, raw water quality, and customer density are environmental conditions that are artificial, while topography is natural. Artificial variables are influenced by environmental condition. As an example, raw water quality is affected by land use, quantity of production is influenced by population growth, and customer density is affected by the occurrence of urban sprawl. Furthermore, the influence of the dynamics of environmental condition (population growth, land conversion, and urban sprawl) towards water supply cost was analyzed using system dynamic modeling. The relationship between environmental conditions, environmental variables, and water supply cost are shown in Figure 1.

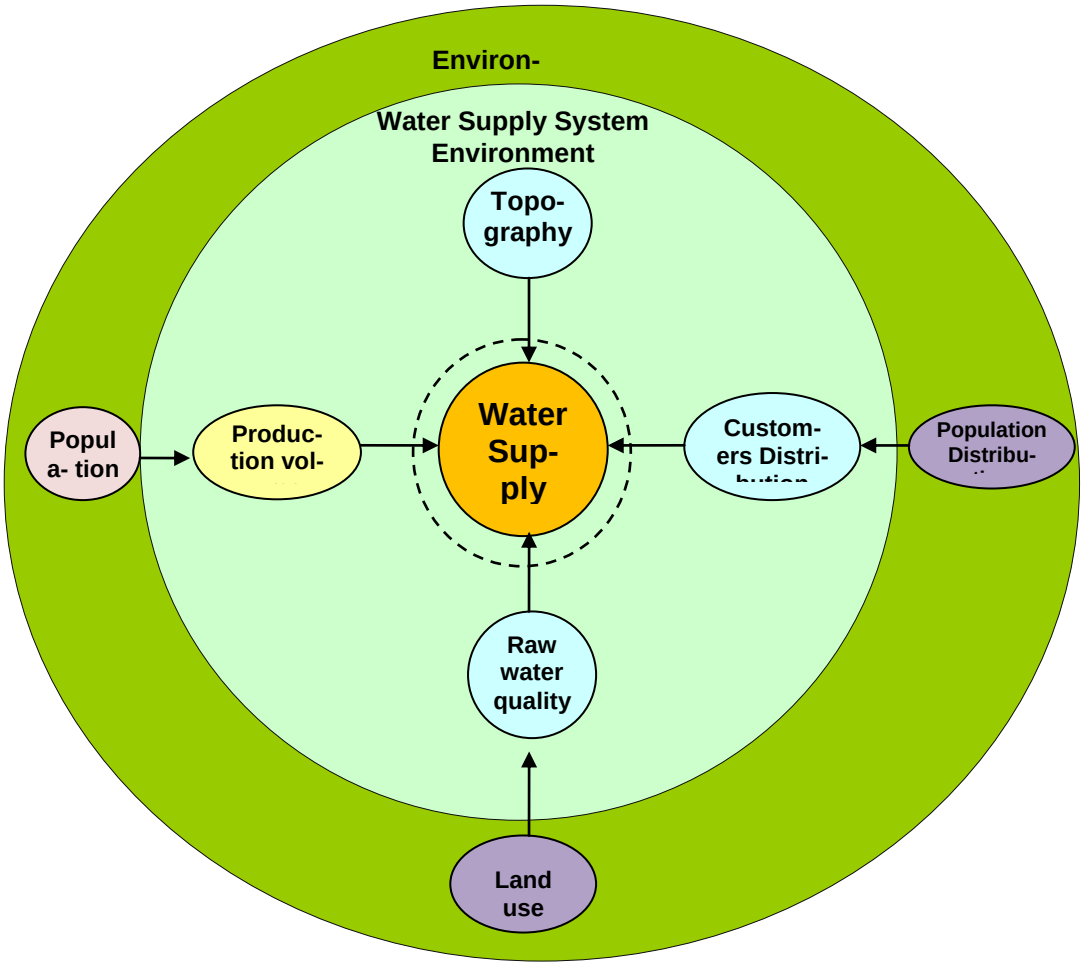


Figure 1: Relationship between Water Supply System, Environmental Variables, and Environment

Global model of influence of environmental condition on water supply cost was developed by tracing the relationship between events (evidence) in determining the cost and their relationship with environmental aspects. The global model is shown in Figure 2.

Increasing number of population generates new customers. The customers require a new network and additional production capacity. New network and additional production capacity could increase the cost of the production system, namely raw water retribution, employee costs, chemical costs, electricity costs, land rent, maintenance, and depreciation, and costs in the distribution system consisting of employee costs, electricity costs, land rent, maintenance, and depreciation.

Changes in land use can alter water quality. In this study water quality parameters observed only water turbidity. Water turbidity was used to represent water quality since in general the largest use of chemicals is to eliminate turbidity. Increased water turbidity can increase the cost of chemicals.

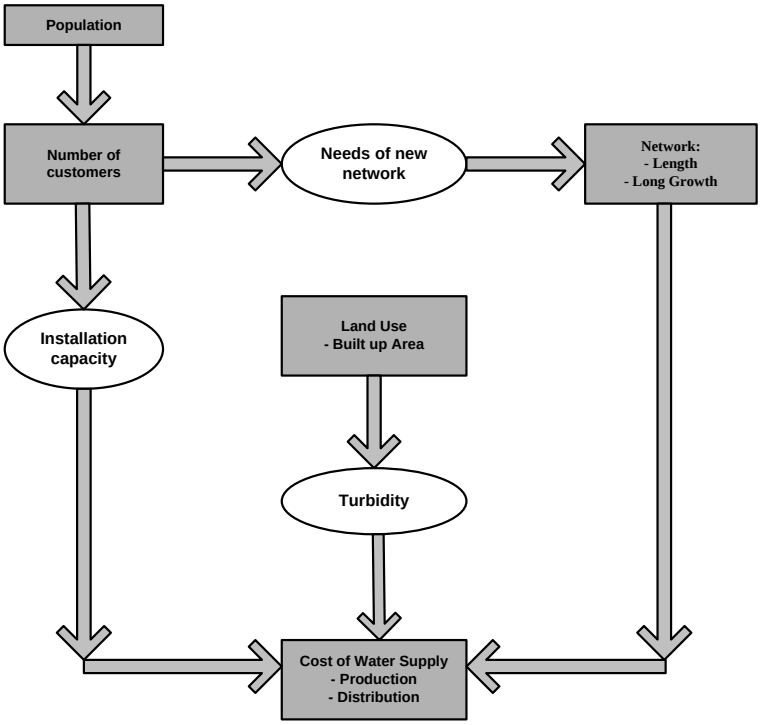


Figure 2: Global Model of Environmental Condition and Water Supply Cost

In this study five sub-models were developed, namely population, customer, network, land use, and cost model. The explanations of each model are as follows.

Population Sub-Model

In population sub-model, the number of population was only influenced by population growth rate.The number of population was determined by population growth that forms a positive causal loop, where a specific population growth rates can increase the population, and increasing population can increase the population growth rate.

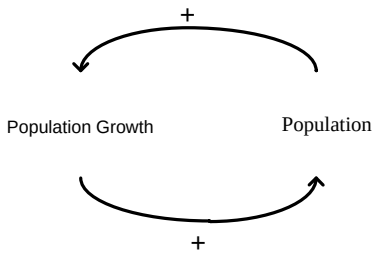


Figure 3: Causal Loop of Population Model

Customer Sub-Model

In customer sub-model, the number of customers was determined by population growth rate and only limited by the availability of water resources capacity. Factors that influence willingness to be a customer, such as service quality and condition of currently owned water sources were not considered in this model.

In this sub-model, addition of new customers increased the number of customers, and increasing the number of customers can reduce the capacity of water resources that can be utilized (available capacity). The reduced capacity of water resources will limit the number of new customers.

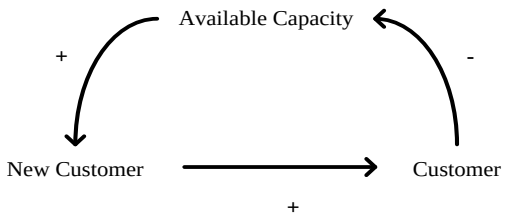


Figure 4: Causal Loop of Customer Sub-Model

Network Sub-Model

In network sub-model, the availability of network was determined by addition new network and deteriorated network. In fact, addition of new networks is not solely determined by the existence of new customers. Policy to expand the service is usually the driving factor of the new network investment. Conversely, the existence of new customers does not necessarily require the addition of new network.

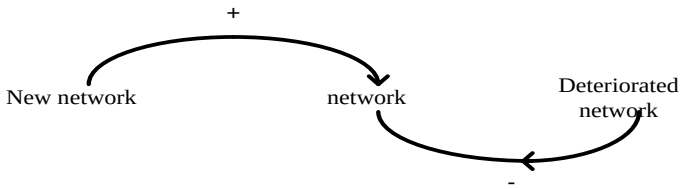


Figure 5: Causal Loop of Network Sub-Model

Land-Use Sub-Model

In the land use sub-model, the model structure was based on the factors of land conversion rate that was triggered by population growth. Conversion of land into built up area was assumed only come from the forest. Total land use other than built up area and forest was assumed to be fixed.

In this sub-model there were two main variables, namely built up area and forest. If the area of forest and built up area were assumed to be fixed (no conversion from other land use), increase in built up area would reduce the forest area, and vice versa.

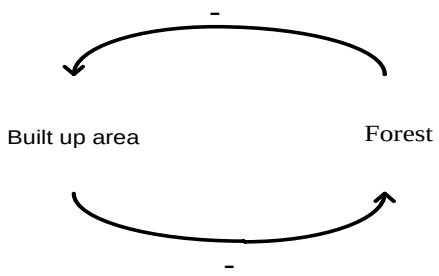


Figure 6: *Causal Loop* of Land Use Sub-Model

Cost Sub-Model

Production costs consists of raw water retribution, employee costs, chemical costs, electricity costs, land rent, maintenance, and depreciation, while distribution costs consists of employee costs, electricity costs, land rent, maintenance, and depreciation.

Cost sub-model can be divided into two parts, namely production costs and distribution costs. Increased number of customers demanding increased production volume, and with the increased volume of production, the number of customers that can be served increases. Increased production volumes require increased design capacity, and with the increased capacity of design, production volume can be increased. Increased production volume will increase the cost of the production, namely raw water retribution, employee costs, chemical costs, electricity costs, land rent, maintenance, and depreciation costs. Changes in land use can alter the conditions of water turbidity. Increased water turbidity can increase the cost of chemicals.

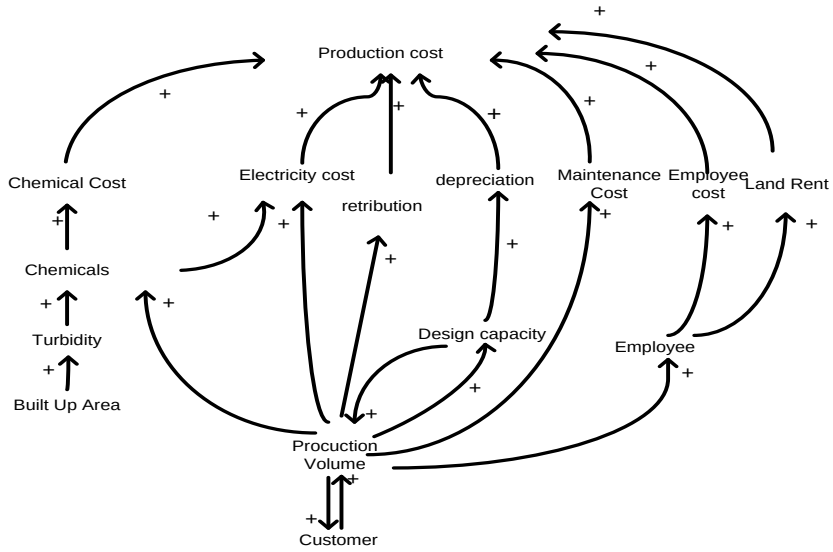


Figure 7: Causal Loop of Production Cost

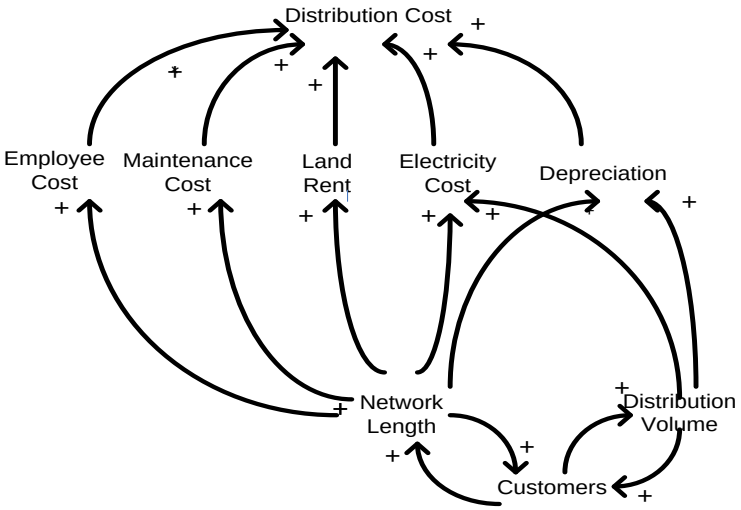


Figure 8: Causal Loop of Distribution Cost

In the model of distribution costs, the increasing number of customers, required increased production volume and the length of network, and with increasing production volume and the length of the network, the number of customers that can be served increases. The increased length of the network affects the cost of employee, maintenance, and land rent, while increasing network length and volume of production affect electricity costs and depreciation.

Causal loop explained above was subsequently changed into model diagram and relations between elements in the model expressed in terms of mathematical equations.Test of model behavior committed against the number of population, the number of customers, network length, and built up area within a period of time that has historical data. In the model developed, year 2000 was used as the initial time. Data from 2001 to 2005 was used as tested data. The test results are shown in Table 3.

Table 3: Statistical Test for Certain Model Parameter

Variable	MAPE[1] (%)	MSE[2] (units[2])
Population	1,6	8.633.835
Customer	2,1	2.251,14
Network Length	3,7	9.639.437
Built Up Area	1,5	241.653

Note: 1) mean absolute percentage error, 2) mean squared error

The effect of environmental dynamics on the water supply cost was observed through various scenarios. Basic scenario was scenario that reflects the conditions that occur at this time. At present, the rate of land conversion from forest to built up area was amounted to 20% per year, the population growth rate is 4% per year, and customer density is 0.078 HC/m. Scenarios 1-3 reflect changes in the basic scenario:

- **Scenario 1: Land Conversion**

  Scenario 1 represented a change in land conversion rate of 20% per year to 30% per year, while other conditions remain constant. Scenario 1 was called land conversion scenario. As known, the bigger the built up area, the higher the turbidity level of water, and the more chemicals were needed.

- **Scenario 2: Population Growth**

  Scenario 2 represented a change in the population growth rate of 4% per year to 5% per year, while other conditions remain constant. Scenario 2 was called population growth scenario. This scenario affected the growth of customers to be served (assuming the scope of services was constant).

- **Scenario 3: Urban Sprawl**

  Scenario 3 represented a change in customer density of 0.078 HC/m to 0.05 HC/m, while the other conditions fixed. Scenario 3 was called urban sprawl scenario. The phenomenon of urban sprawl is a phenomenon that occurs in Bandung Metropolitan Area where Banjaran is located. This phenomenon is demonstrated by the low population density. With the assumption that the distribution of customers following the spread of population, urban sprawl scenario could affect the need for the network.

4 Discussion

In term of production costs per unit, Scenario 2, namely population growth provide the lowest effect on water supply cost. Nevertheless this does not mean that controlling the population growth rate should not be done. In the case of production costs per unit, lower costs can not be interpreted as a result of increasing population growth rate, but as a result of increasing the growth rate of customer. Basic scenario, scenario 1, and scenario 3 give the same effect.

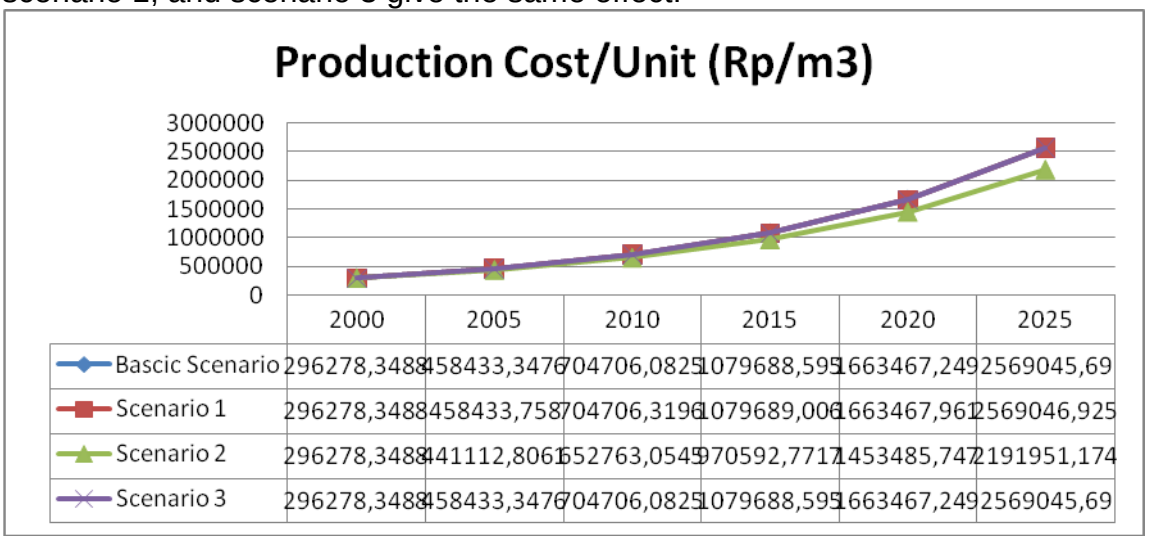
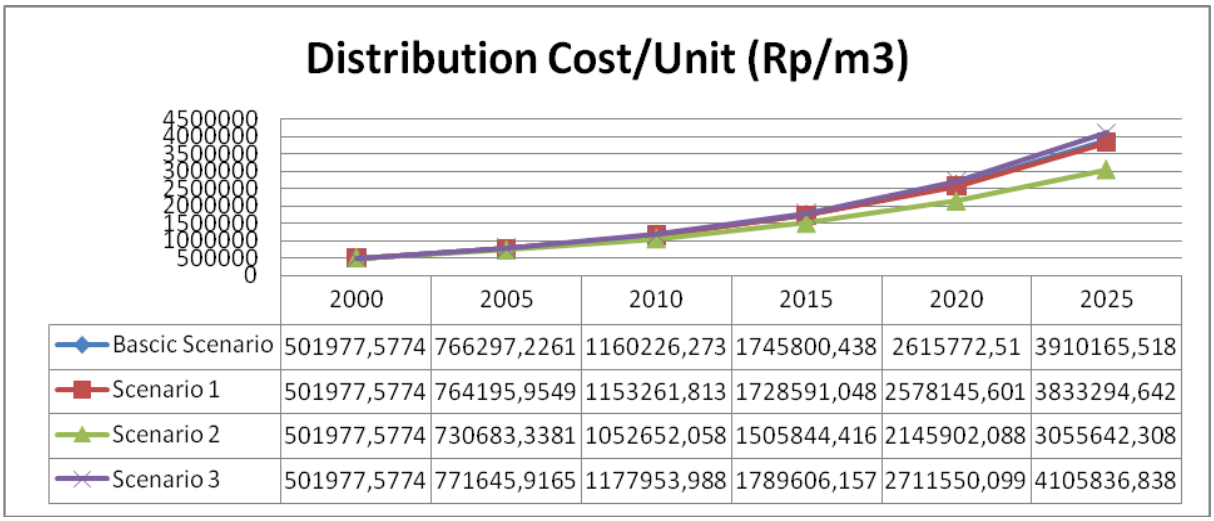


Figure 9: Production Cost/Unit

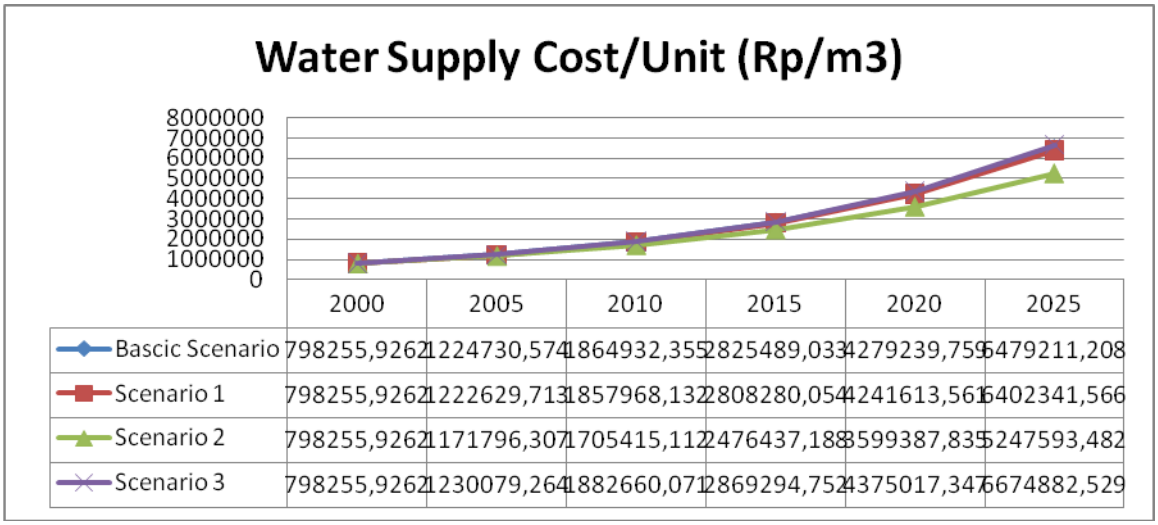
The same as production cost per unit, scenario 2 also provides the lowest effect on distribution costs per unit. The addition of the number of customer is expected to reduce distribution costs per unit.



	2000	2005	2010	2015	2020	2025
Bascic Scenario	501977,5774	766297,2261	1160226,273	1745800,438	2615772,51	3910165,518
Scenario 1	501977,5774	764195,9549	1153261,813	1728591,048	2578145,601	3833294,642
Scenario 2	501977,5774	730683,3381	1052652,058	1505844,416	2145902,088	3055642,308
Scenario 3	501977,5774	771645,9165	1177953,988	1789606,157	2711550,099	4105836,838

Figure 10: Distribution Cost/Unit

In term of total cost, scenario 2 provides the lowest effect and scenario 3 gives the most significant effect. In 2025, scenario 3 will increase water supply cost as much as 3% compared to basic scenario.



	2000	2005	2010	2015	2020	2025
Bascic Scenario	798255,9262	1224730,574	1864932,355	2825489,033	4279239,759	6479211,208
Scenario 1	798255,9262	1222629,713	1857968,132	2808280,054	4241613,561	6402341,566
Scenario 2	798255,9262	1171796,307	1705415,112	2476437,188	3599387,835	5247593,482
Scenario 3	798255,9262	1230079,264	1882660,071	2869294,752	4375017,347	6674882,529

Figure 11: Water Supply Cost/Unit

5 Conclusions

In the long term, the increase of population provided the lowest effect on future water supply cost per unit. Total cost actually will increase with the increase of the number of population, but in term of unit cost, it will decrease with the increase of the number of population. This condition actually showed the existence of economies of scale in water supply system. Nevertheless, this condition does not mean that intervention toward the growth of population should not be taken place, but it means that the scope of service should be increase. At recent time, scope of service of water supply

is still 60% in urban area. Urban sprawl gave the most significant effect on water supply cost. Urban sprawl influences the length of network and finally distribution cost. Urban sprawl should be controlled by applying policy regulated population distribution.

Control of land conversion does not provide significant effects on the variables tested, except the level of water turbidity. However the influence will take place in the short time since the forest area which can be converted into built up area is limited. Controlling urban sprawl (by increasing the density of customers) can only give effect to the long decline in network, but the effect is given not for the influence of population growth.

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Territorial Management from A Cultural Perspective: A Review of Flood Risk Management Policies in the Bangkok Metropolitan Region

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Abstract: This paper examines the applicability and limitations of the proposed analytical framework. The framework was developed to facilitate an analysis of territorial development processes taken culture as an important element shaping planning processes and spatial outcomes. Five main principles underpin the proposed analytical framework are the concept of social-ecological system (Folke *et al.* 2005), culture-changing dynamics (Gullestrup 2006), Institutional Analysis and Development framework (Ostrom 2005), five dimensions of cultures (Hofstede and Hofstede 2005) and cultural theory (Thompson *et al.* 1990). The analysis of territorial development of the Bangkok Metropolitan Region, with special emphasis on the impacts of local cultures on policy initiatives and spatial outcomes in relation to flood risk management in the region, is taken as an example for investigation. The analysis shows that despite its potential subjectivity resulted by heuristic interpretation, the proposed analytical framework tends to be a promising approach.

Keywords: Local Cultures, Flood Risk Management, Bangkok Metropolitan Region (BMR)

1. Introduction

Planners and policy makers have recently increased their concerns regarding effects of climate change on sustainable development of urbanised delta regions, in which approximately half of the world population lives and works (Aquaterra 2009). Flood risk management is an essential issue for development of these sensitive urbanised areas. Reformation in territorial management has been informed by transfers of technology, knowledge and policy to deal with common problems. Nevertheless, previous experiences have shown that applying a successful policy from one case to others do not always produce successful outcomes (Friedmann 2005; de Jong *et al.* 2002). Many scholars have argued that development processes are shaped not just by development plans and policies, but also significantly by local conditions, including cultures (Friedmann 2005; Ostrom 2005).

In order to improve territorial development goal achievement generated by transferred policies, developing notions on dynamics of cultures and their roles in shaping territorial development through planning and implementation processes appears to be of great importance. An understanding of such issues can be enhanced through a systematic analysis of territorial development processes from a cross-cultural comparative perspective. A number of studies address crucial roles of planning cultures in territorial development processes (Knieling and Othengrafen 2009; Sanyal 2005). Knowledge of such issues regarding cultures in a broader sense than just planning cultures is, however, still limited.

This paper is a working paper as part of a PhD research project *Dynamics of Cultures and Territorial Management of Urbanised Delta Regions* that aims to provide a systematic analytical framework and methods to take cultural dimensions into account for policy analysis. The study takes territorial development regarding flood risk management as a pioneer aspect for analysis. The paper explores the applicability and limitations of the proposed analytical framework to explain actual phenomena through an empirical analysis. Effects of cultures on the territorial development outcomes regarding flood risk management in the Bangkok Metropolitan Region (BMR) are investigated, using the proposed analytical framework.

The paper is divided into four sections. The first section summarises the proposed analytical framework by explaining the main components and their place in the institutional transformation processes. Section 2 provides a background of the BMR along with introducing the three periods of analysis. Section 3 investigates the territorial development processes, focusing on aspects relating to flood risk management in the BMR, in three periods of development. The last section addresses the applicability and limitations of the proposed tentative analytical framework resulted from the empirical testing.

2. The Proposed Analytical Framework

The analysis is carried out from planners and policy makers' point of view to understand the places and roles of cultures in development processes, focusing on influences of informal institutions on shaping development policies (formal institutions) and spatial outcomes. The term *institutions* in this paper refers to a broader meaning than just organisational forms. It refers to 'the prescriptions that humans use to organize all forms of repetitive and structured interactions at all scales' (Ostrom 2005: 3).

The proposed analytical framework is underpinned by five main theoretical frameworks, which are a concept of social-ecological system (Folke *et al.* 2005), culture-changing dynamics (Gullestrup 2006), Institutional Analysis and Development (IAD) framework (Ostrom 2005), five dimensions of cultures (Hofstede and Hofstede 2005) and cultural theory (Thompson *et al.* 1990).

2.1 Structure of the Analytical Framework

The proposed framework (see Figure 5) combines two building blocks for two action situations that interact, which will be called hereafter as 'planning situation' and 'implementing situation'. Each building block consists of three main components, namely conditioned factors, action arena and outcomes. The framework represents dynamic processes, with all components performing as dependent variables.

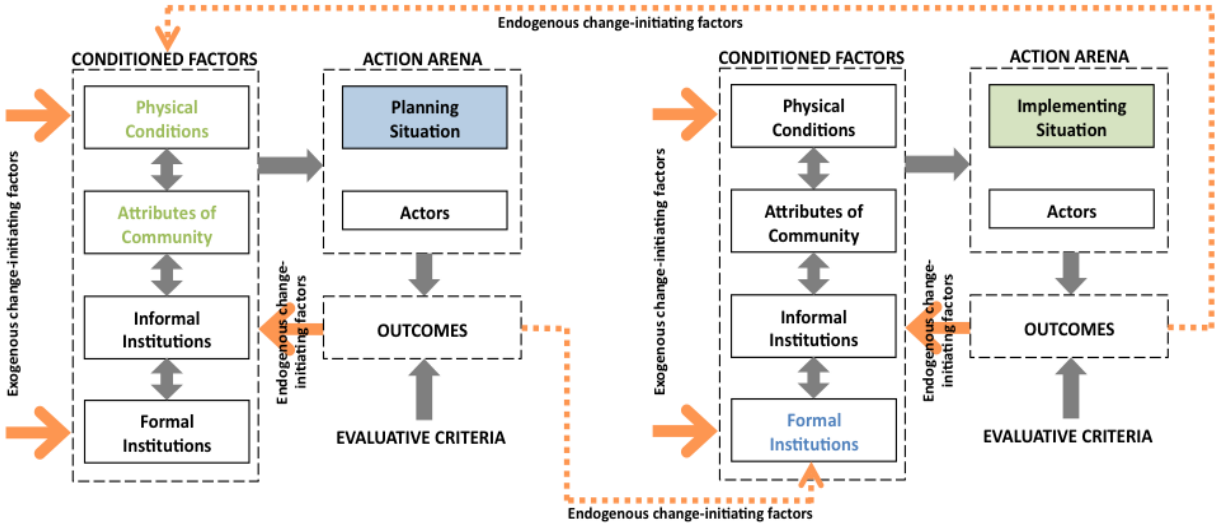

Figure 5 Structure of the proposed analytical framework

The structure of the proposed analytical framework is based on the Institutional Analysis and Development (IAD) framework developed by Ostrom (2005), with some modifications. The major modification is made to the so-called exogenous variables in the IAD framework, which is replaced by the term '***conditioned factors'*** in this paper. The three elements of the exogenous variables are reclassified into four elements: physical conditions, attributes of community, informal institutions and formal institutions. This reclassification results from the integration of the IAD framework and concepts of culture-changing dynamics developed by Gullestrup (2006) to fit the research's purpose.

Physical conditions refer to attributes of the bio-physical and material world of the resource units (Ostrom 2005) - which are, in this case, land and water (in the sense of flood) of the urbanised delta regions. *Attributes of community* refer to Gullestrup (2006)'s 'difficult-to-perceive structural layers', which include social, economic, political & administrative and language & communication structures. *Formal institutions* refer to Gullestrup (2006)'s formalised layers of norms and rules, such as legitimised regulations, instructions, precepts and principles in a form of rules, laws, constitutions and contracts. This includes legitimised rules and laws that regulate the forms of structural layers. These three elements are called in Gullestrup (2006) as manifest culture layers. All layers of Gullestrup (2006)'s core culture layers are considered in this study as *informal institutions*. This includes worldviews and general accepted values and believes, both in partly legitimised or non-legitimised forms.

Conditioned factors are significant variables that structure or condition the action arena. They are continuously changing, influenced by either endogenous or exogenous change-initiating factors or both (Gullestrup 2006). In this study, exogenous

factors refer to the driving forces generated or conditioned by agencies or factors outside a given territory, with special focus on technology, knowledge and policy transfers. This includes both voluntary and imposed transfers. Endogenous factors refer to all the changes or conditions generated by local agents or local conditions, including effects induced by exogenous factors that turn to local conditions. Examples are changes in social class and discourses generated by economic development or political shifts. Despite of their dynamics, the conditioned factors are assumed to be constant within a certain period of time. This is for the purpose of analysis (Gullestrup 2006).

Action arena refers to activities created by actors in the action situations (Ostrom 2005). As mentioned earlier, there are two linking action situations in this case. The outcomes of one action situation lead to changes in the conditioned factors of another situation (see Figure 5). *Planning situation* refers to processes of policy preparation, whereas *implementing situation* refers to processes of policy implementation. In this study, actors are classified into four main groups: providing agent, intervening agent, affecting agent and monitoring agent. Some situations may not comprise all groups of actors.

Outcomes are identified according to the resource systems and units together with the governance systems and users for the analysis. The outcomes are evaluated by evaluative criteria, which in turn effect the adaptations of the conditioned factors and action arena (see Figure 5). Examples of evaluative criteria are efficiency, equity and adaptability. It is important to be clear which group will evaluate the outcomes from which perspective. This is because evaluative criteria may differ between actors.

When outcomes are evaluated by the involved actors as productive or positive, they may increase their commitment to following the institutions that have evolved over time; institutional transformation takes place as a way to change the structure of the situations in the action arena when the outcomes are evaluated as destructive or negative (Ostrom 2005). This refers to changes created by endogenous change-initiating factors. Institutional transformation sometimes occurs due to other reasons, such as, the imposition of a powerful actors. This refers to changes created by exogenous change-initiating factors

2.2 Analytical Approaches and Parameters

Territorial development in this context is considered as a result of the complex and dynamic institutional arrangements of interconnected social-ecological systems in a given territory. This study, therefore, applies two approaches for analysing of governance, which are in terms of human-nature relationships and human-human relationships. Each approach consists of different sets of parameters. Each parameter is analysed and interpreted using common set of cultural dimensions, basing mainly on the combination of Douglas (1970) and Thompson *et al.* (1990)'s cultural theory and part of the Hofstede (2005)'s five dimensions of cultures. This is to make the parameters comparable. The study applies only three dimensions of cultures, which are power distance, integration and uncertainty avoidance.

The *power distance* (PD) indicates degree of control of a unit in the system over others, ranging from symmetrical to asymmetrical transactions. The *integration* (In) indicates level of contact between units in the systems, ranging from individualised to collectivised relationship. The *uncertainty avoidance* (UA) refers to degree of (in)tolerance of ambiguity, ranging from tolerance to intolerance. The application of these dimensions still requires great efforts for further development. Some tentative applications are, however, proposed and explained along with parameters as shown in Table 1.

Table 1 Summarised parameters and their cultural dimensions for analysis

	Human-nature relationships (H-N) - resource management -		**Human-human relationships (H-H)** - social organisation -	
	Parameters	*cul.dime.*	*Parameters*	*cul.dime.*
Physical conditions	Land: topography, soil type, settlement patterns and urbanisation level (population size and density) in terms of limitation, opportunity and risk for development in relation to flood risk Water: characteristics of rainfall, rivers and sea in terms of degree of severity, uncertainty and probability of flooding		Characteristics of land and water in terms of excludability and subtractability of flow: for instance, as public goods, common goods, club goods or private goods	
Attributes of community	Civil society and private sectors: GDP and employment by sectors Public sectors, governments and lobbyists: involving departments and their funding	PD, In	Relationships between social groups and their positions in the community, presenting in accordance to the 2D diagram of (Thompson *et al.* (1990)'s *Cultural Theory*	PD, In
Informal institutions	Conceptions of H-N: principles in religious, rituals, idioms, agricultural practices, meanings given to some terms such as flood	PD, In, UA	Conceptions of H-H: social and economic model of the society, idioms, the principles in religious and language	PD, In
Formal institutions	Legitimised rules, laws, constitutions and contracts relating to land use, flood risk, water and environmental management	PD, In, UA	Legitimised rules, laws, constitutions and contracts relating to land tenure/ownership	PD, In
Development outcomes	Planning Situation: same as the formal institutions Implementing Situation: patterns of land utilisation and land value	PD, In, UA	Planning Situation: same as the formal institutions Implementing Situation: patterns of land tenure/occupation	PD, In

Apart from actors, all parameters are identified in accordance to the two approaches of analysis. Parameters for planning situations and implementing situations are separately identified if they are different; otherwise it means they are similar. Formal institutions between both situations are generally the same set of institutions. Development outcomes of planning situations are basically formal institutions of implementing situations.

2.3 Institutional Transformation Processes and the Change-determining Factors

In this study, an analysis of institutional transformation determination is mainly applied from a concept of culture-changing dynamics developed by Gullestrup (2006). The term 'cultures' in Gullestrup (2006) is interchangeable with the term 'institutions' in this context. Gullestrup (2006) addressed that institutional changes are driven by change-initiating factors, but whether and to which direction that changes will actually occur depends on change-determining factors. Actual changes refer to changes that take effects to a broad scale in a society across actors and across levels of institutions. In this study, whether a real culture change does take place is evaluated from reflections of the change initiatives (emphasising on changes in formal institutions) in spatial outcomes.

The probability of actual culture change/institutional transformation (P.CC) is determined strongly by the relationships amongst four factors, which are degree of integration (DI), degree of homogeneity (DH), contents of change-initiating factors (CiF) and culture-internal power relations (CIPR), as shown in Figure 6 and Figure 7. Figure 6 indicates two different P.CC values at a given combination of DH and DI, influenced by two other factors, which are explained as follows.

The probability of actual institutional transformation is first determined by *degree of homogeneity* (DH). It presumes that a community associated with more diverse knowledge, experience and practical skills will provide more chances for change initiatives to penetrate into and reach a stage, where actual institutional transformation can (but may or may not) take place (Gullestrup 2006). Degree of homogeneity can be assessed from analysing attributes of the community. If the community is greatly uniform, the content of the change-initiating factors (CiF) have to be tailor-made to fit the existing attributes of the community (Gullestrup 2006); otherwise the change initiatives will be rejected from the community.

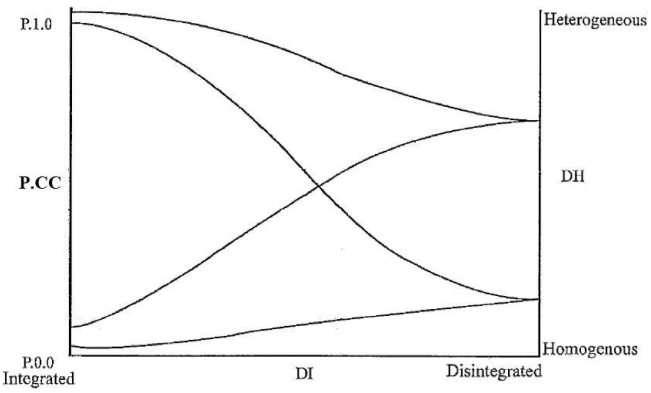

Figure 6 A theoretical relational diagram of change-determining factors

Source: Modified from Gullestrup (2006: 145)

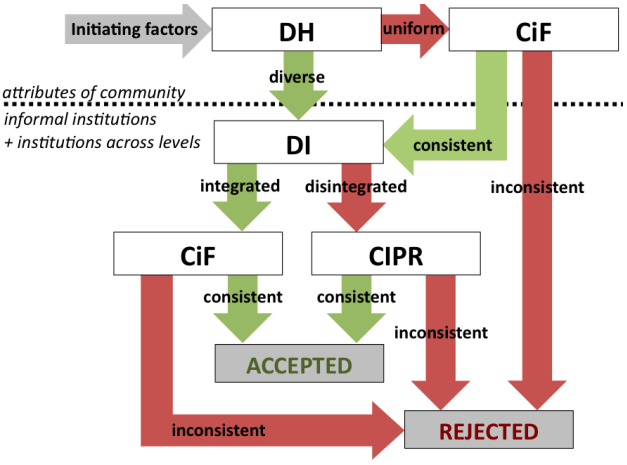

Figure 7 A relationship diagram of four determining factors and their impacts on institutional transformation

The next step is to analyse *degree of integration* (DI) in terms of (i) integration of informal institutions across actors and (ii) logical reflections across levels of institutions. The more integration the cultures/institutions, the higher tendency the institutional transformation will take place to react, either positively or negatively, towards the change-initiating factors (Gullestrup 2006). Positive or negative reaction crucially corresponds with the CiF. The higher corresponding between the CiF and the existing institutional settings, the higher probability is that positive reactions can be expected (Gullestrup 2006), and vice versa (shown in Figure 6 as the above line and the underneath line accordingly).

If the existing institutional settings are highly disintegrated, it is then essential to consider culture-internal power relations (CIPR). CIPR refers to power of a specific group to determine changes over other groups in the community. The decisive factor in a highly disintegrated condition is degree of integration of the change initiatives to the existing institutions of the most powerful actors.

Significant Shifts of Territorial Management In the Bangkok Metropolitan Region

The Bangkok Metropolitan Region (BMR) is located on the lower delta of the Chao Phraya River Basin, where the river meanders through the city and extends to the gulf of Thailand. Its territory is defined in accordance to the administrative boundary, covering six provinces: Bangkok Metropolis, Nonthaburi, Pathumthani, Samutprakan, Samutsakhon and Nakhonpathom (see Figure 8).

Since Bangkok was established as the capital of the kingdom in 1782, a small commercial community covering an area of 4.14 km^2 (BMA 2009) has developed into a large diversified and growing industrial metropolitan region. The BMR now covers an area of 7,761.50 km^2 and accommodates more than 10 million people (BMA 2009). The region has continued to expand its connection to other more peripheral provinces, particularly to the north and the east within the distance of 80 km from the Bangkok CBD since 1990s, and consequently formulating the extended BMR.

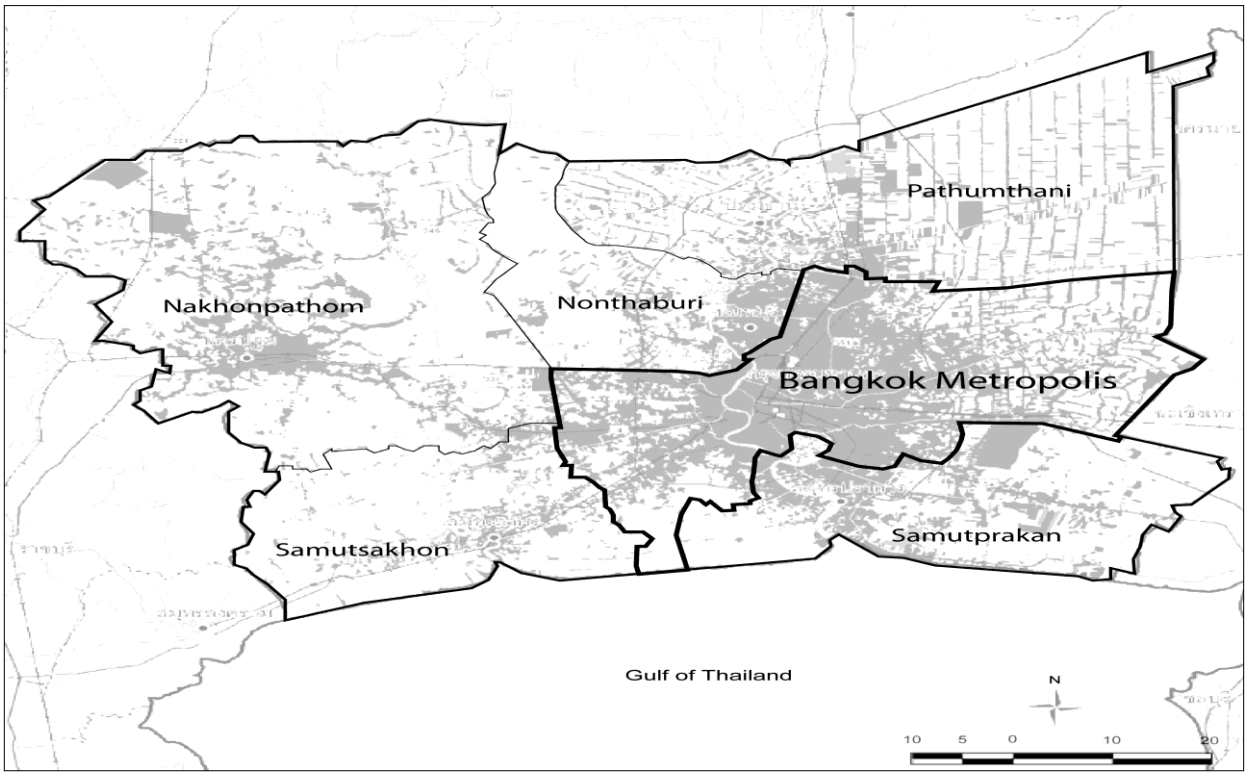

Figure 8: Administrative boundary and settlements in the Bangkok Metropolitan Region in 2002

Source: Reproduced from the map provided by the National and Regional Planning Bureau, Department of Public Works and Town & Country Planning – DPT (2008)

The traditional Thai social and territorial organisations had been maintained until around the turn of the nineteenth century. This includes the decentralised structure of social organisation under the absolute monarchy and the Thai traditional economy, which was based on subsistence economy. Radical shift of the Thai social and territorial development started in the mid of the nineteenth century, underpinned by the development objectives to modernise the country and the liberalised trade agreements first signed in 1855 with the United Kingdom, followed by many other countries.

This resulted in a shift of the Thai economy from subsistence to export-oriented agricultural economy integrating into the world market, and consequently the expansion of land reclamation for rice production further a field, especially into swampy lowlands. The modernisation of the country included changes in administrative structure, social structure as well as political structure. Many strategies for territorial management and regulation were introduced. The society dramatically adapted to the new conditions for development through institutional arrangements. Impacts on spatial development, resulting from these changes were not evident in this period; it became more apparent in the following periods, soon after the World War time.

After World-War II, the country experienced another significant shift in institutions, driven by three main forces: (i) financial and technical aid from international agencies, such as the World Bank and the Asian Development Bank, (ii) dramatically increasing investment of Sino-Thai communities due to political changes in China and

(iii) induced effects from the money spent by the American Army, which had military camps in Thailand during the Vietnam War. These factors initiated a rise of middle class with a high purchasing power, changing life styles of urban families and an influx of rural immigrants drawn by economic development in Bangkok. These effects were important factors driving rapid urban expansion in the BMR stared in the 1970s, including the expansion to the former swampy lowlands initially reclaimed for agricultural purposes.

The third significant shift occurred in the 1990s. This stated clearly first time in the Seventh National Economic and Social Development Plan (1992-1996). It called for a more balanced development, concerning social, economic and environmental aspects, fostered by global trends in sustainable development. Although spatial development in this period is mainly a product of institutional arrangements in the previous periods, significant changes have been observed both in planning sphere and spatial outcomes.

3. Local Cultures And Territorial Development In Relation To Flood Risk Management

The results illustrating in this section are still on a process of development. It contains not all the elements mentioned in the analytical framework. However, it provides a good overview for an application of the proposed analytical framework to explain actual territorial development processes. The analysis is divided into three parts, according to three development periods in the Bangkok Metropolitan Region (BMR). The periods of development are classified according to major shifts in formal institutions and their significant impacts on spatial transformation as earlier explained. They are (i) the period of country modernisation (1850s-1940s), (ii) the beginning of international agencies and rapid growths period (1950s-1980s) and (iii) the period of reorientation towards balanced and sustainable development (1990s-2009).

3.1 The Period of Country Modernisation (1850s-1940s)

Change initiatives and their reflections in formal institutions

This period was affected mainly by exogenous change-initiating factors, which led to transformation of the modes of land control as well as capital and labour (Phongpaichit and Baker 1995; Molle 2005). A significant shift in formal institutions during this period was the administrative modernisation, taking a model from the colonial apparatus of administration established by the British in India (Arghiros 2001). The process started in 1892 to ensure effective central control of rural areas. Major changes were related to new forms of territory division and the transformation of the traditional administration to a more western-like ministerial system. A rather decentralised with area-oriented development approach was reformed to a more centralised with sector-oriented development approach. As a result, common sector-oriented development policies were created by the ministries at the national level and implemented to the whole country.

Furthermore, a modern legislation for land ownership, of which occupancy by utilisation was replaced by title deeds, was introduced. As a result, land, which was recognised as a factor of production, acquired value in itself and became a tradable com-

modity. Additionally, a new land policy that granted ownership of land to the land developers (concessionaires for canalised projects), subject to whether or not the land has already been utilised and claimed, was introduced in the 1880s (Molle 2005). This created an enormous expansion of land reclamation in the region. This expansion processes were enhanced also by the gradual abolition of *nai-phrai* system (the Thai traditional hierarchic social structure with some similarities and differences comparing to a feudal system) from 1874 to 1905, which generated increasing demand of land. This is due to increasing of monetisation of the peasant economy brought by the independence of *phrai* (commoners) and *that* (slaves).

After a few decades of launching the aforementioned new land policies, awareness of potential inconsistencies in development approaches created by landlordism within the Thai traditional mode of agricultural subsistence were raised. This led to the reorientation of the land policy in the beginning of the twentieth century. In 1936, the government fixed the limit of land ownership at 50 *rai* (8 ha) per household (Peleggi 2007), aiming to prohibit large-scale concession of land and promote small-scale concession to peasants.

Analysis of the conditioned factors and their influences on the change determination

As mentioned earlier, the social, economic and political reforms in this period encouraged the rise of a middle class. The abolition of the *nai-phrai* system and the influences from increasing associations with westerners made the community a more diverse society. Although the main player guiding development of the region remained the state (or in other words, the aristocracy), private investors and civic society gradually gained more power and involvement in territorial organisation. This created a high probability to accept transferred technology as well as development concepts and policies in the following periods.

The new land policies created different spatial development patterns in different parts of the region. This depended mainly on relationships between physical conditions and attributes of the community who occupied the land. Despite conflicts of the new development approach with traditional conception as living in harmony with nature, a development policy to transform swampy lowlands into cultivated lands using technology to drain and control water was implemented. This is mainly because of its consistency to the institutions of the aristocrats, which were the most powerful in territorial development of the region in this period. They played a role of both policy makers and land developers (concessionaires). They were western-trained technocrats, and thus rather easily agreed and adopted those transferred ideas. Concessionaires chose swampy lowlands, which remained free from occupation, as the priority areas for development. Lands were then parcelled and rented out to tenant peasants who were just free as a result of the abolition of *phrai* and *that* system a few years before (Peleggi 2007). This led to urban expansion to unattended areas, starting in the 1880s.

However, this did not apply to the peasant groups, with which traditional conception as living in harmony with nature was closely associated. This explains why they chose the fertile with low flood prone as priority areas for their settlements, and left

the unfertile areas with high flood prone rented from the landlords after a few years (Molle 2005). This is underpinned by their close relationship to physical conditions of the land as a production factor for agricultural uses.

3.2 The Beginning of International Agencies and Rapid Growths Period (1950s-1980s)

Changes in conditioned factors resulted from development in the former period

As mentioned earlier, the former period created conditions that enhanced the rise of middle class. It generated also an expansion of land reclamation, initially for agricultural uses and became urbanised areas during this period. Settlements took place in various high flood prone areas in the region. Those high flood prone areas were left unattended mainly for speculative purposes at the beginning of this period; however, urbanisation started taking place in such areas at the end of the period. This was partly due to a great shift of the Thai economy from an export-based agricultural economy towards a more service and manufacturing-oriented economy (Askew 2002). This reduced the level of integration regarding human-nature relationships that was closely related to perceptions of people connecting to agricultural practices.

Change initiatives and their reflections in formal institutions

In this period, development direction was influenced by development approaches suggested by the international development agencies and western-trained technocrats. These technocrats formed a significant professionalised subculture within the customary bureaucratic polity (Askew 2002). This resulted in the establishment of various planning agencies, including the National Economic and Social Development Board (NESDB), the Board of Investment (BOI) as well as the Department of Public Works and Town & Country Planning (DPT), in the 1950s. The new approaches were associated with a higher level of controlling (PD) both in terms of human-nature relationships and human-human relationships with lower uncertainty avoidance (UA) and degree of integration (In) of human and nature. This represented in a form of land use plans with regulations that promoted development in flood risk areas with flood prevention measures.

In addition, the National Economic and Social Development Plans during the 1980s emphasised the significant of privatisation and increasing in engagement of private sectors in development planning (NESDB 2008). This resulted in increasing of establishment and engagement of private agencies, such as chamber of commerce, in development planning processes. In other words, spatial development during this period was oriented by a new form of economic and political organisation in the Thai society, led by market forces and the technocrat governments.

Analysis of the conditioned factors and their influences on the change determination

In this period, the society consisted of diverse groups of actors in both planning situations and implementing situations. This created a high probability to accept the policy initiatives. The contents of the new technocrat-oriented development approaches were rather conform with the informal institutions of policy makers and upper-middle

class groups, which were the most influential groups in the society in shaping territorial development in the region. Despite their inconsistency to physical conditions of the proposed development areas in terms of flood risk, the plans were still taken into actions.

How plans and projects were implemented was, however, another story. Rather than shaping development through comprehensive planning, the state employed the provision of main transport networks and basic infrastructure as a principal measure to encourage economic growth and direct spatial development (RIDA 1996). This development strategy, of which only the main networks were constructed by the state and the communities were in charge to extend those services to further areas on their own, was rather similar to the strategies employed in the former periods. Yet they associated with two main different features: (i) change in types of infrastructure provision from canals excavation to road construction and (ii) change from community-led organisation to private sector-led investments. This clearly showed inconsistency between the change initiatives to formal institutions and the inherited informal institutions of the state. In addition, the social structure already changed from a collectivised to be more individualised society. Communities were not tightly bounded as it was in a period of subsistence agricultural society anymore. This resulted in undesired spatial development patterns created by applying a development approach that required cooperation in a society that lacked of management cooperation.

Regarding spatial development outcomes, in the 1970s swamp areas along the new highways, particularly to the north and the east of the existing city centre, were developed into housing estates. Settlements and development in those areas, which were not suitable for development considering level of flood risk, took place responding to the increasing demand generated by the new middle-class households. This is because their attributes in terms of integration to nature created by their occupation are rather low. The changing attitudes towards land ownership as a mode of speculation and saving also played an important role in spatial transformation of such flood risk areas.

3.3 The Period of Reorientation Towards Balanced and Sustainable Development (1990s-2009)

Changes in conditioned factors resulted from development in the former period

Effects created by economic structural transformation in the former period to be more manufacturing-oriented industry became more evident in this period. This shift resulted in rapid expansion of manufacturing into peripheral areas in the region. It led to dramatic transformation of high flood prone areas with large landholdings and good accessibility, as a result of development policies and plans implemented in the former periods, to facilitate the spatial demand mainly for industrial and large housing estate developments. Many high flood prone areas were urbanised. Flood prevention measures, such as dikes along riverbanks and polder systems, were widely constructed to prevent the highly economic concentration areas of the region. These conditions lowered level of danger and uncertainty created by floods in those prevented areas. By heightening the level of flood control (PD), it lowered level of integration between human and nature systems.

Development in the low flood prone areas did not experienced dramatic changes as it did in the high flood prone areas. The major change was changes in land uses, from agricultural dominant to mixed uses of agricultural and residential uses. This was mainly due to a small landholding characteristic of the areas, which was inherited in the areas as a result of the traditional land policies. However, the level of flood risk in some of these areas became comparatively higher than other areas, which were originally high flood prone. This was due to flood preventive measures to protect such originally high flood prone areas that were developed for activities with higher economic values than agriculture.

Considering the social structure, the number of middle class people and their power in shaping development of the region essentially increased. This partly led to significant shifts of formal institutions in this period as explained below.

Change initiatives and their reflections in formal institutions

The shifts in formal institutions in this period resulted from both endogenous change-initiating factors (increasing in number and roles of middle class groups) and exogenous change-initiating factors (sustainable development discourses - including green movements, balanced development, and cooperative and participation planning). The former extremely centralised state power gave way to a higher degree of devolution and public engagement, as explicitly focused in the 1997 Constitution. These changes are the consequences of the struggles of the middle class through key civic movements in 1973 and 1992. The rise of the middle class resulted in a number of changes, reflecting both directly in the governmental administrative reforms and through indirect interventions. A number of NGOs-based for green movements and public engagement initiated by the middle class were examples of such indirect involvements. In other words, a bureaucratic polity was shifted towards a civic polity and was apparently in sight since the 1990s (Arghiros 2001).

These driving forces resulted in the governance and ministerial reformations as well as enacting of laws and regulations, aiming to enhance sustainable development. Major relevant organisation and legislative changes regarding territorial development in relation to flood risk management were, for examples, the Seventh National Economic and Social Development Plan (1992-1996) – the first plan that explicitly addressed balanced and sustainable development concepts as the main objective for development, the 1997 Constitution – which strongly enforced devolution, public participation and citizen engagement processes, and other consequential actions, such as the establishments and legislations of Local Administration Authorities and Ministry of Natural Resources and Environment, Environmental Protection Act 1992, Land Appropriation Act 2000, Land Readjustment Act 2004, Land Development Act 2008.

Trends in spatial planning also moved towards a more civic approach. Apart from controlling spatial development through *phang-mueng-raum* (a land use zoning plan with restrictions), the Department of Public Works and Town & Country Planning (DPT) began to cooperate with private investors through negotiation processes, soon after the 2003 Land Readjustment Act was launched. Furthermore, the role of the DPT under the central government was changed according to the 1999 Devolution Act. The role of planning was greatly transferred to local authorities. The role of the

DPT was changed into preparing the regional and the national level as to provide strategic development frameworks to the locals. This approach was well cooperated by the local communities in which the customary social organisation was maintained.

Furthermore, the most recent significant change initiative was the introduction of the philosophy of 'sufficiency economy' by His Majesty the King. This concept was stated first time as a development approach for the country in the Ninth National Economic and Social Development Plan (2002-2006). The concept was applied not only to economic field, but rather to a broader aspects of development. Regarding flood risk management, it reflected in various new measures of dealing with flood at different scales, such as using of flood retention at the regional scale, replanting mangrove at the district scale and regulations and guidelines for green-blue-brown coverage ratio at the plot scale.

Analysis of the conditioned factors and their influences on the change determination

Considering the shifts of formal institutions in terms of human-nature relationships, the concepts that increased level of integration (In) to nature resulted by the sustainable development concepts, were likely well accepted in planning situations. However, the degree of acceptance was different amongst actors. For instance, the DPT noticeably applied the concepts in the most recent strategic plan for the BMR; the preventive measures, however remained dominant in flood risk management approach of the Royal Irrigation Department. In implementing situations, the degree of acceptance varied also amongst different actors. This highly connected to their attributes of community. Actors whom their occupations were closely related to nature were likely to accept the new approach more than actors associated with urban life styles. In addition, those who lived in well flood-protected areas were less likely to take the new approach as necessary.

Nevertheless, explanation of the rather high degree of acceptance of new approaches that encourage less control (PD) over nature and being more integrated (In) to nature is quite complicate. Analysis of spatial outcomes alone does not inform whether the acceptance resulted from the consistency of informal institution regarding human-nature relationships or human-human relationships. This is doubtful because the concepts were introduced by H.M. the King, which is greatly respectful in the society; they are also conform with the conceptions of human-nature relationships representing in Buddhism – the main religious of Thai people. Further investigation on relationships between effects of informal institutions on decision-makings thus appears necessary.

Regarding the shifts of formal institutions in terms of human-human relationships, the concepts of devolution and public engagement in planning, which lowered the level of control (PD) and encouraged a better integration in the society (In), were currently not quite well implemented. This was likely to cause by inconsistency between the policy initiatives and the dominant informal institutions in the society. The customary social organisation at all scales, from a family to the national scale, was based on a high power distance (PD) model with different levels of integration (In) of each social group. The inconsistency regarding power distance to the constitutional level of insti-

tutions of the society thus played a crucial role in preventing successful changes to take place, despite the significant changes at the structural level.

4 Observations and Conclusions

This paper presents preliminary results of the first test of applicability of the proposed analytical framework to explain the actual phenomena, taking territorial development regarding flood risk management in the Bangkok Metropolitan Region (BMR) as a pioneer case for analysis. The analysis interpreted cultures and their effects on territorial development processes, mainly from spatial outcomes as well as organisation and policy analysis. This may involve significant deviations resulting from the author's interpretations.

Nevertheless, the analysis shows that the proposed analytical framework tends to be a promising approach to explain territorial development processes from a cultural perspective, despite its potential subjectivity resulted by heuristic interpretation. It shows a high correlation between the four conditioned factors and development outcomes, both in terms of development policies and plans and spatial outcomes. The three cultural dimensions employed to categorise cultures regarding flood risk management also help to facilitate a better understanding on determination of policy acceptance according to the four change-determining factors proposed by Gullestrup (2006).

Further investigation by other methods that may help improving subjectivity of cultural interpretations, particularly of informal institutions, appears necessary. This includes interviews of focus groups, such as planners, policy makers and real estate developers, and questionnaires to civic sectors living in focused areas. In addition, more case studies and issues for investigation of effects of local cultures in territorial development processes would help to improve and assure the validity and applicability of the proposed analytical framework for policy analysis to apply to a broader scope of territorial management in diverse institutional settings and cultural contexts.

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Breathing Walls Concept for Low Cost Comfortable Housing in Developing Countries

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Abstract: Most of the Developing countries are located astride the equator inheriting a hot and dry climate. Their location also makes them water deficient because of low rain. Jhal Magsi is one such location in Pakistan where the temperatures shoot up to 45-47 degrees Celsius in summer days and above 26 degrees during night. Inhabitants dehydrated during day hardly find environment to have a comfortable night. In such a situation 'breathing walls' concept can help cool down houses made from local material. Normal Burnt bricks are used with mud and hay for plastering and cementing with a 3-4 inches gap between the inner and the outer wall gives a comfortable living environment without any extra energy requirement. During day the outer walls get heated from the direct sun rays. Solar heat absorbed by the outer bricks warms and expands the air in the gap reducing the density and ability to transfer the heat to the inner wall. At night, the temperature falls outside thus cooling the outside wall, consequently reducing the temperature and reversing the direction of thermal conductivity in the outer wall bricks. The air inside the walls cools down as well. This temperature drop contracts the air and outer cold air gets inside the walls due to vacuum created by the contraction of inside air through a vent placed at the top of the

outside wall. The gap between the walls helps contain the moisture and cold air during the day repeating the cycle. In addition, the wind catchers also help in developing limited cooling effect. few such accommodations were developed in 1992, 2000 and 2005 has proved that a temperature drop of 10-15 degrees Celsius can be achieved by breathing walls concept without cost exceeding 5-10% for the overall project. Breathing walls concept can help develop comfortable eco-friendly low cost housing in the developing as well as in developed countries by reducing the carbon footprint and recurring energy requirement for cooling or warming the houses.

Key words: Breathing walls, eco-friendly, low-cost housing, cavity walls, developing countries, poverty line.

1 Introduction and Initial Concept Development 1992

This paper is based on simple and common practices in rural areas in developing countries for communities that may be living below poverty line (Tomev 2010). In my opinion 'Poverty can be defined as a situation when any human chooses to deviate from the ethical values and corresponding actions for acquiring food to maintain the relationship of body and soul'. This may be because of political, environmental or any other reason. Morality is the first victim of poverty in most cases. Living in a comfortable house is everyone's dream. For this reason this paper will restrict to 'comfortable and affordable dwellings for the poor'. Results from this work can be applied for multi-storey buildings as well where possible. Realizing the need for discovering, designing, implementing, comfortable and affordable living environment, this paper is being presented as my personal experience in designing and constructing energy efficient housing for the poor.

In constantly changing climate resulting in global warming, arising from the use of fossil fuel has magnified thermal comfort problem. Oil producing countries may be able to provide cheaper fuel to their citizens but the countries that have to import fuel for energy are facing increasing energy cost thereby a difficulty to provide comfortable living environment for their inhabitants. This aspect alone is forcing the poor communities to switch to alternate methods of making homes comfortable. Cost of energy and carbon footprint are increasing in the construction industry in manufacturing building materials like steel, cement, glass, plastics etc. Transportation cost to the construction site is also on the rise due to increasing fossil fuel prices. Although scientific advancements have improved efficiencies in almost all manufacturing processes; for the poor, it is still unaffordable to use industrially products for thermal comfort. Hence they have to resort to more basic methods of construction for achieving thermal comfort.

In one of the community projects in Pakistan, a 10000sqft club house was designed in a conventional manner. The climatic conditions demanded an air conditioned environment. The community was donated with an air conditioning plant. However, the plant's capacity was just half the requirement and funds were not available for an additional plant. This challenge had created an opportunity for improving the design of the club house. 'Necessity is the mother of invention' is a common proverb in local Pakistani language; I wish to add 'and innovation is the father'. This shortfall of air

conditioning plant presented an opportunity to improve the design midway during construction. The idea of breathing wall was created and applied by addition of a 9 inches wall on the sun-side of the building and a soil filled roof top. This created an environment of protecting all walls and the roof from direct sunlight. The problem was resolved partially and the structure stands today saving recurring energy cost in particular and the cost of electricity production and carbon footprint in general. A similar concept was adopted in designing a house in the year 2000 without using a soil filled roof. This was a well organised practice and yielded better results.

Thermal Comfort is considered imperative to improve indoor environments in order to optimise performance depending upon the function (work or leisure). The basic idea is to maximise human resource output. At leisure or home when resting, thermal comfort ensures recuperating energy by a sound sleep in a comfortable room temperature, low noise levels, and quality air circulation; to ensure better oxygen levels for recovering lost body energy from the previous day's work. This will ensure an optimised output at work resulting in improved GDP. An investigation carried out by a team of researchers at Rensselaer Polytechnic Institute in the USA has shown a direct and measureable relationship between individual comfort control and efficiency by use of environmentally responsive workstations (ERW). The results had shown an increase in output by 2%. Human body is an energy system that responds to internal energy levels to the outer environmental conditions. Controlling perspiration, temperature and humidity, human body can function at optimum levels.

2 History of Materials in Construction

The quest of a safe, affordable and comfortable home dates back to 7th century BCE (Pletcher 2009). It actually should have started with first family on planet Earth but those who believe in the Great Flood also accepts that much of manmade houses would have washed away without leaving evidence. Natural and readily available shelters were a common dwelling to offset adverse climatic conditions (Santamouris, Asimakopoulos 1996). Timber, Clay and subsequently clay-lime mortar using stones is the oldest cementing and construction material. Steel, plastics, glass, Portland cement etc are now a common construction material. Materials used in rural areas are either burnt or sunburnt bricks and/or commonly renewable materials that either belongs to the organic family including timber; and different types of soils in several combinations with some addition of hay, lime, and cow dung etc depending upon the cost and convenience of supply. Uses of the above are as follows;

Figure 9 Clay mortar as flooring and Wall plaster

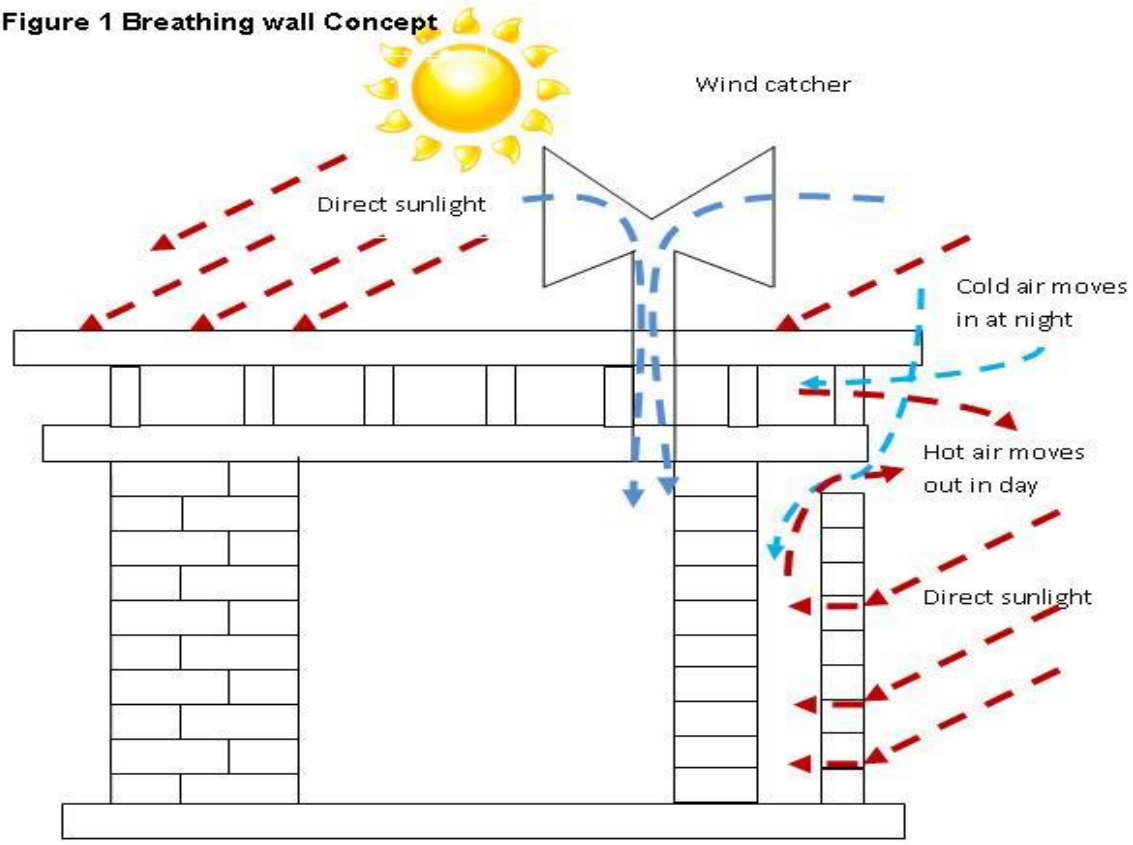
Adhesive quality, workability and strength make clay the most popular and reliable ingredient in mud house construction. Lime is a well-known construction material used since ages. Lime is also used in making cement. Its quality of giving strength gives lime a priority as a construction material. Cow dung is used in most of Asia and Africa as an adhesive agent in clay mortars (Practical Action 2010) this has also been tried to place in-situ lining in field irrigation channels with ease (Ahmed, Yadav 1986). Hay, hemp and rice husk etc are all organic and a crop waste. It has been experienced that these and similar bio waste products are commonly used for enhancing integrity as clay tends to develop cracks on drying. Fibres from similar organic materials are very safe and economically viable for achieving better plastering results. One more advantage of such organic waste is that it stores thermal energy. In one of the buildings cavity walls was filled with rice husk as a deviation to the original concept and the occupants complained that in summers the rooms become comparatively warmer than outside temperature during day and is quite warm even during the whole night. This result has encourage using hay, hemp or rice husk to be used in areas that have colder climates thus saving energy used in warming the household. Common bricks either burnt or sunburnt are made from calcareous soils. In most of the communities in the developing countries in urban areas, only burnt bricks are used for construction. However in rural areas, depending upon the economic prosperity, communities use either sunburnt bricks or burnt bricks if they can find or afford it. Few also use stones trimmed to requirement in place of bricks. With the awareness of using eco-friendly materials in construction, environmentalist and engineers now prefer using eco-friendly materials because the cement industries are responsible for some 7 % of global greenhouse gases (Lee, Her & Kwon 2008).

3 Concept of Breathing Walls and Background

This design was developed as a result of continuous phenomenon of understanding effects of temperature on different materials and their thermal conductivities. Several materials have been used in the past to offset thermal conductivity through the construction material and even to store thermal energy. Dynamic insulation is also a method well-known in Scandinavian countries; in that ventilation air is passed through the fabric of the structure and might pose problems of local discomfort if the difference in interior surface is lower than the room temperature (Gan 2000). Even if the concept works fine; it is in contrast to our title '...low cost comfortable housing...' because any industrial product will raise the cost. The worst medium for thermal conductivity that responds in the shortest timeframe to temperature is air. This is the basic principle of the breathing wall concept. Sketch 1 gives a schematic diagram of how breathing walls work. The direct sunlight is absorbed by the exposed brick wall. The conduction depending upon the density of the material absorbs the energy and conducts it through the medium. The air in the cavity receives this energy and begins to expand. This expansion pushes the warm air outside the wall through the vents left at the upper end of the outer wall. Increase in volume also reduces density of air and proportionately reduces thermal conductivity capability of air. At night, when the temperature falls, the cooling takes place and the inner air also cools resulting in contracting and creating a partial vacuum in the cavity. This vacuum helps the outside cold air to enter the wall cavity with the moisture content thus cooling the air inside the cavity. In addition, the wind catchers that are common in the east can help regulate the fresh air at night in the rooms that can be closed in the morning. With catch-

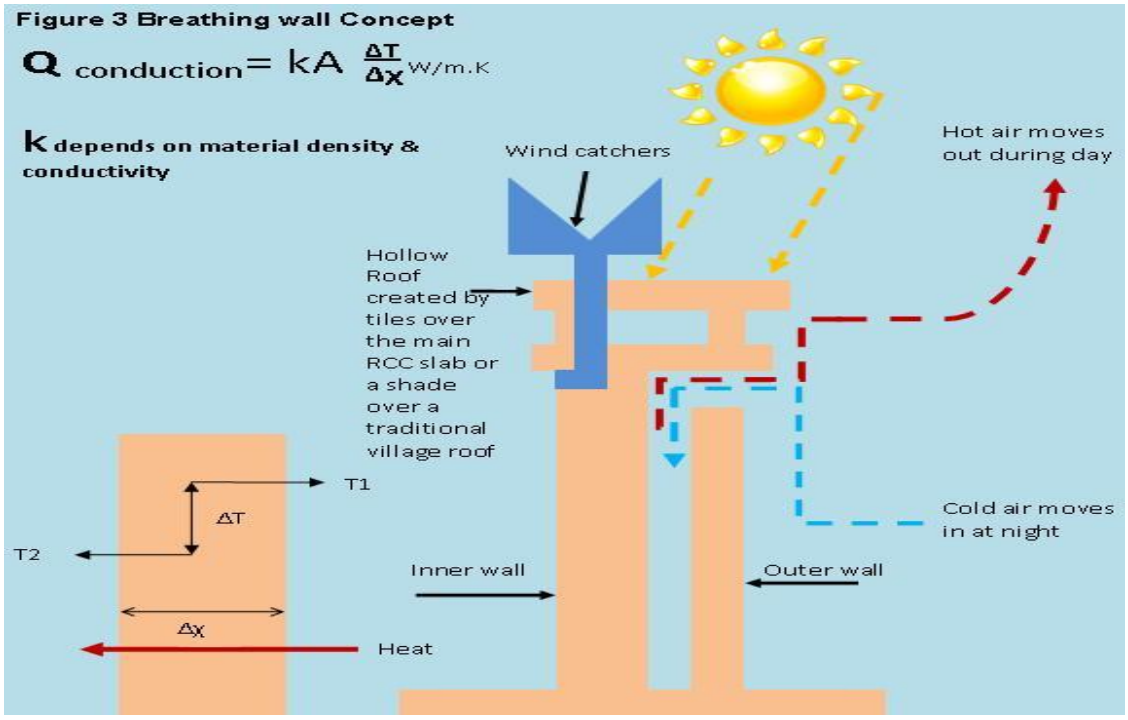
ers can be integrated in the structure by using sunburnt bricks and they work on the reverse phenomenon of fire place exhaust/chimney. This can be seen in the sketch 1 below

Figure 1 Breathing wall Concept



4 Analysis of Breathing Wall practices

Figure 3 Breathing wall Concept



It can be seen from Table-1 that brick's conductivity is 0.72, oak is still better with 0.17, glass is even better with 0.043 but the best material to create a cavity that resists thermal conductivity is the air with just 0.026. Further, urethane rigid foam is equal in thermal conductivity with air; however, producing foam and using it is still expensive for the poor as it is an industrial product. Also, it will have embodied energy and transportation cost involved apart from the addition of polluting the environment.

Table: 1 Thermal Conductivities of Some Materials at Room Temperature

Material	Thermal Conductivity	Material	Thermal Conductivity	Material	Thermal Conductivity
Air	0.026	Silver	429	Copper	401
Urethane Rigid foam*	0.026	Aluminium	237	Iron	80.2
Mercury	8.4	Glass	1.4	Brick	0.72
Water	0.613	Human Skin	0.37	Wood (Oak)	0.17
Helium	0.152	Soft rubber	0.13	Glass fibre	0.043

Source: (Ç engel, Boles 2007)
*embodied energy, cost of material and transportation

Table 2 gives the emissivity value of the materials. It can be seen that choice of colours can also play a vital role in reducing the temperature of the walls exposed to the direct sunlight. Red brick can be improved to have a lighter colour that may absorb lesser thermal energy. Similarly, in concrete walls admixtures can be used to reduce concrete density and further reduce the coefficient of thermal conductivity. It is a matter of choice with respect to location and climatic conditions that engineers and architects may design to get best possible response from the materials and the colour combinations.

Table: 2 Emissivity of Some Materials at 300° K

Material	Emissivity	Material	Emissivity	Material	Emissivity
Aluminium foil	0.07	Black paint	0.98	wood	0.82-0.92
Anodised Aluminium	0.82	White paint	0.90	Soil	0.93-0.96
Polished copper	0.03	White paper	0.92-0.97	Water	0.96
Polished gold	0.03	Asphalt pavement	0.85-0.93	Vegetation	0.92-0.96
Polished silver	0.02	Red Brick	0.93-0.96		
Polished stainless steel	0.17	Human skin	0.95		

Source: (Ç engel, Boles 2007)

Figure 3. Affects of floods and earthquakes in Pakistan

Figure-3 shows that the load bearing walls collapse resulting in the collapse of roof. When the roof collapses then the occupants get trapped and killed. If the pillars are made in RCC and the roof rests on beams then the chances of collapse of wall reduces considerably.

Results and Design Features (Recommendations)

Air foil produces about 28 times more resistance to thermal conductivity as compared to a brick thereby producing better thermal protection. In the structures that were built on this concept by leaving cavities to air, a temperature difference of 10-15°C has been noted. This may not be a concluding result because it will depend on many other meteorological factors e.g. wind speed, moisture content in the structure, humidity and rain fall. However, engineers and architects may try other variations as well and choose the one best suited for that particular environment. Pillars and Roof shall be designed in RCC for strength against collapsing.

Suggested Brick Size (3”X3”X12”) for ease in construction as it will help in interlocking with the outer wall as it is just 3” thick. Such a brick will provide stability.

Brick Laying shall be done in Clay Mortar as the load is already taken be the RCC.

Internal and outer wall can be plastered in cement mortar for protection against rains.

Areas of Hotter Climate

- Should keep the vents open for allowing hot air to escape during day.
- Wind Catchers can be incorporated for room ventilation
- Buildings shall be in lighter colours
- Roof Cover can be of bamboo or other lighter material to avoid direct sun rays on the main roof.

Areas of Cold Climate

- Preferably the Cavity Walls should be air tight to improve thermal conductivity during day and containing the thermal energy inside the house.
- Rice Husk can be used in Cavity Walls as they have better thermal energy storage capacity
- Outer walls may be painted with dark colours for absorbing solar energy.
- Prefabricated Roof Tiles may be used for protection against rains and snow loads.

5 Community Housing and Application in High Rise Buildings

In community housing the same method can be used by making multi-storey houses. The framework can be made in reinforced cement concrete and the walls may be filled in by using cavity method. For maintaining strength from the exposed faces vulnerable to weathering and to maintain the thermal comfort or reducing the air conditioning requirement, outer walls may be plastered in cement mortar. Clay-lime mortar may be used for brick laying for the inner walls and may be plastered with cement mortar for finer finish. Lime mortar can also be used for inner plaster.

For high rise buildings in developed countries it is important to use lighter and stronger material for walls. Construction industry now produces many admixtures that can give lightweight concrete. Prefabricated thin RCC cavity walls can be used in high rise buildings. Cavities shall be used for services like water and electricity supply.

In cold weather locations thermal energy can be stored in high rise buildings by filling the cavities. The filler material should have capacity to retain temperature, this can be achieved if cavities are filled with rice husk, hay or hemp packed in small bags for easy handling. It is important to note that hemp, hay or rice husks are better off in natural packing as compared to pressed mechanically; as it may increase thermal conductivity with the increase in density. Locations that have comparatively hotter climate shall leave the cavities empty for air. It is important to note that air has the least thermal conductivity that further decreases with increase in temperature. The temperature rise in air increases the volume and forces the air out of the wall resulting in reduced density and decreased ability of thermal conductivity. This leaves the inner walls comparatively cooler because expansion is also a cooling process.

6 MIPALCON- The Way Forward-Policy Making and Implementation

The recent disasters in Asia resulting in thousands of deaths due to poor housing designs (mostly not designed by qualified civil engineers and architects) demands that civil engineers, infrastructure planners and policy makers shall become responsible for ensuring sufficient strength and quality of housing and therefore a need was felt to share my experience with others in this field.

Almost all the developing countries have one common factor; and that is illiterate and corrupt leadership. Efficient housing policies cannot be developed by politically motivated illiterate and inefficient bureaucrats. Implementing any policy by them at grass root level is a far cry. When a calamity strikes, international donor agencies rush to help people in the affected areas. By then, damage to life has been done.

Whenever the funds are allocated from any national or international source, they never reach the deserving. The international community keeps spending without the fruits being delivered to the poor. It is especially true in the case of international aid for the poor. I strongly suggest in the interest of the donors and the needy; that the aid shall be associated with certain conditions of design and deliverance. The donor agencies shall appoint their representatives to deliver rather than asking the governments to ensure deliverance. Conferences like MIPALCON 2010 can help us stan-

dardise the designs for community housing and all aspects of a housing colony including and not restricting to waste management, clean water supply, health centres, primary and secondary schools and employment. It is important that the aid-package shall impart training for the human resource to produce skilled labour that can be used for reconstruction of the housing through training centres. The same sufferers can be used as labour for reconstruction and can be paid. This will help them earn a living through labour and will maintain their interest in building the community. Establishing a cottage industry can also be part of the reconstruction plan that can help the poor to live a respectable life. Associating local academic institutions and their research and development to create sustainability should be a vision that MIPALCON shall always have. This will help us to globally contribute to environmental improvement and reduction in the production of carbon dioxide to the atmosphere and poverty. Most of the scientist and researchers are of the opinion that future energy demand will double in the developing countries as compared to the developed countries (Rotty 1979). This approach will help reduce future carbon footprint in developing countries.

7 Conclusion

Engineering and precisely civil engineering is to strike a fine balance between strength, aesthetics, cost; and aspect of sustainable environment. It can be seen that switching to breathing wall concept can help us reduce the cost of the house and also add to the improvement of the environment together with reducing our energy demand in the developing and the developed world if it can be adopted as a standard practice for providing community houses to the needy. Planet earth has transformed into global village as a result of scientific advancements even then we have failed to provide a respectable and safe shelter to the poor who toil sweat to produce that grain of wheat. I will conclude with the quote by Marion Hubbert King '*our ignorance is not so vast as our failure to use what we know'* (Hubbert 1956). I wish this design and the suggested concept that can also be used for multi-storey buildings be accepted as a standard practice with the developed and the developing countries. This alone will reduce the carbon footprint to a considerable extent. In most of the analyses carried out for construction industry, the embodied energy is seldom taken into account for calculating carbon dioxide. Breathing walls concept has emerged as a logical development from the experience of construction; the suggested method for multi-storey buildings is recommended to the architects and the engineers. Any addition or variation is possible depending on the affordability, ingenuity and aestheticism of the designer/user.

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Energy Efficient Homes in Pakistan: Challenges and Potential for Energy Efficient Sustainable Developments

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Abstract: This research paper aims to analyse energy efficiency provisions for low carbon dwellings within the current legal and regulatory framework and identifies the challenges to such developments. The outcomes of this study are recommendations for the necessary policy responses to better enable Energy Efficient Homes in Pakistan.

Pakistan is facing the challenges of acute energy shortages. The local energy resources are minimal, and the country is heavily dependent on the import of fossil fuels to meet domestic needs and support economic growth. However the increasing divide between the demand and supply of energy has decelerated the pace of economic development and industrialisation of the country. The domestic sector is responsible for twenty percent (20%) of the total energy consumption. This level of energy consumption is due to the low levels of passive energy supply, utilisation of poor building materials, urban design challenges and energy intensive sources for thermal comfort which are allowed within the current legal and regulatory framework. The main instruments to achieve energy efficient and low carbon dwellings are facing

challenges such as weak and poorly defined legal and regulatory frameworks, institutional and individual delivery capacity issues and poor enforcement mechanisms from the development agencies. There is need to adopt a holistic approach to improve the prevailing legal and regulatory framework, the capacity and enforcement mechanisms, on the energy efficiency and environmental performance. This will lead to lower energy consumption within the housing sector in Pakistan and an improved energy efficiency awareness and culture in the modern development initiatives.

Key Words: Efficiency, Passive design, Legal and Regulatory, Capacity, Sustainable Homes

1 Introduction

"A low energy path is the best way towards a sustainable future" (WCED, 1987). This path reflects a paradigm shift from traditional to energy efficient developments whilst ensuring a balanced interaction among environmental, social and economic concerns (Bell and Morse, 2003). The concept of sustainable development has gained momentum and significant recognition in order to avoid expected threats of climate change and fuel poverty across the globe. But there is still a long way in front of the policy makers, planners, environmentalists and even the general public to achieve the requisite targets of sustainable developments to improve the quality of life for current and future generations (Khator and Fairchild, 2006). Currently, the world is confronted with the challenges of higher energy consumption, CO_2 emissions and unsustainable development in the housing sector. The intentions of nations around the globe are quite evident from their policies, legal and regulatory frameworks, research and development initiatives and international commitments to engage into efforts to conserve energy. A number of initiatives, policies and plans have been globally discussed and adopted not only to conserve energy but also to safe guard the environment from the severe impacts of climate change. The focus of sustainable economic development is to utilise nation's limited resources in a sustainable, energy efficient and environment friendly way.

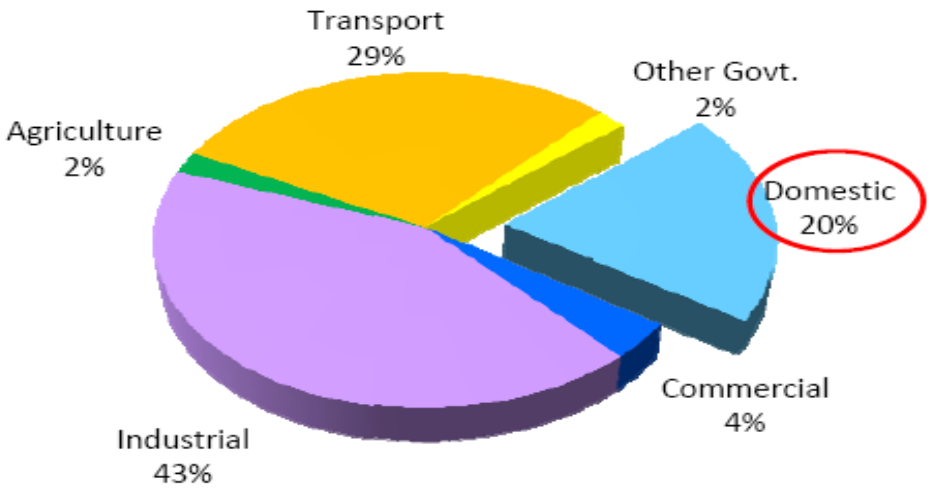
Pakistan is facing the challenges of acute energy shortages (Raja et al., 1996). The local energy resources are insufficient for its needs and the country is heavily dependent on the import of fossil fuels. The intermittent electricity supply and unplanned load shedding are becoming a culture in Pakistan whilst domestic activities and economic growth demands excessive and continuous supply of energy. The total installed power generation capacity in Pakistan is 19560 MW (CCP, 2010). The Water and Power Development Authority (WAPDA), Pakistan Atomic Energy Commission (PAEC) and Karachi Electric Supply Corporation (KESC) are the responsible agencies for power generation, transmission and distribution. About 31 % of the installed capacity is generated by Independent Power Producers (IPPs) (CCP, 2010).

Continuous and adequate energy supply is the traditional pre-requisite to ensure sustainable economic growth in the country. Currently, only 65-70% of the total population has access to electricity and the country is facing serious power shortages up to 6000 MW (CCP, 2010). The big gap between the demand and supply of energy has decelerated the pace of economic development and industrialisation in the country.

To ensure sustainable economic growth and better quality of life, there is a need to exploit not only innovative, environmentally friendly, sustainable and renewable sources of power production (Raja et al., 1996) but also develop an energy efficient culture of energy consumption in all sectors.

The domestic sector in Pakistan is responsible for a substantial portion of total energy consumption. Figure 1 shows that the domestic sector utilises 20% of total energy as compared to Transport 29%, Industrial 43%, Agriculture 2%, Commercial 4% and other consumption 2% (ADB, 2009).

Figure 1: Energy Consumption by Sector FY 2008



Source: Pakistan Sustainable Energy Efficiency Development Programme (ADB, 2009)

Currently per capita energy consumption in Pakistan i.e. 500 kilowatt hours per year is still very low as compared to the global average per capita consumption (Conca, 2008). But these figures are expected to increase with the increase in the country's economic growth. Given the current energy supply crisis, increases to domestic energy use must be counteracted by improvements in the building energy use regulation and enforcement. The absence of passive energy means, utilisation of poor building materials, urban design challenges and energy intensive sources for thermal comfort which are allowed within the current legal and regulatory framework challenge the sustainable development initiatives in the country. The concept of energy efficient homes and energy conservation is at the early stage of its development despite the fact that the traditional buildings constructed centuries ago are more energy efficient than today's modern developments in the cities of Pakistan (Qureshi, 2008).

This study aims to analyse energy efficiency provisions for low carbon dwellings within the current legal and regulatory framework that further leads to the identification of the challenges to such developments. The outcomes of this study are policy recommendations for Energy Efficient Homes (EEH) in Pakistan.

2 Building Practices in Pakistan

The built environment is responsible for huge energy consumption and CO_2 emissions where buildings are the major part and have a substantial share in the total energy consumption in Pakistan and across the globe. According to the International Energy Agency (2005), *"30-40 per cent of the worldwide energy is being used in buildings. Up to 90 per cent of the energy is utilised during the operational stage of buildings, for the purposes of heating, cooling, and lighting"* (Soharwardi, 2009). In Pakistan attention is not being paid to a sustainable design for energy efficiency and environmental performance of buildings. The main drivers for a building design include layout, aesthetics, capital cost, novelty and market resale value, whereas energy efficiency, conservation, environmental performance and higher operational costs are totally ignored at the planning, design, construction and operational life of the buildings (Mathur, 2007). Modern building design in Pakistan lacks energy efficiency measures although traditional architecture utilises solar passive means, thermal mass, shared shading, central courtyard and even street patterns to achieve thermal comfort levels both in the winter and summer (Alamgir, 2008). Sustainability features such as location, function, layout, materials, daylighting, waste, water consumption, energy efficient appliances, energy resources, adaptability and compatibility with the surrounding environment play a significant role towards energy conservation and carbon reductions during the whole life cycle of the buildings (Younger et al., 2008). Some of these considerations may cost more initially, but offer long-term savings (Younger et al., 2008) and better quality of life for current and future generations.

Legal and regulatory frameworks and city planning practices with effective energy efficient considerations in the housing not only facilitates energy conservation but also sustainable urban development in the broader context. However, energy efficiency and conservation concepts are not well adopted in Pakistan's real estate market despite "strong relationship between energy and planning components such as land-use, buildings, built form, transportation, urban form, and infrastructure systems"(Duvarci and Kutluca, 2008).

3 Energy Efficiency Potential In The Housing Sector

Pakistan is facing energy shortages due to poor planning of the energy sector, low production and inefficient consumption. The intermittent, unreliable and poor quality of energy supply culture in the country is influencing economic growth of the country and hindering foreign direct investment. Moreover, higher cost of energy production through conventional methods with the technologies utilised by IPPs are responsible for considerable investment in the energy sector. Such investments in technologies utilising expensive imported fossil fuels e.g. oil have ensured the deceleration of economic development. In this context, energy conservation in the domestic sector is one of the options to reduce overall current and future energy deficits. The adoption of energy efficiency and conservation measures can make available substantial capital resources for social and economic development of the society along with environmental benefits (US Congress, 2008).

The residential sector comprises 24 million households in Pakistan (ADB, 2009) with a 30% overall energy efficiency potential in the housing sector (ENERCON, 2008 http://www.enercon.gov.pk/). The energy consumption distribution in the residential sector is on average 59% natural gas, 34%, electricity, 2% Oil and 5% LPG. This distribution is dominated by two main sources of energy consumption i.e. electricity and natural gas. Electricity is mainly used to run home appliances such as lighting, fans, motors, refrigerators and air conditioners whereas natural gas is being use for space and water heating and cooking. Electricity consumption in domestic sector is 33,704 GWh/year (ADB, 2009) and power consumption for 9.8 million electric home appliances is 3530 MW (ENERCON, 2008 http://www.enercon.gov.pk/). Energy efficient appliances offset their initial relatively higher cost during their operational life. According to the Pakistan Energy Yearbook 2008, there is at least 10% potential to save energy by introducing energy efficient appliances (ADB, 2009 and ENERCON, 2008). Moreover, significant amounts of energy can be conserved by replacing Incandescent light Bulbs (IBs 37% of the total residential points i.e. 117.4 million) with Compact Fluorescent Lamps (CFLs) (ADB, 2009).

The energy efficiency potential in cooking, water and space heating appliances with gas is 40%, 30% and 36 % respectively (ADB, 2009). This can be achieved by replacement of older systems, retrofitting/upgrading newer appliances and encouraging more efficient appliance use, especially in new residential developments (Byambasaikhan et al. 2009). All gas based appliances in the residential sector are expected to contribute substantially to energy security and economical energy supplies for future sustainable developments.

Energy savings can be achieved by improving building materials, wall insulation, double or triple glazed windows, orientation (new developments), water consumption, waste management and proper roof insulation in existing buildings and new developments. According to the ADB report on Sustainable Energy Efficiency Development Programme of Pakistan, roof insulation can reduce up to 20% of electricity demand for thermal comfort in summer (ADB, 2009).

New developments are expected to play a significant role not only to provide shelter but also substantial energy efficiency and conservation in the housing sector. The estimated housing demand in 2008 was 570,000 units, with the annual supply of 300,000 units and a shortfall of 270,000 units per year (NHP, 2001). With the introduction of energy efficiency measures, these 300,000 new housing units also have the potential to save 297000 MWh/year.

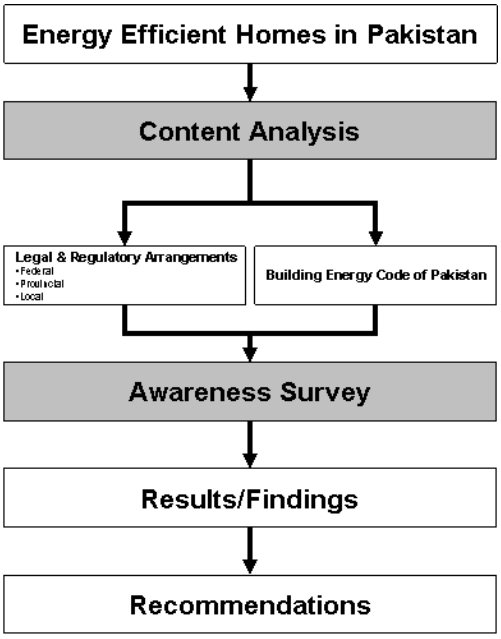
4 Methodology

The research method adopted in this research study is that of descriptive evaluation, which involves both theoretical and practical considerations to strengthen analysis and research outcomes. It provides input from three components (i.e. legal and regulatory arrangements, Building Energy Code of Pakistan and the institutional response i.e. awareness survey) and comprises two phases (see Fig.-2). The first phase involves the content analysis of legal, regulatory and policy arrangements for energy efficiency, environmental performance in the housing sector at Federal, Provincial and Local levels and Building Energy Code of Pakistan. The results from the content

analysis are expected to identify gaps, dissemination of federal policies into provincial plans and local legislations and challenges to the Building Energy Code of Pakistan.

The second phase of the research method is based on institutional response through a simple dichotomous survey to identify level of awareness of the Building Energy Code of Pakistan and its application in the real estate market. The method of enquiry is based on an enumeration survey that followed a structured format and closed ended question from three different organizations involved in policy planning, capacity building and professional growth, development and management activities in the housing sector. The survey of the professional urban planners at the Urban Unit, City and Regional Planning Department, UET Lahore and Lahore Development Authority is to provide awareness level and dissemination of the Building Energy Code of Pakistan from Federal to Local level.

Figure 2: Research Methodology



The final phase of the research method analyses the results from the content analysis and awareness survey, which leads to the research findings. The outcomes of this study are a set of policy recommendations for an energy efficient culture in the housing sector in Pakistan.

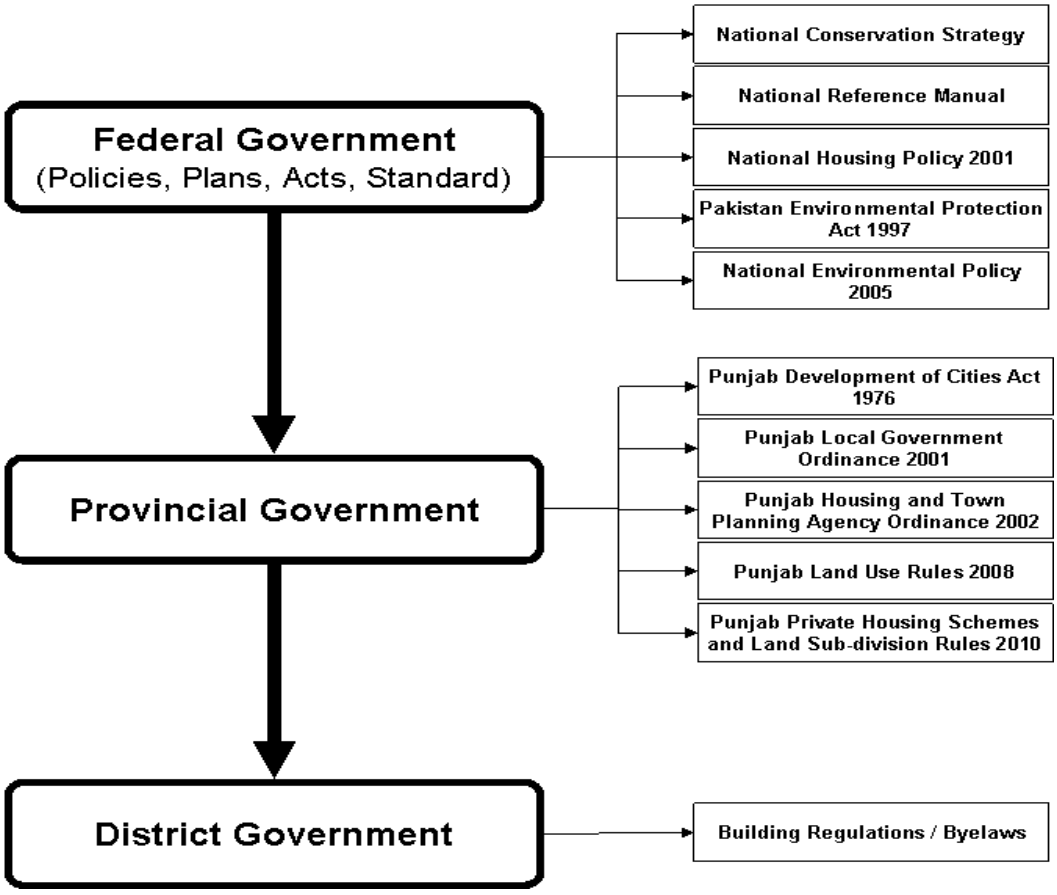
4.1 Energy Efficiency Legal and Regulatory Framework in Pakistan

The legal and regulatory framework for energy efficient homes, like other developing nations, is in transition in Pakistan. To achieve the objective of energy conservation in the housing sector, environmental protection, integrated land use planning, development and management nation-wide broad principles, policies and laws have been established at the Federal level in Pakistan through Acts, Ordinances, national policy, planning manuals and codes. The Federal policies and acts set a broad framework for devising provincial level policies and regional development plans. Provincial level

polices and plans are legally “binding” for large, medium, small towns and villages for planning, development, management and decisions making. Consequently, whenever District Governments wish to prepare or modify any of its land use or development plan, they are legally bound to follow the provisions of provincial policies and plans at the provincial and local level.

It is obvious that the main instrument and the driving force for energy efficiency, conservation and improvements in the housing sector will be legislation and enforcement (Clarke, et al., 2008).

Figure 3: Legal and Regulatory Framework in Pakistan



Source: (Syeda and Akbar, 2007 The Urban Unit, P&D Punjab)

4.2 Legal and Regulatory Arrangement

The Pakistani government is struggling to introduce energy efficient homes due to fragmentary legislative provisions. Although the Building Energy Code of Pakistan was initially launched in 1990, it could not achieve expected energy efficiency targets in the housing sector. A brief analysis of legal and regulatory provisions with a focus on energy efficiency, environmental performance, energy conservation measures, quality of life and overall sustainable development in the housing sector at Federal, Provincial (Punjab) and Local levels has been described in Annex-1.The evaluation of the legal, regulatory and policy arrangements at the Federal level including the National Conservation Strategy, National Reference Manual, Environmental Protection Act 1997, National Housing Policy 2001 and the National Environmental Policy,

cover a wide range of environmental concerns such as industrial pollution, transport pollution, hazardous substances and sustainable development but no specific measures are adopted for energy efficient and environment friendly sustainable developments in the housing sector. Similarly, at the provincial level the legislative provisions focus on devolution plan, environmental control, urban design, passive means of energy, indoor environment, ecological balance, beautification of administrative areas, implementation of rules and bye-laws, provision of shelter and cost effectiveness issues rather energy efficiency and conservation. Moreover, the Federal and Provincial legal provisions provide an opportunity under different sections to make rules and Bye-laws to carry out the purposes of the concerned law. Unfortunately subordinate legislations have not been framed to provide an enabling environment for energy efficient homes.

4.3 Building Energy Code of Pakistan

The Building Energy Code of Pakistan 1990 was initially prepared by National Energy Conservation Centre (ENERCON), Planning and Development Division and Ministry of Housing and Works Environment and Urban Affairs Division. The Code aimed to provide energy efficient design and construction of buildings for optimum thermal comfort levels and lower domestic energy consumption. Initially the Code was considered as the postscript of Building Code of Pakistan with minimum performance standards for building walls, roofs, windows and openings, heat, ventilation and air conditioning (HVAC) equipment and lighting. These HVAC arrangements were based on American Society of Heating Refrigerating and Air-Conditioning Engineers (ASHRAE) standards. The code was non mandatory at that time but was expected to be the part of mandatory requirements with the dissemination from federal to local levels, gradual improvement in the federal, provincial and local legislations, continuous capacity building and research and development activities. However after 20 years, including research and development by ENERCON, Pakistan is still far from achieving optimum energy efficiency and environmental performance of the buildings. Currently, ENERCON is updating the Code according to the contemporary building requirements. A draft document, based on the previous Code, has already been prepared in 2009. The Code has divided the whole country in five different climatic zones. The Code facilitates "*new buildings and portions of existing buildings, new systems and equipments and change in use of buildings*" (BECP, 1990). The factors covered in the code for energy efficient homes mainly include*, "building envelopes, building mechanical systems and equipment, including heating, ventilating, and air conditioning (HVAC), service water heating, lighting and electrical power and motors"* (BECP, 1990).

The Code provides a basis to sustainable building standards in Pakistan. It was introduced as a non statutory standard in 1990 (still having non mandatory status) and could not disseminate to local levels due to legal, institutional, political, financial, awareness, delivery capacity and coordination barriers between federal and local levels. The Code is the first step to ensure energy efficiency, thermal comfort with minimum energy consumption, carbon reductions and sustainability of new and existing buildings.

5 Energy Efficiency Awareness Survey

The energy efficiency awareness survey conducted in 2010 evaluated the level of awareness and dissemination of Pakistan Building Energy Code from the Federal to Local level during the last 20 years. The survey was simply based on a dichotomous question, whereas Yes/No question was used to distinguish professional town planners familiar with the Pakistan Building Energy Code for energy efficiency, conservation and improved environmental performance of the buildings. The fieldwork for the survey was performed by the professional town planners (co-authors) in the three organisations.

Three organisations namely The Urban Unit, P&D Department (Provincial); City & Regional Planning Department, UET Lahore (Academia); and Lahore Development Authority (local development agency) were selected for the survey. The selection of these three different organisations is based on their functions and unique role in planning, development and management measures at different levels within existing legal framework.

The survey aimed to determine the existing level of awareness among the town planning professionals involved in policy planning and establishment of legal and regulatory arrangements at provincial level (The Urban Unit); academia involved in education and training of the professional qualified town planning graduates (City and Regional Planning Department) and Professional town planners involved in the implementation and enforcement of the Building Regulations and all development activities (Lahore Development Authority). All professional Town planners across three organizations were contacted to evaluate the level of awareness about the Pakistan Building Energy Code.

Table 1: Energy Efficiency Awareness Survey

ENERGY EFFICIENCY AWARENESS SURVEY						
SR.NO	**ORGANISATION**	**LEVEL**	**PROFESSIIONAL PLANNERS**	**ANSWERED**	**YES**	**NO**
1	Lahore Development Authority	Local	33	22	3	19
2	CRP Department, UET Lahore	Provincial	13	10	3	7
3	The Urban Unit, P&D Punjab	Provincial	5	5	3	2

The results from the energy efficiency awareness survey clearly depict very low level of awareness about the existing non statutory Building Energy Code of Pakistan. This indicates poor networking between federal, provincial and local academic, planning and development agencies, lack of trained professionals, individual and institutional capacity building. The lack of professional awareness impedes public awareness about Energy Efficiency standards, renewable technologies, orientation consideration, building materials, international best practices, water consumption and energy conservation at large. The low level of dissemination of energy efficiency measures during the last two decades is the real dilemma for future sustainable new developments and refurbishments in Pakistan.

6 Analysis

Energy efficiency and conservation measures in the domestic sector have great potential not only to reduce energy deficit, financial benefits to the general public and better quality of life but also considerable capital resources for other economic development activities. The energy efficiency potential in the domestic sector (i.e. 30%) can be achieved by the introduction of sustainable designs, materials, insulations, efficient electrical appliances, gas heaters and cookers. For instance there is 10% i.e. 353 MW potential to save energy from electric home appliances whereas total production from PAEC is 462 MW. Moreover, substantial saving in electricity consumptions can be achieved by introducing CFLs instead of IBs and 30 to 40% savings can be achieved in cooking, water and space heating appliances with gas (ADB, 2009).

The review of legal and regulatory provisions at Federal, Provincial (Punjab) and Local level for energy efficiency, housing, urban planning and development reveals a poor and deficient policy framework for energy efficiency and energy conservation in the housing sector in Pakistan. It does not provide the enabling environment to support and disseminate energy efficiency measures in the building practices. The existing laws do provide broad statements about energy efficiency, conservation, GHG reductions, environmental impacts and overall better quality of life, but broad provisions under different Sections have not been trickled down to subordinate legislation and standards for real applications, dissemination and enforcement. The current situation depicts a lack of enabling laws and regulations at local levels to support and integrate energy efficiency initiatives in the current building practices in different parts of Pakistan. This deficiency is also being reflected from the non existence of international best practices such as Leadership in Environmental and Energy Design (LEED), Building Research Establishment Environmental Assessment Method (BREEAM) and Deutsche Gesellschaft fur Nachhaltiges Bauen (DNGB) rated developments; inadequate energy efficiency standards under the current legal umbrella; lack of energy efficient labelled appliances and goods for thermal comfort, energy conservation and other domestic operational activities along with substantial reduction in the carbon emissions.

Laws and legal provisions have always been an effective instrument to strengthen and provide strong foundation to institutional structures to enforce and achieve short and long term development targets. Due to poorly defined legal and regulatory frameworks in Pakistan, the institutional arrangement to strengthen energy efficiency initiatives is also facing challenges. One of the major challenges is the lack of substantial financing in this sector whilst a wide range of energy efficient building materials, sustainable technologies and equipment has already been integrated in the construction industry in developed and developing countries. Currently, penetration of energy efficiency, energy conservation measures and sustainable technologies are almost negligible in the domestic sector in Pakistan. Financial institution, established financial companies, government development agencies, real estate developers are reluctant to invest in this sector and exploit the social, economic and environmental potentials of energy efficient homes in Pakistan.

The relatively high energy consumption in the housing sector seems a potential for energy efficient refurbishment and new developments. Current culture of higher en-

ergy consumption, lack of motivation, resistance to adopt contemporary tested energy conservation measures and sustainable technologies are upfront challenges. Four major players namely government (federal, provincial and local), private sector (investors, real estate developers etc.), civil society (NGOs, CBOs etc.) and general public (Individual household) need to play active role from policy framework at federal level to on ground development at the individual dwelling unit. The government influential and pro-active role towards energy efficient developments in terms of comprehensive energy efficiency policy framework, legal and regulatory arrangements, benchmarking for short term and long term targets, performance based financial allocations, subsidies and coordination among policy institutions and development agencies, is inevitable to enhance motivation and energy efficiency culture in Pakistan. Private sector including national and international financial institutions, real estate developers and business communities are merely paying attention to integrate energy efficiency measures and renewable sources of energy in the housing sector. New developments are simply swallowing green fields in the name of high tech infrastructure provisions for economic benefits with little attention to social needs and virtually no attention to energy efficiency, conservation and environmental concerns at overall development and individual dwelling unit levels. The private sector needs to play a model role for the energy efficiency initiatives in the housing sector in Pakistan with the introduction of innovative design solutions, materials, ecological and management measures and contemporary sustainable technologies. This will lead to sustainable development with more economic benefits and market acceptability due to consumer and environmental considerations. Civil society organisation including Non-governmental Organisations (NGOs) and Community-based Organisations are expected to play a significant role in terms of capacity building, localise standards, model sustainable developments and mass awareness of energy efficiency, conservation and environmental issues in the housing sector. The common people need to adopt such initiatives not only for their own social, economic and environmental benefits but also for future generations. The private sector needs to stimulate indigenous industries developing the necessary low cost materials to enable a low carbon building to be constructed. Moreover, the role of academia must be realised and strengthened for professional and general capacity building at large.

The Pakistan Building Energy Code covers minimum energy efficiency, energy conservation and other features of sustainable developments for existing and new buildings in Pakistan. The Code is facing technical, legal and regulatory, economic, social and cultural and capacity issues in the delivery of Energy Efficient Homes in Pakistan. These challenges include;

- Non-statutory and voluntary status of Code not only causing poor usability but also poor dissemination of energy efficiency measures at lower tier legislations.
- Insufficient incorporation of energy efficiency measures in Building Regulations and Bye-Laws as envisaged in the Code according to five different climatic zones of Pakistan.
- The code covers new buildings and refurbishments (all building types are being covered). No specific energy efficiency measures have been incorporated for different land uses such as residential, offices, shops, schools, hotels, government buildings etc.

- No minimum acceptable level for energy efficient homes based on energy efficiency and sustainability features in any particular building, although there are specific standard requirements for individual components of the building such as roof, windows and HVAC etc.
- No standard parameters have been incorporated to assess and evaluate energy efficiency and environmental performance during design, construction and operation period of building life.
- No specific standards have been elaborated for efficient building materials, equipments and appliances.
- The Code does not talk about other sustainability factors such as water consumption, surface water runoff, location, appliances, cooking system, heating system, waste management, daylighting, ecological impact etc.
- Proper attention has not been paid to the ecological factors and enhancement of the site before and after the construction.
- Lack of established institutions at provincial levels to translate federal policies to provincial and local plans. More over poor coordination and culture of isolation in federal, provincial and local bodies is also a dilemma for such initiatives in Pakistan
- Exemptions such as buildings without electricity or fossil fuel utilisation, minimum use of electricity and gas and equipment and portions of building systems that use energy primarily for manufacturing industry and processes, warehouses, storage and agriculture need to be rectified.
- Lack of awareness among the professionals and general public which lead to poor or no interest toward energy efficient homes.
- No consideration to integrate gradually sustainable renewable technologies in the housing sector
- Lack of individual and institutional capacity and implementation framework and feedback
- Poor consideration towards international best practice sustainable development initiatives.

The Pakistan Building Energy Code is just the first step towards sustainability and energy efficient sustainable homes in Pakistan. The real challenge is the awareness, market acceptability, appreciation and full adoption of these measures. Moreover, gradual contemporary improvements, preparation of technical guides and manuals, practical sheets, educational curriculum, training manuals, professional certifications and adoption of international best practices are demanding fronts for mainstreaming energy efficiency in the housing sector in Pakistan.

7 Key Findings

The descriptive analysis of legal and regulatory framework, Building Energy Code of Pakistan and results from the awareness survey reveals that;

- Domestic sector has significant energy efficiency potential that needs to be exploited not only for social, economic and environmental benefits but also better quality of life at large.
- Lack of enabling environment at the Federal, Provincial and Local levels has resulted in a fragmented and voluntary energy efficiency, legal, regulatory and policy framework
- Lack of awareness about energy efficiency, conservation and environmental performance measures among the professionals in particular the academia and professional government agencies.
- Lack of institutional arrangements and poor coordination among existing Federal, Provincial and Local government departments and agencies.
- Individual and Institutional capacity constraints to enforce energy efficiency provisions under the existing legal framework.
- Limited Research and Development initiatives by professional bodies, research institutions, government agencies and international organizations.
- Limited professional and technical expertise across Pakistan to evaluate energy consumption and performance of buildings, equipments and appliances.
- Lack of substantial financing in the domestic energy sector due to weak legal and policy framework, market acceptability, confidence and adoption issues.
- Poor market acceptability due lower per capita income and higher capital cost of energy efficient products, materials, equipments and appliances. This shows limited awareness about low operational cost, economic and environmental benefits over the life time of these.
- Low level of awareness regarding international best practices on energy efficiency.
- No concept of subsidies and incentives for energy efficiency in the housing sector to achieve social, economic and environmental benefits in the broader context.

8 Conclusions and Recommendations

The analysis of legal and regulatory provisions for energy efficient homes reveals fragmentary and weak legislative arrangements in Pakistan. Major Challenges in disintegrating energy efficiency parameters in the housing sector include poor dissemination of federal government initiatives into provincial plans and subordinate legislation at local level; poor institutional arrangement and delivery capacity; lack of awareness, negligible public interest and lack of financing due to weak legal framework. Moreover, Building Energy Code of Pakistan is facing technical, legal and regulatory, economic, and delivery capacity issues. A low level of professional and public awareness about energy efficiency and environmental performance of the buildings is also a barrier for future energy efficient and sustainable developments in Pakistan. The aim of Energy Efficient Homes in Pakistan is to conserve energy, achieve substantial carbon reduction in the housing sector along with reduction in overall energy deficit. The following set of recommendations provides a systematic road map to better enable energy efficient culture in Pakistan.

Recommendation 1

Development and adoption of overarching legal, regulatory and policy framework for Energy Efficient Homes in Pakistan. The Government intends to enact the Pakistan Energy Efficiency and Conservation Bill, which will provide a legal framework and a regulator role to National Energy Conservation Centre (ENERCON) to coordinate and implement national energy conservation and energy efficiency initiatives and policies. This will also provide a legal support to Building Energy Code of Pakistan because under its statutory authority ENERCON will be able to develop such standards and energy efficiency parameters. The integration of these standards and measures with the provincial and subordinate legislations especially Building Regulation and Bye Laws is the pre-requisite of Energy Efficient Homes in Pakistan. There is need to have clear and doable energy conservation and carbon reduction targets with a comprehensive road map. This road map will enable all enforcing authorities to gradually improve Building Regulations and Bye Laws in order to comply with energy efficiency and environmental performance of the buildings.

Recommendation 2

Establishment of a comprehensive Institutional framework with explicit role and responsibilities from federal to local level. This framework will enable provincial government/departments to translate federal policies into provincial plans and legal binding for the local governments to incorporate energy efficiency measures and achieve set targets of energy conservation at household level.

Recommendation 3

Standardisation and labelling schemes for equipment and appliances such as refrigerators, air conditioners, gas heaters, gas stoves, washing machines, driers etc.

Recommendation 4

Continuous research and development, training and capacity building of provincial and local government departments and authorities. The role of educational institutions (academia) and research institutions is strongly recommended for such trainings and research and development activities, case studies and demonstration sites/projects on energy efficient sustainable developments.

Recommendation 5

Review and incorporate other sustainability factors such as water consumption, waste water, waste management, renewable source of energy, local materials, location, ecological consideration etc. in the Building Energy Code of Pakistan.

Recommendation 6

Prepare technical guides, and manuals, training manuals, educational curriculum, softwares and professional certifications for Professional planners, architects, engineers, and other Code Officials

Recommendation 7

Development of a robust database for existing and new buildings for better energy efficiency solution and record.

Recommendation 8

Introduction of subsidies and incentives against substantial improvements in the energy efficiency and environmental performance of the individual building.

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Annex 1

A.1 Federal Level

A.1.1 National Conservation Strategy

The Pakistan National Conservation Strategy (NCS) was adopted in 1992 with the challenges of protection, conservation, rehabilitation and improvement of the environment, prevention and control of pollution and sustainable development. The NCS targeted fourteen core areas along with three operating principles. These principles include "*Public partnership in development and management; integration of environment and economics in decision making and improvements in the quality of life"* (Hanson et al., 2000). The derived implementation mechanism involved seven key stakeholders/partners from government (federal, provincial, district) and the society in order to achieve the objectives of sustainable development. Increasing Energy Efficiency, one of the core areas, targeted energy efficiency in building, retrofits and appliances and identified policies such as development of alternative energy sources and efficient use of energy only. Moreover, practical measures such as use of fuel efficient cookers, introduction of private sector for commercial development of local energy sources and solar water heaters were suggested in the NCS (Sohaib and Athar, 2002). The Strategy covered wide range of areas and sectors instead of more focused and doable road map towards sustainable development. It put great emphasis on NEQS, EIAs, public awareness about environmental issues, Institutional strengthening and protection of natural resources for better quality of life. However it could not focus properly the "*Macro-economic and sectoral economic policies,*" and housing sector in particular (Hanson et al., 2000).

A.1.2 National Reference Manual on Planning and Infrastructure Standards

The National Reference Manual is the only reference document for planning and infrastructure provisions for development activities in Pakistan. The concept of energy efficient homes has not been dealt with in the manual. No specific measures have been suggested to adopt energy efficiency and environmental performance of the buildings. The Physical Planning Process has briefly incorporated environment and orientation considerations to exploit wind and solar energy. General guidelines cover planning and designing of lots in a layout plan at a neighbourhood level according to different climatic zones (cold composite, cool composite, normal composite, warm composite, extra dry cool, extra dry hot, inland maritime and maritime) and climatic effects in different regions of Pakistan. These guidelines comprise plot dimensions, building lines, plot relationship and arrangement for effective and efficient use of passive means (NRM, 1986). The basic design and layout considerations have been incorporated in the Manual but these standards are not legally bindings for the professionals and developers in the housing industry. Even development schemes by the federal and provincial governments and registered developers during the last two decades have not considered these passive considerations as guiding principles to enhance energy efficiency and environmental performance of buildings at individual and neighbourhood level. Moreover, the Manual has not been reviewed and updated

since 1986 to meet the requirements of contemporary energy efficient homes, environmental performance and carbon reductions.

A.1.3 National Housing Policy 2001

The National Housing Policy 2001 highlighted the government's role to exploit resources whilst facilitating and regulating development initiatives to enhance economic activity (Rizvi, 2001). The policy has put great emphasis on "*resource mobilisation, land availability, incentives for home ownership, incentives to developers and constructors and promotion of research and development activities to make construction cost effective"* (Ali et al. 2010 and NHP, 2001). The objective was contributing affordability and cost effectiveness instead of energy efficiency, thermal comfort and environmental performance of buildings. Key considerations of the Housing Policy include revision and improvement of planning and building regulations, codes and standards, building materials, construction technology, capacity building, coordination among different development agencies at federal, provincial and local levels (NHP, 2001).

A.1.4 Pakistan Environmental Protection Act 1997

The Pakistan Environmental Protection Act 1997 was enacted to strengthen Environmental Protection Agency created under 1983 ordinance for the protection, conservation, rehabilitation and improvement of the environment. The Act mainly focused on the implementation of Council's policies (established under section 3 of the act), delegation of powers to government agencies, enforcement of NEQS, introduction of EIA / IEE review procedures, regulatory regime for hazardous wastes, resource generation through establishment of provincial sustainable development fund, pollution charges and providing an appeals process for environmental cases (PEPA, 1997). The environmental concerns in terms of transport pollution, hazardous substances and industry related issues, were covered thoroughly but no specific arrangement had been ensured for energy efficient and environment friendly sustainable developments in the housing sector.

A.1.5 National Environmental Policy 2005

The National Environmental Policy 2005 focused on energy security and to achieve energy efficient, environmentally friendly and sustainable arrangements for the future. The policy aimed "*to protect, conserve and restore environment to improve quality of life through sustainable development"* (NEP, 2005). The policy challenged different strategic issues such as sustainable development, cost effective and energy efficient measures to improve economic productivity and poverty alleviation, reduction in CO_2 and Green House Gas emissions, gender mainstreaming and energy supply to rural areas. The policy provides broad general, sectoral and cross sectoral guidelines to Federal, Provincial and Local District governments to address environmental issues. The policy provides strategic direction under section 3(7) (Energy Efficiency and Renewables) of the sectoral guidelines to adopt energy efficiency and conservation measures leading to sustainable developments. No doubt the policy has covered a wide range of sectoral and cross sectoral areas with a long shopping

list of initiatives and measures. These guidelines describe what is required for short term and long term sustainable development activities but the questions are how to do (road map, system and systematic legal and regulatory arrangement, transformation of federal policies and legislation to provincial and local rules and regulations, integration of renewable technologies) and who will do (individual and institutional capacity, enforcement mechanism with rational bench marking).

A.2 Provincial Level

A.2.1 Punjab Development of Cities Act, 1976

The Punjab Development of Cities Act 1976 was promulgated to improve quality of life in the cities of Punjab through a systematised planning and development. The act emphasised on "*an integrated development approach and a continuing process of planning and development, to ensure optimum utilization of resources, economical and effective utilization of land and to evolve policies and programmes, relating to the improvement of the environment of housing, industrial development, traffic, transportation, health, education, water supply, sewerage, drainage, solid waste disposal and related issues"* (PDCA, 1976).*"* The Punjab development of Cities Act does not highlight energy efficient buildings, domestic energy conservation and environmental performance of the buildings. However, section 7(2) and 2(v) identifies few measures for environmental improvements, development control and beautification of the areas rather energy efficient sustainable developments.

A.2.2 Punjab Local Government Ordinance 2001

The Punjab Local Government Ordinance 2001 was promulgated to "*devolve political power and decentralise administrative and financial authority to accountable local governments for good governance, effective delivery of services and transparent decision making through institutionalised participation of the people at grass-roots level"* (PLGO, 2001). The Ordinance provides a comprehensive legal and administrative arrangement for the devolution plan but energy conservation and energy efficiency in the housing sector has not been specifically entertained. However, Section (40) and 6th Schedule Section (27) describes environmental control, urban design, passive means of energy, indoor environment, ecological balance, beautification of administrative areas and implementation of rules and bye-laws. Moreover, Sections 191 and 192 facilitate the Councils to make rules and Bye-laws to carry out the purposes of the Ordinance. But subordinate legislations have not been framed to provide an enabling environment for energy efficient homes across the whole province.

A.2.3 The Punjab Housing and Town Planning Agency Ordinance, 2002

The Punjab Housing and Town Planning Agency Ordinance 2002 was enacted to establish Punjab Housing and Town-Planning Agency. The main functions of the Agency, as envisaged in the ordinance, are to provide shelter and to establish a comprehensive system of Town Planning at Provincial, District, Tehsil and Union Council levels. The Ordinance describes few functions and powers of the agency to adopt environment friendly measures in the housing sector. The Section 4(2)(i)(ii)(iii)

and (vii) clearly facilitate to *"develop indigenous and cost effective approaches; adopt parameters of the national housing policy; low cost housing; and promotion of environment for friendly and standardised construction activities"*(PHATA, 2002). Moreover, under Section 4 sub-section 2 (xviii)(xix) the agency may provide technical assistance to the District Governments and Tehsil Municipal Administrations and coordination with the federal government for housing and town planning development initiatives (PHATA, 2002). The main focus of the Ordinance is the provision of shelter and cost effectiveness rather energy conservation.

A.2.4 Punjab Land Use Rules 2008

The Punjab Land Use (Classification, Reclassification and Redevelopment) Rules 2008 has been framed under section 191 of the Punjab Local Government Ordinance 2001 and section 44 and 43 of LDA Act 1975 and Punjab Development of Cities Act 1976 respectively. The main objective of the Rules is the classification, reclassification and redevelopment of the land uses in order to ensure sustainable, harmonious and compact development in the cities. The Rules provide comprehensive planning framework for different land uses and development activities in urban, peri-urban and agriculture areas. However, energy efficiency and environmental performance of existing housing stock and future dwellings has not been considered in these Rules (PLUR, 2008).

A.2.5 Punjab Private Housing Schemes and Land Sub-Division Rules 2010

The Punjab Private Housing Schemes and Land Sub-Division Rules 2010 have been notified under the section 191 of the Punjab Local Government Ordinance 2001. These Rules define procedural criteria to sanction housing developments and planning standards for housing schemes and sub-divisions. These planning standards incorporate minimum standards for open spaces or park, graveyard, commercial area, public buildings, maximum size of residential plot, roads, solid waste management, provisions for low income groups, tube well location, site of grid station and green strips. There is nothing about energy efficiency, environmental performance, exploitation of passive means for sunlight and wind by systematic and innovative arrangement of streets and roads (PHS&LSR, 2001).

A.3 Local Level

A.3.1 Building Regulations/Byelaws

The Building Regulations and Byelaws adopted by Development Authorities and Local Governments in Punjab have incorporated environmental issues in the form of environmental impact assessment, considerations for flood plain areas and environmentally sensitive areas. Moreover, internal lighting and ventilation specification (such as external openings and internal wells), fire safety precautions, emergency exits and standard specifications for utility services such as water, drainage, sanitation, solid waste management and electricity have been comprehensively elaborated for individual and common development activities (BR, 2007). The concept of Energy Efficient Homes is missing in the Building Regulations and Byelaws. The limited envi-

ronmental concerns in the Regulations are targeting better quality of life. Different features such as optimum utilisation of passive means, design considerations, materials, integration of contemporary renewable technologies, insulation, double or triple glazed windows, thermal bridging, embodied energy etc. contributing to energy efficiency, environmental performance of the buildings and energy conservation has not been incorporated in these Regulations.

Rural Energy Development Programme – a Bottom up Approach in Rural Energy Development in Nepal

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Abstract: Nepal is one of the richest countries in water resources in the world. Water resource is one of the major natural endowments of Nepal. The country has more than 6000 rivers and rivulets originating from Great Himalayas and Mountains and makes their way southwards through deep gorges. The hydropower potential is estimated at 83,000 MW but only less than 1 percent has been exploited up to now. Only 43 percent of rural people have access to electricity. Central grid connection to electrify the rural area is quite impossible in scattered settlements in the mountainous country like Nepal. The only option to electrify the rural area is decentralize energy development and distribution of mini grid from micro hydro and other renewable energy resources.
The Rural Energy Development Programme (REDP) is a joint programme of UNDP, WB, Government of Nepal and Local Government and has objective to enhance rural livelihoods and preserve the natural environment by supporting the sustainable development of rural energy systems. The programme extending sustainable energy services into the remote and isolated areas of Nepal. Micro hydroelectric power is taken as the entry point for rural development to achieve poverty alleviation and support MDG. This paper deals with different aspects of programme including community mobilization and participation, decentralization, bottom up participatory planning, cost sharing, institutional involvement, impacts, lesson learn, and some highlight on energy situation in Nepal.

Key Words: Rural energy, micro hydro, integrated development, community participation, decentralization, bottom up participatory planning

1 Introduction

Nepal is a landlocked country lies between India to the east, south and west and Tibet China to the north. A total land area of 147,181 sq. km and a boundary perimeter of 2,926 km enclose. The country stretches from east to west with mean length 885Km and widens from north and south with mean breadth of 193 Km, She occupies only 0.03 percent and 0.3 percent of total land area of the world and Asia respectively.

Map 1: Map of Nepal

Ecologically, the country is divided into three zones: the rugged Himalayas to the north, the central hill ranges and the Terai – the flat Gangetic plains of the south. The altitude varies from 70 m to 8848 meters from mean sea level. Climatic conditions vary from cool summers and severe winters in the north, to subtropical summers and mild winters in the south. Nepal boasts of having eight of the world's 10 highest peaks, including the world's highest peak, Mount Everest (8,850 m.), on the northern (CBS 2008).

Total population of the country has reached about 26.9 millions (2008), out of which 86 percent lives in rural area and 14 percent lives in urban area. The population growth rate is 2.25 percent and per capita GDP at current US $ 470.

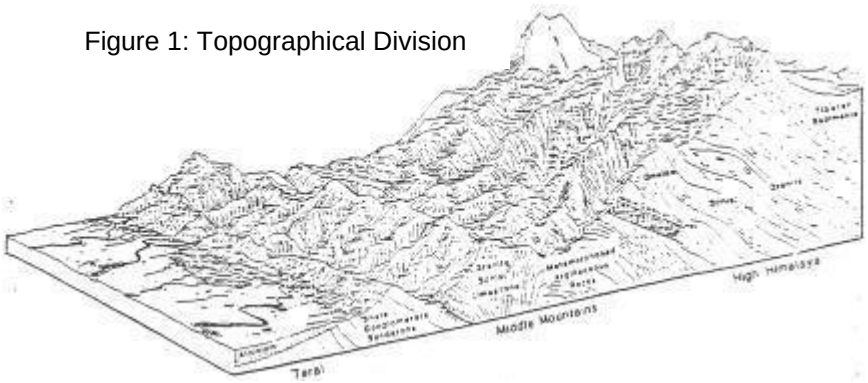
The country is divided into 75 administrative districts. Districts are further divided into smaller units, called Village Development committees (VDCs - total 3915) and Municipalities (total - 58).

2 Renewable Resources and Production

2.1 Hydropower

Nepal has huge potential to generate electricity from water resources. It has more than 6000 rivers and rivulets giving total annual runoff from the country are about 224 billion cubic meters/year. Nepal has total hydro power potential is about 83,000 MW out of which 43,000 MW is economically viable. Unfortunately only less than 1 percent of total potential has been generated so far. The first hydro power station (500 KW) was installed in 1911, called Pharping hydro power station near Kathmandu, the capital city. Various hydropower projects generated 650 MW of electricity and only 645 MW is connected to the national grid, while rest of the energy generated from small hydropower stations and have been providing electricity services at local levels. The total electricity generated has reached 703 MW including 53.41 MW from thermal power stations (Economic Survey 2009). Nepal's topography gives it enormous scope for the development of hydroelectricity, which probably provides the only realistic basis for its further economic development. Small-scale hydro plants are the most viable option for rural electrification. Large projects, however, in view of Nepal's limited financial resources, would probably require power export contracts with India as a prerequisite.

Figure 1: Topographical Division



2.2 Solar Energy

The average solar radiation varies from 3.6 to 6.2 Kwh/m2/day and sun shines for about 300 days with an average of 6.8 light hours per day (Energy Sector Synopsis, Report, 2010)). It is favorable condition for exploitation of solar energy in the country. About 5 MWp of photovoltaic power is currently being used in various public and private sectors though more than Solar Home System (SHS) till 2009. Present days SHS have been fully commercialized and till 2009 more than 185,000 SWH have been installed in the country.

2.3 Wind Energy

The studies by DANGRID a Danish consulting firm in 1992 reported that a potential to generate 200 MW of electrical power with an annual energy production of 500 GWh from the wind resources along the 12 km valley between Kagbeni and Chusang in Mustang district where wind power potential is tremendous. The Center for Energy Studies/ IOE and with support from United Nations Environment Program/ Global Environment Facility (UNEP/GEF) has conducted the assessment and shows a total area of 6074km2 with a wind power density greater than 300 watt/m2 opening up the possibility for numerous wind energy projects. Only 10% of this area has been analyzed for project feasibility. Nepal could potentially generate more than 3000 MW of electricity from wind energy. Most potential project sites lie in conservation zones in the mid-hills and high mountains (AEPC). AEPC has installed six wind-solar hybrid systems which generate 400 watts of power (150 watts solar, 250 watts wind) in Pyuthan, Mutang and Palpa. There is no signification wind energy production in the country.

2.4 Biomass

2.4.1 Forestry

The forestry resources are only a main energy resource which is fulfilling most of the energy need in Nepal. Forestry covers about 29 percent, and shrubs covers about 11 percent of the total land of the country and it is decreasing at the rate of 1.7 percent for different domestic needs for example fire wood, constructional materials etc (State of Environment 2006). Per capita fuel wood consumption in the Hills is estimated to be 640 kg, while it is 479 kg/person/year for the Terai. The per capita timber consumption per annum was estimated at 0.07 m3 /year in 1985 and is estimated to have increased to 0.11 m3/year by the year 2000 on the basis of the national timber demand projected to be about 2.5 million m3/year by 2000 (GoN/ADB/FINNIDA, 1998, SoE 2006). Firewood consumption is about 77 percent of total energy consumption in the country.

2.4.2 Agriculture Residue and Animal Waste

Agriculture residue and animal waste play an important role in rural energy system. Agricultural residues and animal waste used in total energy consumption is about four percent and six percent respectively. About 10 percent of total energy fulfil by agriculture residue and animal waste.

2.5 Rural HH Energy Technology

2.5.1 Biogas

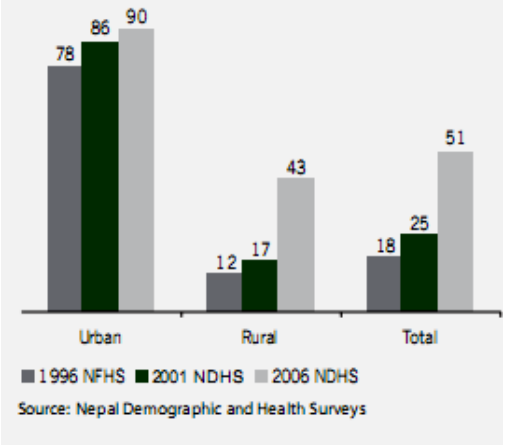
Cattle rising are one of the main livelihood phenomenon associated to rural people in Nepal. This plays very crucial role to fulfil the rural energy consumption. The potentiality of producing biogas is about 1.9 million plants out of which 1 million are economically viable (WECS 2010) up to now total 20,5820 biogas plants has been installed (BSP Nepal).

2.5.2 Improved Cook Stove Technology

There is a huge potential for biomass technologies like Improved Cooking Stoves (ICS), Beehive briquettes, Briquetting mechanism, Gasifier. More than 331,000 ICS have been so far installed through various government and non-government organizations though the potential to install is about 3 million household.

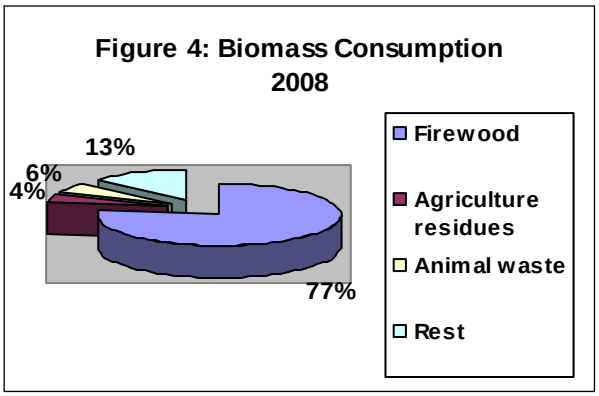
3 Energy Consumption Pattern

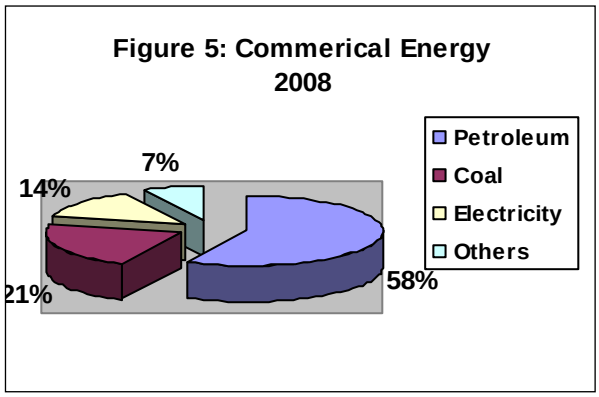
Figure 2: Percentage of household with access to electricity



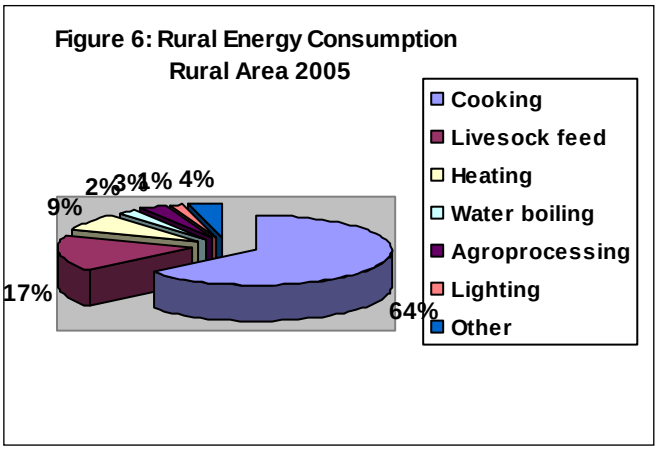
Nepal is country where the most of the people live in rural areas and where poverty is greater compared to urban centres and valleys. Social and economic inequalities, low economic growth, unbalanced development approaches, discrimination, exclusion, environmental deterioration and inappropriate policies/technologies lead to a vicious circle of poverty, which can be perceived as one of the key contributing factors of the current conflict in the country. Energy consumption per capita is extremely low, 0.34 TOE or 14.64 GJ. Nepal per capita energy consumption for year 2005 was about one fifth of world average per capita energy consumption. On an average energy consumption in Nepal is increasing by about 2.28% annually. Biomass-based and conventional energy resources are predominant in the energy consumption, and are primarily used for cooking and lighting purposes.

As of 2009, micro-hydro (including pico-hydro) electrification schemes installed in various part of the country with the total installed capacity of about 13.9 MW covering about 110,000 households. Similarly 331,000 households are using improved cook stoves, 185,000 solar home (SHS) systems and 205,820 biogas plants have been installed. Despite of high energy generation potential the country experiences electricity load shedding up to 16 hr/day in winter and 2 hr/day in summer. The energy consumption pattern is shown in following charts.





4 Rural Energy Situation



The main source of rural energy is biomass. Only 43 percent of rural people have access to electricity which is used mostly for lighting and milling purposes. Central grid connection to electrify the rural area is quite impossible because of scattered settlements and difficult terrain. The only option to electrify the rural area is decentralize energy development from micro hydro and other renewable energy resources and distribute from mini grid. Development of rural Nepal largely depends on the development of agriculture and agro-based industries. In order to develop agriculture and agro-based industries, energy is one of the most important inputs that have to be integrated with rural development policies and programs. This is why this paper focuses on the integration of the different forms of energy and the rural development.

5 Overview of REDP

The Rural Energy Development Programme (REDP) is a pioneer programme in rural energy sector in Nepal. It is a joint programme between Government of Nepal (GoN) and the United Nations Development Programme (UNDP), the World Bank and Local Government (LG). This programme was initiated on 16th August 1996 as a first phase as a pilot programme and second phase in 2004. The programme is people's central in nature and shown very good impact on rural people. After successful completion these two phases and demand from the communities and local governments, the GoN has forced to implement the third phase of REDP. The phase three has been effective from 1 September 2007. Decentralization, bottom up participatory planning, participatory decision making and implementation, participatory monitoring and evaluation activities are basic pillars for the successful implementation of the program. REDP is supporting the Government of Nepal (GoN) to implement the Rural

Energy Policy 2006 in 40 districts in this third phase. The Alternative Energy Promotion Center (AEPC) of Ministry of Environment, Ministry of Science and Technology is the government executing agency.

6 Goal

The main goal of the programme is peace building through sustainable development based-on social capital building, economic growth and environment management.

7 Strategic Framework

REDP promotes an integrated approach to sustainable rural energy systems development in order to have impact in the following action areas: (1) rural development; (2) improved quality of life for women and children; (3) promotion of efficient end-use technologies, including the promotion of the non-farm activities, and (4) conservation and restoration of the natural environment. It is the programme policy to provide technical assistance not only for use of UNDP resources allocated through this programme, but also to provide technical support in promoting rural energy development from other sources (DDC, VDC, community, donors, government agencies, and others) at all levels - centre, district and community. The holistic development, decentralization, community mobilization, and bottom up planning process are the main strategies of the programme.

8 Objective of the Programme

The overall objective of the programme is to enhance rural livelihoods and preserve the natural environment by supporting the sustainable development of rural energy systems, specifically micro hydro for sustainable development and poverty reduction.

9 Working Modality - Holistic Community Development Approach

The programme has been adopted holistic community development approach as an essential vehicle for self-governance to ensure active participation of local people at all levels to manage and operate rural energy systems, primarily micro hydropower and other community development initiatives in a sustainable manner by linking rural energy with rural economic activities and ultimately impact positively on livelihood of the rural people.

9.1 Basic Principles

There are six basic principles adopted by the programme in community mobilization process:

Figure 7: Six Principles of REDP Community Mobilization Process

Organization Development: The program sensitizes community members to organize themselves and work collectively to mobilize local resources effectively for productive uses.

Capital Formation: Capital for development work is mobilized through internal and external sources. Regular saving and credit by the community members help to create further assets for the capital formation.

Skill Enhancement: Skilled people perform their tasks more efficiently compared to those unskilled; the programme enhancing their capacities to use and maximize the benefits of the resources.

Technology Promotion: Introduction, adoption, operation and finally internalization of appropriate modern technologies are considered essential for creating various employment opportunities for the rural population, and community development. These technologies also substitute expensive and unhealthy energy sources such as kerosene, diesel, petrol, fuel wood, which reduces the drudgery to rural people.

Environmental Management: Long term and sustainable operation of MH schemes depends upon the conservation and management of water sources. REDP promotes community forestry, plantation and reforestation, watershed management, environment education and health and sanitation programs to protect the environment.

Vulnerable Community Empowerment: This process empowers vulnerable groups, women, and ethnic groups and brings them to mainstream of development. These groups encourage to participate in project planning, implementation and management process.

In addition to these six principles, REDP ensures participation of male and female beneficiaries participation, transparency, rule of law, appropriate technology, accountability and consensus based on inclusive decision-making processes which ensues the principle of good governance at all programme stage; which are the key success factors of the programme.

10 Community Mobilisation Process

Community mobilisation process is the most important part of the programme implementation process. The success of the programme is mainly depends on how effectively community has been mobilised. During the community mobilisation process, basically two organizations are formulated at grass route level. These are as follow:

Community Organisation (CO): CO is an organisation of people who live in close proximity and share common interests and willing to work together for the common goal. At least one male and one female member from each beneficiary household becomes a member of the organisation. These are broad-based organizations. All decisions are made during a weekly meeting on consensus basis. It also runs adult education class for the members. Adult education class is mandatory for women community organisation.

Functional Group (FG): FG is formed from two or more community organizations who organise themselves to achieve a certain objective. A working committee is formed which is proportionately represented by members of all COs. All member of the group meet at least once a month. During the meeting, decisions on working committees are made.

Management committee is formed to operate and maintain the MH schemes. It is represented proportionately by all COs. It makes decisions on electricity distribution, electricity tariff, employee management, operation and maintenance of the MH schemes.

10.1 Stages of organization formation

There are four stages of formation of community organization.

Stage I: Formation of Community Organisation (CO)

The first step of community mobilization process is to sensitize VDC chairperson, vice chairperson, Ward chairperson, members and secretary and local people. A meeting is organised with VDC and Ward personnel in order to brief them about the objective and principle of the REDP program. A Community Mobiliser is appointed in the VDC and establishes a contact office in the VDC. Community Mobiliser goes to each and every households of the VDC and aware them about the REDP program and its objective. Public meetings are organised. It is mandatory that at least one male and one female member from each beneficiary household are present during the meeting. In the second meeting, representative of Community Organisation (CO) is formed. Chairperson and manager of the CO are appointed. Baseline Survey of the VDC is then conducted.

Stage II: Formation of Micro Hydro Functional Group (MHFG)

The matured COs are encouraged to organise themselves into MHFG. At least two COs, one female CO and one male CO form the MHFG. A representative executive committee is formed from all participating beneficiary COs. Proportionate representation from all COs are required. Other Functional Groups for alternative energy sources like biogas, solar energy improved cooking stove are also formed. If needed

and resources are available, other Functional Group are formed together with COs working in forest, irrigation, drinking water, skill development etc. Every month a mass meeting is organised. It is mandatory for all members of Functional Group to attend the meeting. COs and WC of Functional Group submit the progress report and decisions on future activities are made.

Stage III: Legal Recognition

After six months of the successful operation of the MH plant, the group is registered as legal entity. DDC and VDC representative and community members discuss and decide on the registration of the group. The following are the possible registration options:

Non Governmental Organisation (NGO); Cottage Industry; Company; Multipurpose Cooperative; Micro hydro cooperative

Most of the functional groups are willing to register as Micro hydro cooperative.

Stage IV: Internalisation

For long term sustainability of the MH schemes, community are trained and empowered to operate and maintain the scheme on their own. Responsibility of Community Mobiliser is gradually shifted from the community.

11 Bottom up Participatory Planning Process

District energy situation/need assessment

LSGA 1999 and Rural Energy Policy 2006 have emphasized the bottom up planning process and given tremendous authority to local government to plan implement and operate local

After establishing the DDC:DEES; first of all need assessment has been carried out to formulate the clear picture of district energy situation with potential resources available in the district. A participatory exercise to assess the energy situation and needs of a district is carried out by DDC: DEES. For this, data from various primary and secondary sources are collected and processed and prepare a District Energy Situation Report. VDC leaders are oriented and sensitized on role and importance of energy in community development, rural energy technologies and about REDP.

11.1 Stages of Bottom up planning process

Bottom up planning process is a unique feature adopted by REDP. Under the given laws, policies and regulations, REDP broadly categorised the bottom up planning process in three tiers although all other steps are integrated with in the framework of LSGA planning process. Due to the absence of representative in local government and insurgencies in the country, some steps have not been carried out formally. The planning process starts at the community level and ends at the district level.

Before starting community level planning process the following activities has taken in DDC and VDC.

- Dissemination of directives and information, budget ceiling for next year provided by sectoral ministries and NPC
- Analysis and review of directives, policies, guidelines, estimated budget provided by sectoral ministries/NPC.
- Dissemination of information of programme objectives, activities, resources, and allocation of estimated budget per VDC
- Distribution of project request forms and orientation to VDC chairperson, secretary and others to fill the form
- Situation analysis, programmes & projects analysis to be carried out in ward/ settlement level by VDC

Figure 7: Flow chart of bottom up planning process

Community Level Planning

The planning at this level is the foundation of planning process. The VDC chairperson and the Ward chairperson facilitate the communities in the ward to identify energy-related problems, agree on possible solutions and prioritize the projects with respect to importance, feasibility and ease of implementation. These identified energy projects from all communities are compiled and prioritized at ward level and forward to VDC.

VDC Level Planning

All the energy projects identified at the community and ward levels are further discussed in VDC and Village Council (VC) level. They compile and categorize energy projects into three categories according to their felt needs, resources, people participation, and ease to implementation.

Category 1: Projects that can be implemented at the community or ward level.

Category 2: Projects that can be implemented at the VDC level, and

Category 3: Projects that require external support.

After approving VDC and VC, all projects list are forward to Ilaka level for further consultation and improvement.

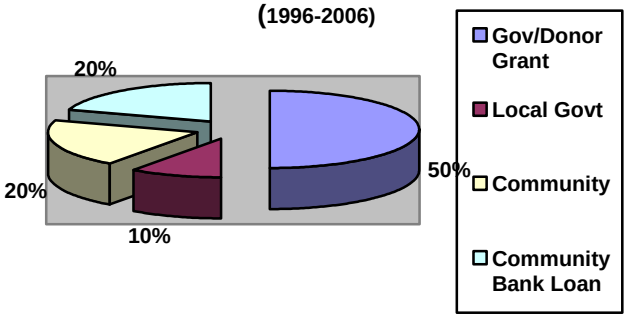
District Level Planning

After receiving all prioritised list of projects from all Ilakas; DDC: DEES drafts the annual plan and program of the district after discussions with related local bodies, line agencies, SOs and NGOs. The draft is submitted to the District Energy Committee (DEC) and to Integrated Coordination Committee for feedbacks. The final plan will approve by DDC and ultimately by District Council (DC). The DDCs compile, finalise and publish the energy plan and programs approved by DC in an annual basis. This annual plan will ultimately forward to NPC for approval and additional resources mobilisation from the central. This annual plan encompasses both planning and implementation of energy systems and also incorporates the energy and environment related activities of communities, villages and districts. Similarly DDC:DEES prepare five year District Energy Plan and Programmes in participatory way.

12 Subsidy and Cost Sharing

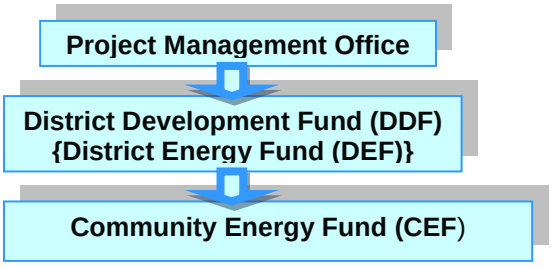
Cost sharing is another important feature of REDP projects. For sustainability of the projects cost sharing from the community and local government is very important. Generally REDP provide NRs 15,000 per household (HH) and not exceeding NRs 1,25,000 per KW (5 to 500 KW), similarly up to 5 KW 12,000 per HH and not exceeding to 97,500 per KW and similar way other RETs get subsidy as according to subsidy policy of GoN.

Figure 8: Cost Sharing (1996-2006)



In general, the government subsidy / donor grant accounts to approximately 50% of the total micro hydro plant installation cost, DDC and VDC investment 10% and community in-kind (labor and locally available construction materials) contribution 20%. The rest of 20% of the total cost are mobilized by the community as cash or bank loan. Project funds for the various activities are channelized to Community Energy Fund (CEF) through a District Energy Fund (DEF), which operates through the District Development Fund (DDF). CEF is managed by

Figure 9: Fund Flow



the community in order to encourage local ownership. The role in project management is limited for facilitation, technical assistance, monitoring and evaluation.

13 Institutional Setup

Success factor of any project depends on it's institutional setup and cooperation from other institutes. There are different committees, boards, stakeholders and institutions involve in the implementation stage of the programme. Involving local government institutions added more advantage to implement project activities at grassroots level. The following actors and institutions have been involved in REDP's MHS programme.

Table 1: Institutions involved

Central/national level	District level	Community level
Ministry of Environment /AEPC National Executive Agency **Programme Advisory Committee (PAC**) Secretary of MoE chair, and representatives from Ministry of finance, Ministry of Local development, Ministry of energy, Ministry of forests and Soil conservations (MoFSC), National Planning Commission (NPC), Department of Women (DoW), The World bank, ADDCN, NAVIN, and UNDP. Provides overall policy direction, assesses progress and achievement. **Programme Executive Board (PEB)** NPD (Chair and project executive role), ARR, Energy, Environment and Disaster Management Unit, UNDP (Senior Supplier role) and representatives of MoF, ADDCN, and NAVIN (Senior beneficiary role). Responsible for making consensus-based management decisions, including approval of programme revision and work plans. **Project Management Support Unit** National Programme Manager(NPM) Chief of Unit Professional and support staff responsible for implementation, **Technical Review Committee (TRC)** Technical, financial, social and environmental evaluation and endorsement of each MHS. **Agricultural Development Bank of Nepal Ltd. Nepal (ADB/N**) Provision of loans for MHS purchase. **Micro Hydro Private Companies/Supplier** Engaged in manufacturing, supply, and installation of micro-hydro turbines, including other electro-mechanical components.	**District Development Committee (DDC) District Executive Agency** **District Energy and Environment Management Committee (DEEMC)** DDC chair, LDO, and energy development officer (EDO) for day-to-day implementation activities. **District Development Committee: Disrict Energy and Environment Section (DDC:DEES)** Planning, management and implementation activities. **District Energy Fund (DEF)** fund mobilization and utilization **Support Organization (SO)** Local NGOs implementing the community mobilization process at community level **Rural Energy Service Centre (RESC**) Private sector organization providing technical (survey, fabrication, repair and maintenance) support for the micro-hydro system technology.	**Community Organization (CO)** Broad-based grass-roots organization of community people. there are separate COs for men and women. **Micro-Hydro Functional Group (MHFG)** Users' group specifically for planning and management of micro-hydro. Made up of members from the COs, ensuring equitable participation. **Community Energy Fund (CEF)** Mobilization and utilization of fund, Including grant, equity, loan and monthly electricity tariff collected from consumers.

14 Physical Output

Table 2: Physical output

Key achievements of REDP (as of July 2010 from 1996)		
Rural energy systems		
Micro hydro schemes	290 (5,050.2 kW), 49,987 HHs	
Biogas plant with toilet attached	6,364	
Solar home systems	2,591	
Improved cooking stove	13,459	
Environment initiatives		
Nursery establishment	183	
Community-managed forests	415	
Plantation	3,335,914 (plants)	
Toilet construction	26,489	
Environment classes/campaigns	1437	
Trial Road Construction	836m	
Tap/Pond Construction	440	
Human resource development		
Training on technical subjects	2,989	
Environment management training	2,708	
Training: income generation and micro enterprise	8,562	
Institutional development training	15,782	
Orientation/Study Visit/Consultative	2,429	
Others	4,901	
Community mobilization		
	Male	Female
Community organization	4,876	5,651
Community members	267,789	
Cumulative weekly saving (Rs)	58,869,318	
Cumulative investments (Rs)	110,066,496	
Institutional development		
District Energy Fund	40	
Rural Energy Development Section	40	
Note: 1. At the current rate US$1.00 = Rs.73		
2. All figures are in number except indicated in parentheses.		

15 Direct Impacts Observed from the Project

- Decrease in firewood, fossil fuel consumption for cooking, heating, lighting milling and small industrial purposes.

- Reduction in indoor air pollution by introducing new renewable energy technology such as micro hydro, biogas, solar home system, smoke less cook stove.
- Overall improvement in hygienic conditions inside, around the homes, and surrounding environment: number of community forestry increased.
- Enhancement of rural livelihoods, through income generating activities from off-farm and on-farm activities.

- Increase in women's literacy rate, with more girls joining the local school.
- Increase in Community cohesion (social harmony), now possible in community gatherings after dark and actively participate in social activities..
- Increased in community based infrastructure development projects like electricity, school, water supply irrigation, village road etc.

- Drudgery to women specially grain grinding, water carrying, and indoor pollution reduced significantly.
- Narrow down the gap of digital divider between urban and rural due to access to information technology (TV, Radio, Computer, Telephone, and Mobile).
- Decentralized rural energy planning, implementation, operation and maintenance capacity of communities, NGOs, private sectors and local governments have increased and understand the concept of sustainable development as they equipped with different types of tools, techniques, trainings and orientations.

16 Lessons Learned

Bottom up planning process is very important for the local level projects; this process actually addresses the needs of the local community therefore success rate of such projects are high and they are more sustainable. It is better to adopt holistic development approach rather than targeted development because holistic development covers all aspect of community development.

In a community, small grant may bring much more positive changes in the community and at the same times it mobilise other resources significantly. Community utilise fund effectively and efficiently. Direct involvement of local government and community in development programme will increase the sustainability and it develops inherent feeling of ownership of the project. Social capital is very important for short run as

well as for long run because it is a collective strength of the community, local and central government.

17 Recommendation

The following recommendation has been made for further effective implementation of programme.

- Scientific subsidy polices should be introduce so the inflation and market price can be addressed automatically.
- Promote decentralise local grid system between micro hydro so that surplus and deficit power can be managed in local communities.
- Mechanism has to develop to connect power generated by micro hydro to national grid so that communities can sell surplus power and get extra income.
- Benefit sharing mechanism has to development to share the benefit among the stakeholder and the people who are not covered by the project.
- Promote white LED for lighting, which is more efficient then the conventional light so that more households will be benefited and more energy will be available for other end use purpose.
- Insurance mechanism has to introduce on renewable energy system so that community don't have to worry about natural calamities and other accidents.
- Increase coverage of the programme in more DDCs and VDCs so that it minimised the disparity between DDCs and VDCs in rural energy sector and other social benefits that the programme offers.

18 Award and International Recognition

International community has recognised this programme as a one of the best programme in rural energy sector. This programme has been recognized with many internationally prestigious awards such as Energy Globe Award 2000, Austria; Pearl of Knowledge Award 2005, Thailand; Global 100 Eco-Tech Award 2005, Japan.

19 Conclusion

Community mobilization, along with elements good governance such as participation, transparency, rule of law, appropriate technology, accountability and consensus based on inclusive decision-making processes are the key factors for the successful implementation of the REDP programme, the beauty of the programme is people's centre, formation of social capital, bottom up participatory planning and management which contribute the holistic sustainable development; which enhance the rural livelihoods. Even a small grant, community has very good positive impact in their livelihood and able to mobilize additional resource from their own and other's resources.

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Inland Waterway Transportation Development in an Environmental-Friendly Way

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Abstract: Inland waterway transportation （IWT） is a green mode of transportation. In the past decade, the inland waterway transportation system in Zhejiang Province has been developed in an environmental-friendly way. The article presents an environmental management framework for sustainable IWT development and describes some successful practices and experiments in the IWT developing activities.

Key Words: Inland waterway transportation, environment, development

1 Introduction

Economic development, infrastructure needs, environmental consideration, can be and should be harmony with nature. In the case of river management for navigation infrastructure and operation, decision had been always based upon specific costs and benefits, without consideration on environmental impacts. [1] However, in the past decade, under the national developing guideline, the development of inland waterway transportation (IWT) system in Zhejiang Province has been undergoing a new pattern, developing IWT in an environmental-friendly way.

2 Background information on IWT development in Zhejiang

Zhejiang Province locates to the south of the Yangzi River, facing the East China Sea. It is a densely-populated area. About 51 million people live on a land area of 0.1 million km^2. It is one of the richest areas in China. Its GDP in 2009 is 335 billion dollars, 6570 dollars per capita. Rich precipitation helps to form many rivers and lakes in this area. There are about 10000-km inland waterways in the Province, including the world-famous Grand Canal. After dozens of years' development, there about 1000-km inland waterway that is navigable for 500-t vessels. In 2009, the IWT system transported 219 million tons of cargo, with an average hauling distance of 150 km. This is 14.5% of the Province's freight traffic[2].

The history of IWT development of Zhejiang Province represents a general trace of many inland waterway systems. IWT had been the major and sometimes the only transport method before road transportation became dominant because of its advantages of shiftiness and convenience. IWT left the scope of people's daily life, but its slow, dirty and backward image remained. When people realized that the severe environmental effect of ever-increasing road traffic had brought about great damage to our ecological system and living surrounding, IWT came back into the focus of a sus-

tainable transportation system in future. But it is not a simple return. People have more understanding on the meaning of a successful IWT system. More consideration on social and environmental impacts has been taken into account in the process of development.

Chart 1 Map of Zhejiang Province and its inland waterways

3 Approaches of environmental-orientated IWT development

Inland waterway transportation is a typical green mode of transportation. It has big capacity but cost-saving. The transport capacity of a Class IV channel (navigable for 500-t vessels) equals to that of three 4-lane highways. A new 8-lane highway would have been constructed if all the goods, transported by IWT between Zhejiang and Shanghai, had been carried on trucks. The transport cost per ton-km for IWT is 0.064 yuan, 1/2 of railway and 1/7 of highway. It is characterized as low energy-consumption and low emission. The energy consumption for one billion tons of goods transported by inland waterways is 7900 tce per kilometer, 69% of that by railway and 16% of that by highway. A study shows that if all goods transported by inland waterway in 2006 had been shifted to highway, the additional environmental cost would have been 7 billion yuan.

Few waterways, whether natural or man-made, have been developed and maintained for IWT only. They usually serve multiple purposes, such as agricultural irrigation and drainage, drinking water supply, industrial processing water, waste water discharge, fishery, recreation, hydropower generation, and flood control. Furthermore, while IWT is essential to modern society, there could be significant negative environmental impact, including the loss of habitat. The new approach of IWT devel-

opment is to make it a multi-goal activity, taking social and environment factors into consideration. An environmental management framework for sustainable IWT development can be summarized from the practices of Zhejiang in the past decade.

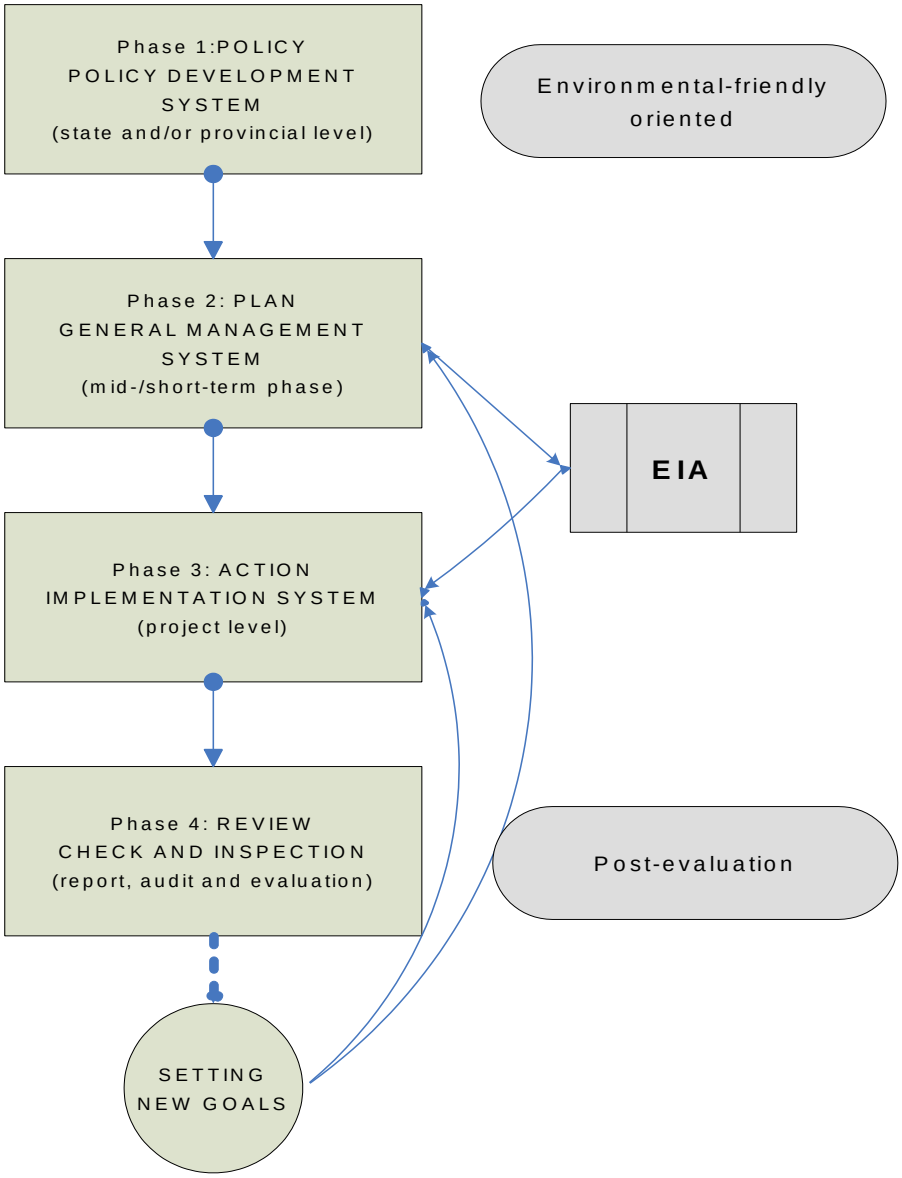

Chart 2 Environmental management framework for sustainable IWT development

Phase 1- Policy: In the past decade, the Central Government of China set out an important national developing guideline “to build up a resource-economical and environmental-friendly society” in stead of the resource consuming-driven developing pattern. A champion is undergoing to develop a smooth, efficient, safe and green transportation system by promoting IWT system and shift more traffic from road to inland waterway. Zhejiang Province also has decided to develop the inland waterways into not only transport corridors, but also ecological, cultural and scenery corridors.

Phase 2 - Plan: In response to updated developing trend, the Province has drawn out a new IWT Plan as a provincial developing strategy. For the first time, an environmental impact assessment (EIA) was carried out at this phase. The report gives a general research on any obvious social and environmental impacts of the IWT Plan. Potential conflicts with other plans are searched out, and counter-measures are composed, including changing waterway routes, strengthening flood control facilities, introducing precautious environmental actions where risks of serious or irreversible environmental damages are likely to take place. The Plan and EIA also set out mid- and short-term goals for vessel standardization and modernization, waste collection systems at ports, maritime patrol regulations, and salvage action plans.

Phase 3 - Action: An EIA is obliged to take place for each IWT project. Environmental gains and losses are identified and countermeasures for potential environmental risks are listed and updated at each phase of the project. A supervising system has been established, using third-party supervision to ensure the fulfilment of all the countermeasures. New techniques have been applied in construction and operation of the system, such as eco-bank protection, soil recycling, synchronized lift of bridge structure, and waste and oil collection of vessels. Historical heritage and relics protection is also a big factor in the selection of alternatives.

Phase 4 - Review: A checking procedure of environmental measures listed in EIA is a must for the completion of the whole project. A check list provides the overall information on how the project has fulfilled the environmental tasks during construction period. A series of samples are collected to monitor the environmental status during operation period, by IWT project owner and/or the environmental department.

The Loop: A closed loop for continuous environmental protection has been formed during the IWT developing activities in the past decade. Post evaluation of IWT project gives new ideas for further development. New goals are set out for IWT projects in better combination between infrastructure development and ecological preservation and environmental protection.

4 Experiment and Practices

4.1 Planning industrial developing axles along inland waterways

Jiaxing has a dense inland waterway network. There are more than 50 km canals in every 100-km^2 land. Boats and barges were still the only transport tool for many villages and townships in the 1970s. Inland waterway transportation plays a very important role in people’s daily life and economical activities. The Municipality of Jiaxing has made a plan on the use of waterfront and the corresponding hinterland to provide guidelines of the layout of industry zones along inland waterways. The Plan draws

out five industrial developing axles along five main inland waterways and specifies the type of industry for each section. Accordingly, land use plan behind each section is also adjusted to fit in the needs for different types of factories. Several transition centers connecting inland waterway with highway and railway are planned on each axle. Factories with large demand of transportation, such as building material producing, petrol processing, paper making, feed processing, can reduce cost of production by saving transportation cost if they are located directly along inland waterways. On the other hand, the city receives great environmental benefit because a big portion of road traffic is reduced or shifted to inland waterways, and therefore noise, emission and dust are much less.

Chart 3 Planned industry developing axles along inland waterways in Jiaxing[3]

In the past ten years, the Municipality has put in great investment to improve the transportation infrastructure and facilities in these developing axles. The perfect and convenient transportation system has attracted many factories to locate in these industry zones. By the end of 2009, there are more than 700 enterprises in these industry zones, producing about 15% of the total GDP of the Municipality.

4.2 Synchronized lift of bridge structure

The Qifeng Bridge is located on Hujiashen Channel. It was built as a two-lane highway bridge in 2003, with a clear space of 5.5 m high. It became a “bottleneck” in 2005, when the Channel was upgraded to a Class IV waterway, which needs a clear space of 7m high. What to be done with this newly-built bridge? To pull it down and rebuild a new one is the easiest but apparently not the best choice. Twenty eight poles of the bridges were cut in the middle and the whole bridge, including 12 approaching spans, were lifted up by 1.5 meter at the same time. The whole weight was

6000 tons, but with the computerized synchronizing technique, the renovation of the Bridge was very successful, resulting in significant economic and environmental benefits.

Chart 4 shows clearly that the synchronized lift technique saved about ten million yuan, as well as relieved many negative impacts on the surroundings due to less construction work and shorter construction period.

	Alternative 1[1)]	Alternative 2[2)]
Cost	12 million yuan	2.5 million yuan
Construction time	24 months	3 months
Construction waste	More than 6000 tons	About 50 tons
Construction site	12000 m^2	300 m^2
Waterway traffic stop	500 days	60 days
Traffic diversion cost	2.5 million yuan	150000 yuan

1): Alternative 1 refers to building a new bridge.

2) Alternative 2 refers to renovating the bridge using the synchronized lift technique.

Chart 4 Comparison of two alternatives[4]

4.3 Ecological bank protection

The northern part of Zhejiang is one of the earliest regions where inland waterway transportation started. It is also a region with densely-distributed cities and towns. Because of the limitation of space and land, the traditional bank revetment is usually vertical, made of stone blocks. While it gives a good protection from water wash, it takes little consideration on the ecological side and has several shortcomings:

- High construction cost, because most of the construction materials need to be excavated from stone mines and transported to working site
- Long construction period and uncertainty in construction quality, because most of the construction work is done by manpower.

- Stopping water exchange cycle and reduce habitat in wetland for amphibious animals, because of the vertical impermeable stone walls.

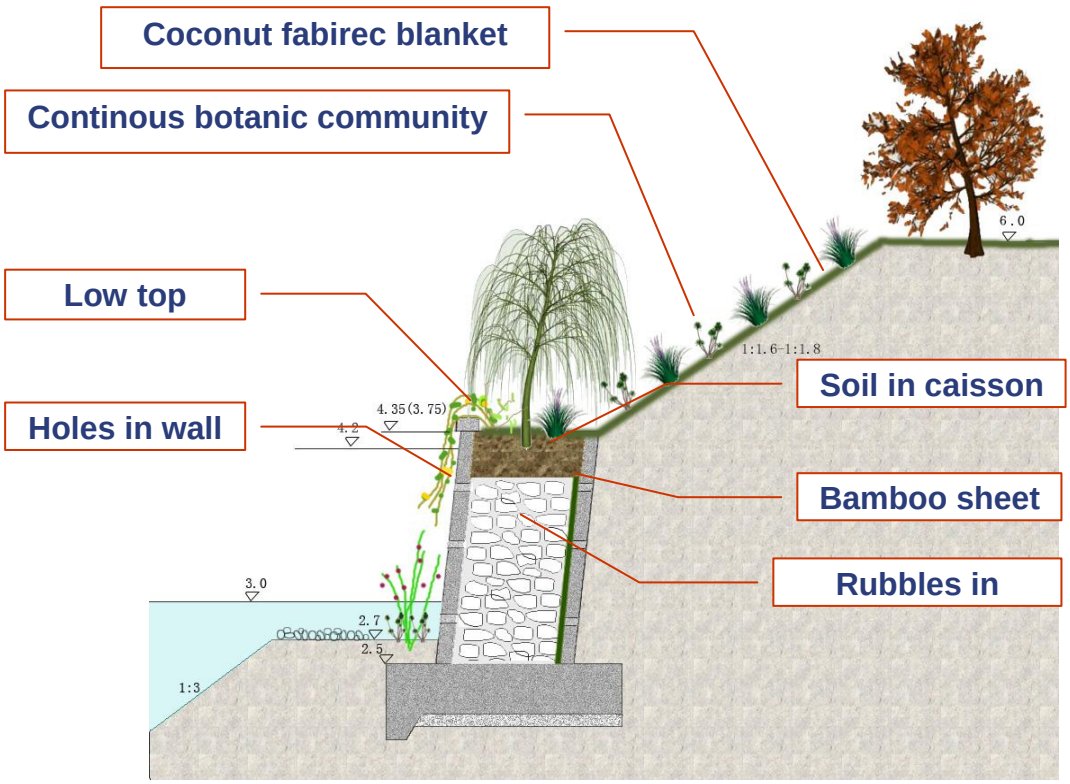

Chart 5 Cross section of a permeable prefabricated concrete [5]

The idea of ecological bank protection is to develop IWT while wetland eco-system is preserved. A newly-designed eco-bank structure, permeable prefabricated concrete caisson, was constructed. The structure is mainly formed in two parts: the lower part is a permeable caisson filled with rubbles and the upper part is a gentle slope covered with coconut fabric. Firstly, the caisson allows water to go through but stops soil, therefore the bank is “breathable”. The space among the rubbles provides habitat for fish and amphibious animals and growing space for water plant roots. Secondly, the coconut fabric forms a protecting blanket before the vegetation on the slop gets strong enough to stop erosion. As time passes the fabric degrades to become organic fertilizer for the vegetation. Thirdly, domestic plants and vegetation are selected to construct a wetland biotic community. Furthermore, a 50-cm-thick layer of soil covers the top of the caisson to guarantee the continuity of the community. Mixed botanic groups of emergent plants, hanging plants, grass, bushes, woods and trees have successfully re-established an artificial but stable wetland eco-system, together with plankton, fish, amphibious animals and birds that joined in later.

The structure is economically and environmentally feasible. With cheaper and reachable materials and practical technique, the structure fulfils the task of bank protection as well as preserving wetland’s species diversity. A post evaluation presents several advantages of the structure:

- The prefabrication and mechanized installation of the main parts of the retaining wall makes it possible to speed up the construction. The construction time is only one-fourth of the traditional style. The construction quality is also much better and easy to be controlled.
- Cost for civil works is 100 yuan less per meter. Though the plants cost some investment, but when the preserved eco-system is added as an evaluating factor, the investment is worthwhile.
- Because of the use of caisson, raw rock is no more a must. Every meter of retaining wall needs 0.5 m3 less of stone. This means about 1,000,000 m3 of stone can be saved to complete the upgrading works in the later five years.

4.4 Disposal and recycling of excavated and dredged soil

Earthwork is an important part of IWT upgrading construction. A study shows that more than 50 million cubic meter of soil was produced in the past ten years, half dry and half wet. How to deal with the soil is not only an engineering problem, but rather an environmental concern. Improper disposal of soil can lead to environmental disasters, such as soil erosion and water condemnation. Some common solutions are borrowing nearby land for temporary storage, reclamation of land, making bricks, and filling abandoned ponds. However, as the available land becomes limited and the environmental regulations become stricter, new ideas have to be innovated to deal with the disposal of soil and to overcome the timing, space and quality problems of excavated and dredged soil.

Soil exchange service information center:

The concept is to set up a public website of an information platform accessible to all potential “suppliers” and “consumers” of excavated and dredged soil from IWT projects, and some self-financing storage yards. The platform requires the “suppliers” and “consumers” to put in data about when, where, what kind and how much soil is supplied or needed. In return, they can use the platform as a match tool. If a real estate developer finds, on the platform, that an IWT project will provide the qualified soil just at the time when he starts the planting works, he can contact the IWT project and work out a transfer plan directly to his construction site. Dredged soil can be stored in a storage yard, with qualified environmental protection and processing measures, until it gets dry enough to be used. The use of the Platform is free, but the storage yard is a paid service.

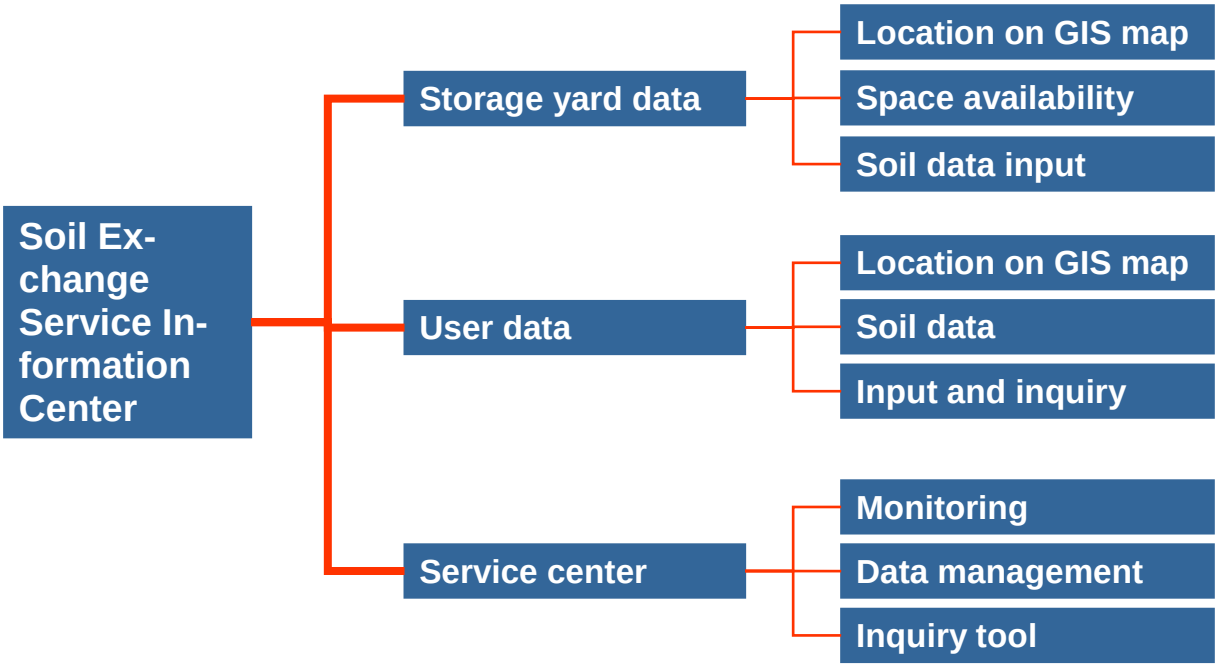

Chart 5 Structure of SESIC Platform [6]

Dry excavated soil for road construction:

The common material for roadbed is mining slag, a mix of rock and soil from stone mine. As the mine resource becomes less, the cost of traditional construction method increases. A mixture of dry excavated soil and lime can produce a good material for roadbed. Two parallel projects were selected to start the practice, a highway project and a waterway project. The two projects were only one km away and the construction timing was designed to ensure constant supply of soil for roadbed construction. Under such arrangement, the excavated soil could be transported to road construction site without any storage and the transport distance was the shortest. The 10-km-long highway used about 0.5 million cubic meter of soil, excavated from 10-km-long waterway. A study shows that the arrangement saved about 1.6 million yuan for transportation and 45 million yuan for borrowing land. It would have needed about 20-25 ha of land to store the soil, and more than 50,000 trucks to transport the soil out of the construction site. Think about the cost behind and the noise, dust, emission that would have caused by the transfer!

5 Way to go

After several years' hard work, a more efficient, safe and green IWT system begins to take shape. But it is still too early to celebrate. More challenges are ahead. From the beginning of this year, IWT Plan is being updated. The two major projects are the Grand Canal and the Qiangtangjiang River.

The Grand Canal and its stretches have a history of more than two thousand years. It is now applying to UNESCO for the title of World Heritage. Therefore, the big task of the upgrading planning is to find a good balance between heritage protection and

IWT development. A detailed survey is carried out by the cultural heritage sector, in hand with the IWT sector, to identify the scope and items of physical and non-physical heritages and historical relics along the Canal. The primary thought is to make a buffer zone of 400 m wide on two sides of the Canal. No construction activity, which is not related to IWT, flood control and heritage conservation, is allowed to take place in this protected zone.

The Qiantangjiang River is the biggest river in Zhejiang. It runs from west to east across the Province, connecting inland areas with big seaports. Compared with the eastern part of the Province, the mountainous western part is less developed, and a transport corridor with big capacity is essential to local economy. Dams and locks are designed to get enough water depth and make the river navigable for 5000-t vessels. A big portion of the investment goes into resettlement, environmental compensation and water facilities of this region where the ecological system is fragile and sensitive. Dozens of studies are going on to eliminate or relieve the environmental impacts.

These are just plans, ideas in our mind. Actions will be followed. With our efforts, we have the confidence to build our inland waterways smoother, greener and more beautiful.

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Social Infrastructure Networks: The Role of the Social Infrastructure Allocation on the Territorial Attractiveness

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Abstract: "In 2008, the world reaches an invisible but momentous milestone: For the first time in history, more than half its human population, 3,3 billion people, will be living in urban areas" UNFPA (2007).The physical expansion of the built environment has continued all around the world. The promise of the "city" as the best engine to create civilization, economic development and welfare could be one of the most visible features of the XX century. The prestige of the "Urbanized" life over the wild non developed one, common in the open land can be seen as a root of strong migration phenomenon in some regions around the world. The dream of an improvement in the living standards as well as the concentration of human development opportunities may be seen as "half reality" that built contexts offer for their citizens (not matter at what real costs), configure the scenario of a territorial "competition" between urbanized and less even non urbanized territories (Giffinger 2009)[9]. Under this territorial competition perspective Global cities compete not only between each others but among territorial and transnational levels, affecting the development of nations and the course of the economy. One of the key factors for the constitution of this attraction poles is based on the concentration of infrastructures that together bear, drive and boost the different possible interaction between all the involved actors. It is not so difficult to imagine how important is the provision and maintenance of technical infrastructures and their networks as Transportation, basic services (Energy, water…) and telecommunications, for the performance of this built agglomerations. Nevertheless not any built agglomeration might be called a city even an urbanized context. At this point of development none less important than technical infrastructures are the social infrastructures. Social infrastructures as retail (Markets), health, education and recreation, play a fundamental role on the sustainability, organization and consolidation of built environments as long as they maximize the accessibility to human resources, they shape the quality of the human capital and their allocation organize the territory as well as the movement (destinations) of the actors. Thus the present document seeks to underline the role of the social infrastructures on the territorial attractiveness at different regional scales; analyze the features of the different social facilities and finally is an attempt to define the networks of these infrastructures.

Key Words: Social Infrastructure, place attractiveness, infrastructure allocation.

[9] Giffinger, Rudolf & Stallbohn, Mariana (2009). ***Challenges of metropolitan development: Strategic efforts in comparison of Barcelona and Vienna***. Paper for EURA-Conference, Madrid, June 2009.

1 Introduction

The trend of urbanisation has continuing all over the world. According with United Nations and other researchers we are living for the first time in a moment where more than the half of the entire population of the world, 3,3 Billion People, is concentrated in urban areas (UNFPA 2007)[10]. This fast urbanisation process has several implications and impacts at the environmental, economical and social level, influencing the entire sustainability of a territory as well as the quality of life with in.

Impacts of cities and metropolis like Mexico City with more than 20 million inhabitants in its metropolitan region, Sao Paulo with 17 million or even Bogota with almost 8 million are visible in their entire countries when we try to answer questions like: how to feed their population, or how to educate them, or how to clean them.

One of the key elements associated to the sustainability of a place is the management of their natural and human resources through the infrastructure, in order to improve accessibility, distribution, use and regeneration of them in a long run.

Thus, Infrastructures understood as “the basic physical and organisational structures needed for the operation of a society or enterprise, or the services and facilities necessary for an economy (society) to function”[11] are at the core of the discussion of sustainability and quality of life in built environments as well as in a regional perspective.

Different characteristics of infrastructures like capacity, quality or accessibility to it play an important role in analysing the level of service of it and the effectiveness in managing the resources.

The present work deal with the allocation of social infrastructures and it impacts on the territorial attractiveness of a place, its implications on migration, on territorial capital and territorial competition as well as on natural and human resources.

1.1 Main and related questions

The main question the present paper is dealing with and trying to answer is:
What is it that makes some built environments, places or regions more attractive than other to live or migrate in?
Behind this core question it is possible to perceive some other important questions:
Are social infrastructures such as the related with health, education, security, sport, recreation and culture, a factor influencing decision of resettlement of a citizen?
How do social infrastructures affect the territorial capital of a place?

Is it possible to improve or affect some how the management of resources in a place due to the allocation of social infrastructure?

And finally which type of different strategies could be used during the planning process as well as during analysis faces in order to improve allocation of social infrastructures?

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[10] United Nation Population Fund (2007). ***State of world population 2007. Unleashing the Potential of Urban Growth***. Seen in : http://www.unfpa.org/swp/2007/english/introduction.html , 2007-08-05

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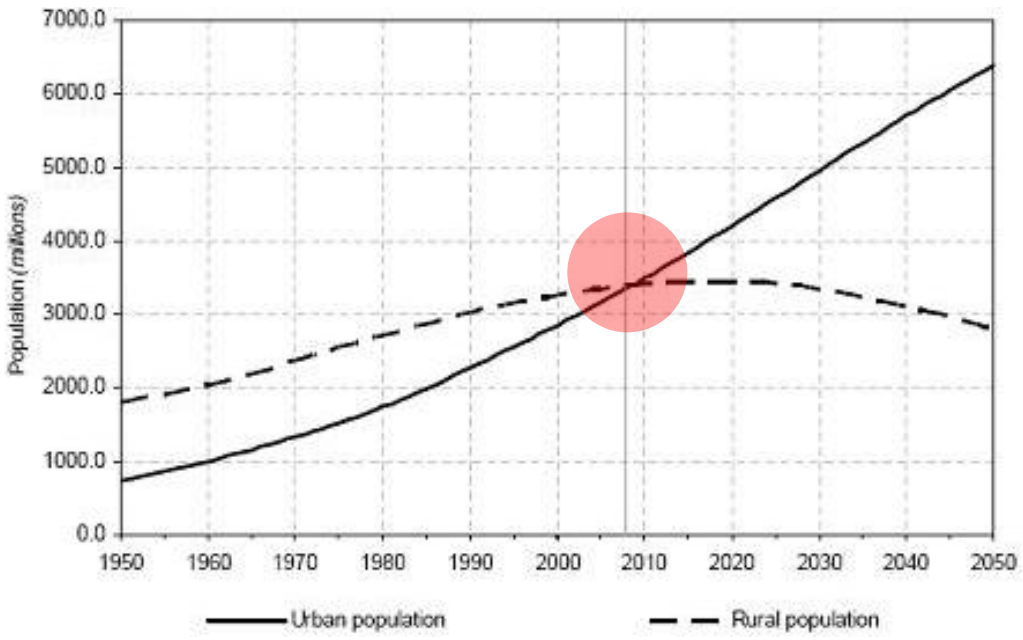
1.2 Topic description and relevance

According to the 2004/5 UN-Habitat report “state of the world’s cities” by 2003 there were 39 cities over 5 milllion in population and 6 over 10 million (UN_Habitat 2004).



Urban and rural populations of the world 1950-2050. UN 2007 WUP document

The urban population growth around the world has been and will continue being one of the central topics on development discussions during the next years. Different evidences all over the world shown how the growth of immigration in the cities maintain a positive tendency, emptying the rural areas and densifying built environments in an unbalanced territorial competition where at the end no one, the city or the rural, is really winning.

Huge negative environmental impacts, high social disparity, territorial fragmentation, urban sprawl and poverty are some of the main problems associated with Rapid urban Growth in different metropolis all over the world.

The successfully attractiveness of the urban territory sold and spread all over the world based on the dream for better job opportunities and a better quality of life have to be reviewed under the perspective of giving a choice to the migrants.

Concentration of most of the social infrastructures in some urban places has built with the pass of the years a monopolised system in some countries, where inhabitants do not have more options to study, go to the right medical centre or find justice than in big cities. Therefore is it possible to say that concentration (Isolation) of social infrastructures in urban contexts is creating big disparities between territories and population due to the lack of accessibility those social facilities some of them have.

1.3 Seeks of the following paper

The following paper is an attempt to find out the role of the social infrastructure on the territorial attractiveness at the micro and macro scales.

It also looks for understand how social infrastructures allocation affect the capital of a region and how it influences the resources of a place.

Finally with the following paper is presented a basic organisational network structures related to it.

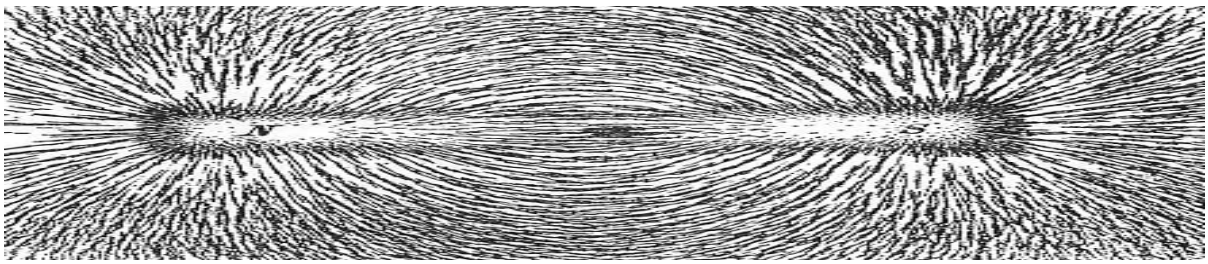
The topic of the following document takes part of a wider doctorate research: “Networking Infrastructures: The syntax of the infra-lattices affecting territorial development”, directed for Univ.Prof.Mg.Dr.Rudolf Giffinger at the Vienna University of Technology, Department of Spatial Development, Infrastructure and Environmental Planning, Centre of Regional Science.

2 Problem statements

Magnetism is probably one of the most relevant and effective capacities of the built environment. Behaving as a magnet, cities and metropolis have become strength migrant attraction poles due to the multiple possibilities they offer for different publics.

Is at the built environment where the best job opportunities are suppose to be found, where the highest interaction between inhabitants is possible and also where the better possibilities for human development as education and culture might be found.

The overlapping of different urban systems and networks like the one for housing, retail or transportation during the history, the increase and constantly improvement of those systems and the consolidation of recognisable “place personality” make easily for citizens to feel represented with their city.



Magnetism. The attractiveness of a territory may be compare with the power of a magnet. Image from internet free source.

Thus it is possible to talk of a territorial competition between built environments that are attracting and winning migrants against rural environments in a kind of synoikism[12] process, where more than exchange and interaction between the two

[12] *Synoicism, Synoecism or Synecism is the amalgamation of villages and small towns in Ancient Hellas into larger political units such as a single city. The world itself means “dwelling together”, or “to unite together under one capital city”. In the city states of Classical Greece, synoecism occurred when*

environments emerge a dependency and monopoly of the human development possibilities.

3 Place Attractiveness

"*The ability of places to attract migrants is of fundamental importance to local and regional development*" (Niedomysl 2010[13]). There are several reasons why people migrate, as well as there are different types of migration being the most relevant for the present research rural – urban migration and urban – urban migrations.

The sense of place, what makes a territory attractive is a sum of different elements with regard to its history, its socioeconomic characteristics and its geographical component. All these elements define the capital of the built environment, and together constitute the specific identity of every city.

Thus it is possible to imagine how some cities identities are closer to each other and other not, producing competitiveness between some in terms of attracting specific labour force or specific skilled professionals like "*the creative class*" for example (Florida 2002, 2005).

Concentration of social infrastructures in specific built environments as a method of allocation will, under the theoretical construct until now presented, increase the sense of place just in those areas, motivating unidirectional in-migration.

3.1 Migration

There are several relationships between urbanisation processes and migration. According with Kraler[14] for example "*Urbanisation is closely related to migration*"… and international migration into major Urban centres has to do with Economic linkages (global value chains), structural economic change (service economies), cities as the political centres (international organisations) and Cities as the religious and cultural centres. And here is really relevant to be accurate and clarify that there are different kinds of "human mobility" associated to the urban magnetism and that not all are here analyzed like tourism, commuting, exile and exodus (closer to the processes relevant for the present work but traditionally used to explain migration attracted at the industrialization period).

As said before the kind of migration relevant for the present analysis is a rural-urban long term migration, motivated principally for the desire of human development and the absence of social infrastructures at the origin point. This will be described at the next chapter but it refers to territories with lack of education provision, absence of

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the "demos" combined, usually by force, with and submerged the "politiea" to form one political union. Definition took from Wikipedia. Seen in July 2010 at: http://en.wikipedia.org/wiki/Synoecism

[13] Niedomysl, Thomas (2010). ***Towards a conceptual framework of place attractiveness: A migration perspective***. Geografiska Annaler: Series B, Human Geography 92 (1): 97–109.

[14] Kraler, Albert (2010). ***Migration and urbanization: Theoretical approaches to studying migration related aspects of urbanizations***. Conference made at the Vienna University of Technology, April 20th, 2010. International Centre for Migration Policy Development.

cultural centres and reduced markets among other. Or in a wider way places with a small capacity to allow interchange at the academic, cultural and sociological level.

3.2 Territorial capital and competition

Looking for a better understanding on the described territorial competition, indentifying what is an urban area become relevant.

Several definitions might be used to clarify the difference between both rural and urbanized environments, but according to Kraler (2010 idem.) four elements play a role in order to identifying what an urban area is: The density of the built environment (number of houses per area), the population density (Inhabitants per square kilometre), the functionality of the place (urban areas allow and promote specific functions as business centres or infrastructures like schools, health services and markets), and the economic sector distribution (low share of agriculture, high share of services and industry).

Authors and researchers like Giffinger (2009) or Camagni (2007, 2009) have proposed that competitiveness based on the territorial capital is one of the driving forces of regional development[15].

For Camagni "*In terms of international and interregional trade theory, regions do not compete with each other on the basis of a Ricardian "comparative advantage" principle – which guarantees each region a role in the international division of labour – but rather on a Smithian "absolute advantage" principle, similar in nature to Porter's concept of competitive advantage (Camagni 2002)… Definition of possible growth strategies for each region, city or territory must necessarily rely on local assets and potential, and their full and wise – exploitation: in short, on what is increasingly called territorial capital*"[16].

As seen with the concept of territorial capital, Camagni calls the attention to the use or exploitation of local (natural) resources. Social Infrastructures are related with resources but at the human development level, what means they are related to human resources as will be presented in the next chapter.

Thus talking about from the perspective of the human development and quality of life, allocation, growth, improvement and renovation of social infrastructures will influence the human territorial capital of a place and therefore it competitiveness in a global perspective.

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[15] Giffinger Rudolf (2009). ***Territorial capital: It's meaning for urban and regional development***. International scientific conference: Regional development, spatial planning and strategic governance; Belgrade, December 2009.

[16] Camagni, Roberto (2009). ***Territorial capital and regional development***. In Handbook of regional growth and development theories; Capello Roberta and Nijkamp Peter editors. Edward Elgar Publishing Limited, UK.

4 Social Infrastructures

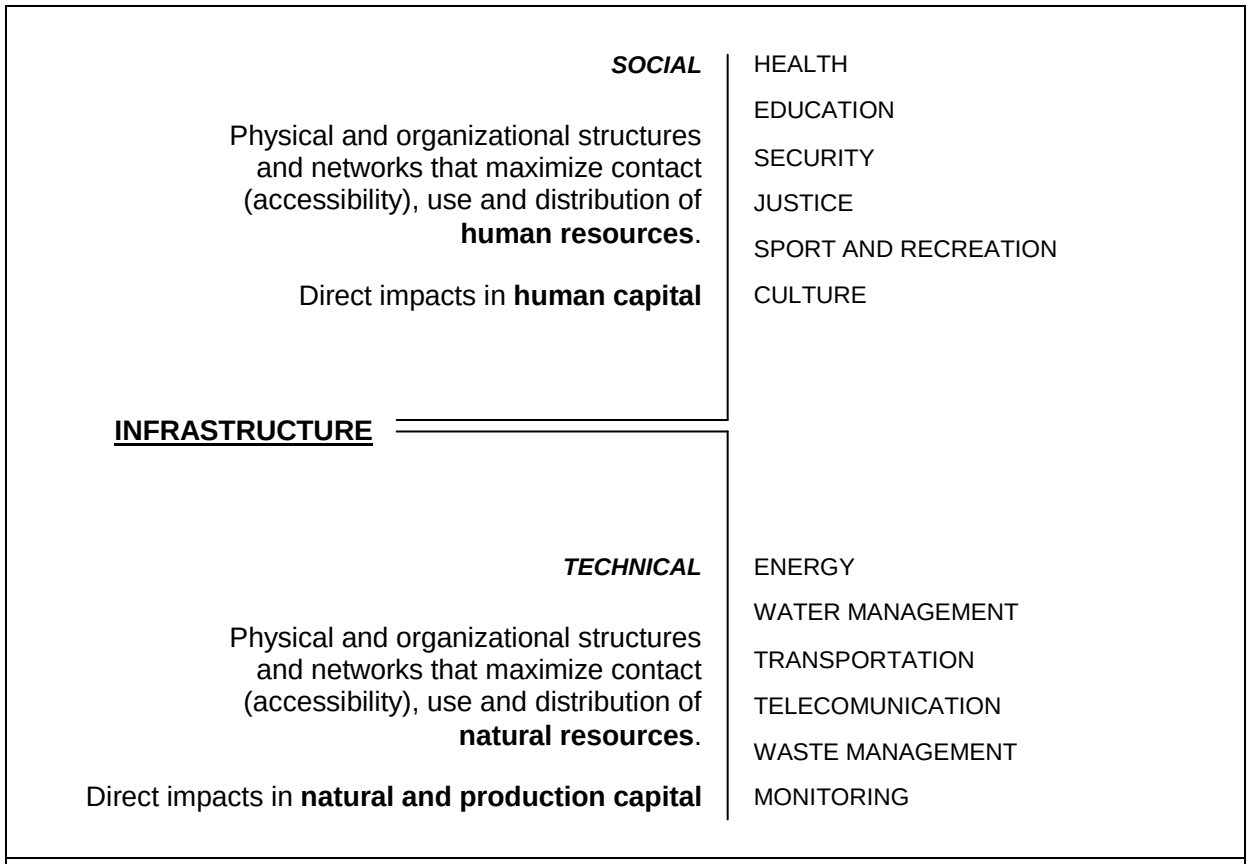
The term infrastructure is usually associated to technical infrastructures like those related with energy, water management, transportation, telecommunication, waste management and monitoring.

In the present work and aiming for a systemic comprehension of the facilities involve the term “Social Infrastructures” is proposed covering those infrastructures related to health, education, security, justice, sport, recreation and culture.

Facilities associated as social infrastructures in the present work have been defined from different authors with in other concepts like services or urban equipments (scholar equipments, health equipments and so on). The intention behind involve all them under the concept “Social Infrastructure” is oriented to watch them as a specifically system that overlap other different systems at the built environment.

4.1 Resources and Infrastructures

Using the definition of Infrastructure lived at the introduction of the present document Technical Infrastructures are the physical and organisational structures and networks that maximize contact (accessibility), use and distribution of **natural resources**.
In fact technical infrastructures are in direct contact with natural resources like water, wind and earth and allow us a better management and use or exploitation of them.
Symmetrically Social infrastructures are understood here as the physical and organisational structures and networks that maximize contact (accessibility), use and distribution of **human resources**. Know how (practical knowledge), Know what (facts), Know why (science) or know who (networking), together with intangible cultural assets are all social or human resources. These resources, as the natural ones should be managed, used and exploited in a sustainable way, allowing new outcomes, improvements and actualization of the sociological and human environment.
While improvement, new investment and direct works on technical infrastructures will produce direct impacts on production and **natural capital**, social infrastructure investments or improvement will have direct impacts on **human capital**.



Social and technical Infrastructure Diagram. Author.

4.2 Networks

By definition, the term infrastructure means not only a facility but an interconnected system, a network. Infrastructures are organisational structures of interchange, not just buildings or independent facilities.

Networks interconnectivity is real and visible when talking about technical infrastructures, like energy transmission lines, or highways on transportation (in transport the infrastructure is the network itself), or in water pipelines, and so on.

But when talking about social infrastructure, networks are not so clearly defined, or are established in other levels.

Networks play a role in social infrastructure at least in two ways: during the planning process and in a sociological level.

Social infrastructure networks are useful during the planning process in order to allocate in a systematic and coordinated manner the new facilities. Overlapping different systems as a methodology will allow planners to check for “connectivity’s” of the system with the built environment.

The second kind of network associated with the social infrastructure is a social network. Social networks are established for citizens but the fact that institutions are part of an entire system will motivate them and give them already a node where to connect with the others.

5 Role of the Social Infrastructure Allocation

The last part of the paper is dedicated to the role itself of the social infrastructures allocation, what might be understood from two different sides: One is a general organisational role, where due to the allocation the entire context functionality is affected or activated. In this role, the social infrastructure might be allocated in two ways, centralized or distributed.

Besides organisational roles social infrastructure might be used to develop an entire networking structure of the built environment. Here, through the allocation of social infrastructure an overlapped planning process is carried out in order to integrate urban clusters in a network lecture.

5.1 Organisational Role

Mainly there are two place allocation methods: One based on concentration of social infrastructures in one spatial unite. This method is developing a spatial efficiency order, where investments are centralized in one big (normally) multifunctional place.

The second organizational method is a spatial distributive method, where, in stead of a centralized organization, social infrastructures are divided all over the build environment, looking for a spatial equity or equilibrium.

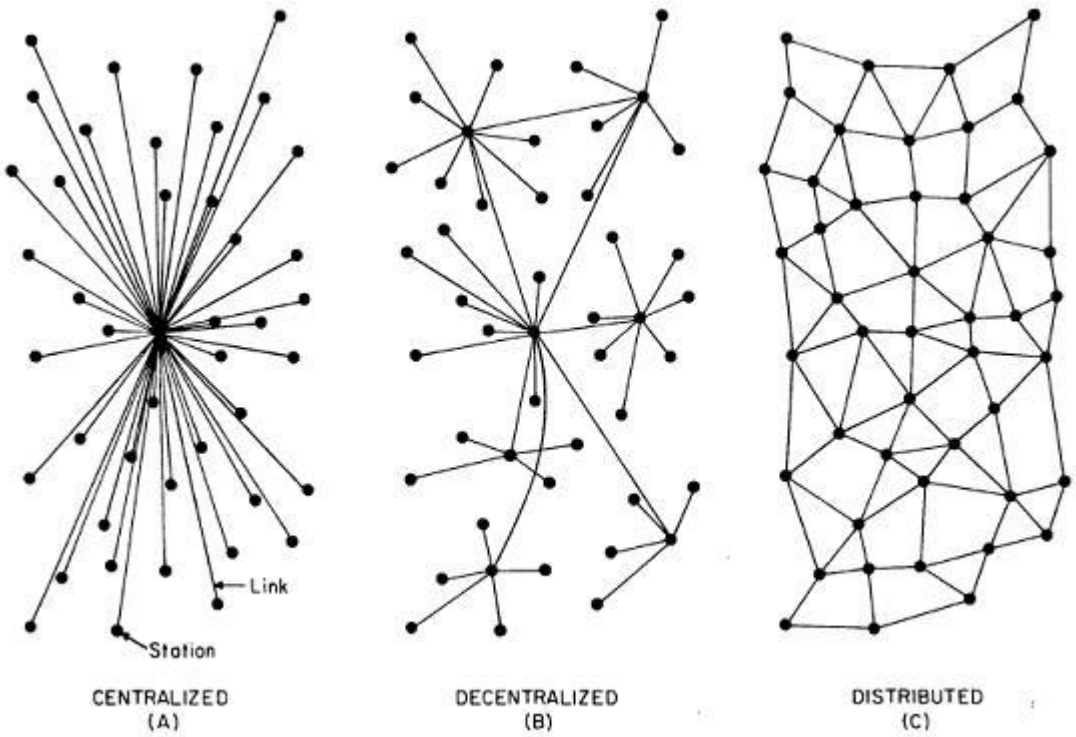
This distributive approach should be done with regard to different developments concepts:

- Geometrical equilibrium: where every certain xx meters a facility should be allocated (also possible to carry out following catchment areas capacities).
- According to population densities of the context: where facilities will not follow a geometrical abstract grid but will react to the specific amount of inhabitants are found on the context.
- With regard to development corridors: Distributive approach where social infrastructures are distributed along planned development corridors in order to influence uses along the corridors.
- Based on transport accessibility: Allocation will react to how transport accessibility analysis suggests a right place is.

5.2 Network development Role

Aiming for a continued urban experience (opposite to a fragmented experience), social infrastructure allocation might be used to regenerate the structure of built environment, giving or assigning hierarchies to the urban clusters as a participants of a network.

Urban network experience built among the overlapping of different systems will rediscover for example brown fields and including them again to the built environment experience. Consolidation of networks systems with in the urban territory are looking for a reconstruction of the urban fabric and its continuity lecture and use.



Main 3 spatial network systems. Image from internet free source.

6 Conclusions and further work

A better quality of life as well as human development perspectives are reason that influences the choice of a migrant at the moment of resettled.

Social infrastructures are not the first reason why many people migrate, but distribution of it might help with a more equity and sustainable territory, as well as with a more balanced used of the human resources.

Social infrastructures might affect the territorial capital of place while affecting human capital. Social infrastructures improve the way human capital is managed.

Allocation of social infrastructures is a key factor on spatial and social equity construction.

The concept of territorial capital based on absolute advantages analyzed from the perspective of the human capital and human resources still has a perspective of analysis when talking about migration (“dynamic capital”). How does skilled and professional migration affect the human territorial capital of a place and its absolute advantages?

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Remote Sensing and GIS for Urban Infrastructure Planning and Management

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Abstract. This paper provides an overview on recent achievements in urban remote sensing and GIS, designed to support infrastructure planning and management. Some of the topics covered will deal with the usage of high spatial resolution satellite images and object-based image analysis for automatically classifying urban land cover and land use. Information on land cover and land use is precisely useful for assessing the needs for expanding the currently available technical and social infrastructure, for conducting evaluations on urban quality of life and urban microclimate, for detecting illegal urban sprawl, and for assessing the city impervious surface and the related flood-prone areas, among other topics. The elaboration of 3D city models, based on satellite images stereoscopy and/or airborne laser scanning sensors will also be handled. Such models are useful for managing the urban infrastructure, since water supply and waste water pipelines; city lighting equipments; manholes; roads network; train and subway railways and stations; TV, telephone and internet antennas and underground cables; urban vegetation; schools; hospitals; kindergartens and alike can all be visualized in three-dimensional mode. These 3D models are also useful in emergency situations, for they provide strategic information on fire plugs and best routes for ambulances, fireman and police vehicles. The use of digital elevation models combined with thermal satellite bands has been extensively explored to identify urban heat islands and subsidize environmental comfort analyses, and some examples in this regard will be as well presented. GIS databases associated with refined quantitative methods can be used for automated site suitability analysis and this topic will also be approached. Spatial analysis techniques applied to GIS data will be shown within the scope of socioeconomic studies, conceived to understand social exclusion in cities. Population estimates based on the use of orbital and airborne remote sensing images will be dealt with, since updated information on urban population is crucial for supporting the action of civil defence in the case of natural hazards and for planning new investments in social and technical infrastructure. The use of GPS equipments in buses for improving the quality of public transportation is illustrated in this paper as well. And finally, the employment of remote sensing and GIS in broader fields related to the urban environment will be introduced, such as global environmental change, natural disasters and civil defence; public health; and simulation and predictions of urban growth and urban land use change based on the use of remotely sensed data, statistical techniques and computer modelling platforms.

Key Words: Remote Sensing, Geographical Information Systems, 3D City Models, Automatic Classification of Urban Land Cover/Land Use, Dynamic Models of Urban Land Use Change.

1 Introduction

Remote sensing can be defined as a set of activities aimed at obtaining data on the natural resources of the Earth and its environment by means of sensors on board of low and high altitude platforms (e.g. balloons, rockets, aircrafts, and satellites), which detect the electromagnetic radiation reflected or emitted by a target, converting it into a signal that is further processed, generating imagery products (Slater, 1980).

The resulting need of processing the great amount of information derived from remotely sensed data in an accurate and operational manner gave rise to the creation of Geographical Information Systems (GIS), which consist in a "set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes" (Burrough, 1986).

Since the launching of the first civil satellite – ERTS 1 (Earth Resources Technology Satellite) by the National Aeronautics and Space Administration (NASA) in the USA in 1972, remote sensing images have been intensively used to explore the urban and regional environment. Along the four latest decades, the humankind witnessed remarkable advances in the field of Earth observation technologies. A profusion of new remote sensing satellites and constellation of satellites came into scene with ever increasing spatial, radiometric, spectral, and temporal resolution. Equipments of Global Positioning Systems (GPS) became more and more popular and are currently part of our daily routine, in our mobiles and in our cars (for navigation or security reasons). An amazingly growing number of GIS platforms have been created, rendering available sophisticated algorithms for images processing, statistical spatial analysis, spatial inference, digital cartographic mapping, generation of 3D city and relief models, and spatio-temporal simulation of dynamic geographic phenomena, amongst other applications.

Remote sensing and GIS offer nowadays a wide range of possibilities to investigate the urban realm and extract information on socio-economic, biophysical and technical features within its domain. The technically savvy people ought to make the best use of the available technology in Remote Sensing and GIS in order to provide subsidies for urban public policies and actions as well as support decision making processes in the scope of urban infrastructure planning and management. Some of these investigation possibilities will be presented in the next sections.

2 Possible Applications of Remote Sensing and GIS to Urban Infrastructure Planning and Management

2.1 Site Suitability Analysis

Digital maps, in some cases derived from information directly extracted from remote sensing images, are useful to drive site suitability analyses designed to find optimal locations for certain kinds of land use. An example in this sense concerns a work targeted to select an optimal place to shelter an intermodal freight terminal along the Tietê Waterway located in Sao Paulo State, Brazil. Ferries in this region are meant to transport raw sugar cane along the navigable stretch of the Piracicaba River, a tributary of Tietê. Several biophysical and socio-economic variables were jointly combined in a Fuzzy Gama analysis (Figure 1) that overcame the hindrances of conventional qualitative analyses usually made through the overlay of maps. Not only one scenario is possible, but rather many scenarios, defined according to fluctuations in the value of the Gama index (*Y*).

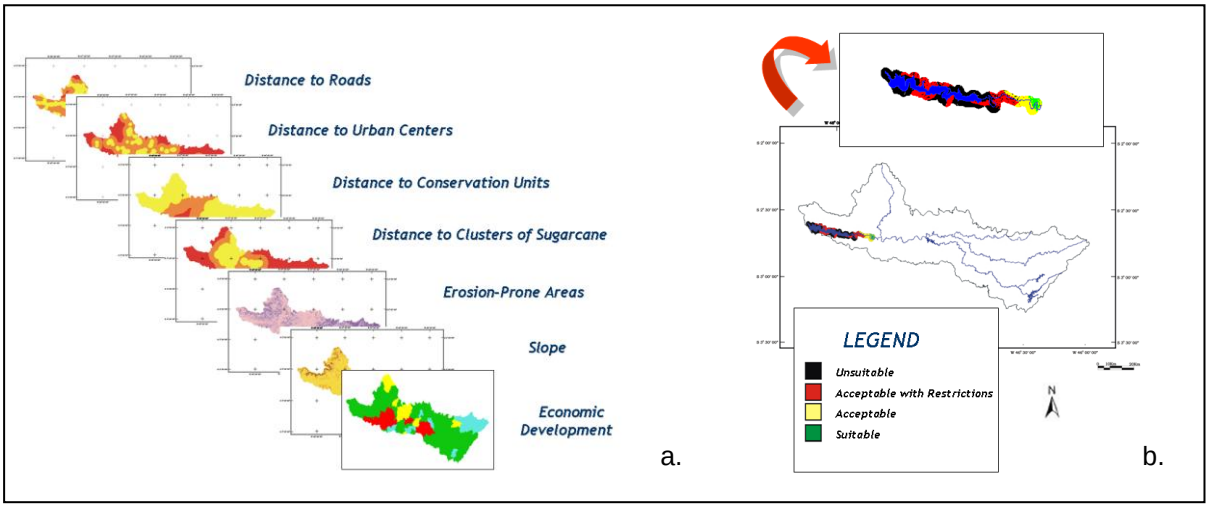


Figure 1: Site suitability analysis for the implementation of an intermodal freight terminal along the navigable stretch of the Piracicaba River. a. Variables used in the analysis. b. Result showing categories of suitability for a 2km buffer along both margins of the navigable stretch, within the borders of the Piracicaba municipality.
Source: Almeida et al. (2001).

2.2 Land Cover and Land Use Classification

A recent trend in automatic digital classification of urban land cover and land use is the employment of 'Object-Based Image Analysis' (OBIA). This methodology consists in the usage of hierarchical semantic networks and multiple levels of classification interrelated with them. It strives to emulate the human cognitive process, which is based on contextual vision, for interpreting scenes. A work in this line has been carried out for the city of São José dos Campos, southeast of Brazil.

The semantic net started from a pan-sharpened QuickBird image and a GIS layer containing the city streets network, assigned to Level 3; a classification of vegetation,

shadow, and built-up areas was carried out and assigned to Level 2. And observing these two levels, a classification of urban land cover was finally executed at Level 1.

On a second stage, a binary layer referring to areas below and above a given threshold of streets greening density was inserted as Level 6, and residential and non-residential blocks were classified at Level 5. Observing simultaneously Levels 1, 5, and 6, a classification of homogeneous residential zones was accomplished at Level 4.

Levels 1 to 3 concern the first stage of the classification process, taking into account mainly spectral and geometric information, and Levels 4, 5, and 6 regard the second stage, mostly considering class-related and topological information (Figure 2). This is all done automatically in a way that resembles how the brain of a human interpreter processes spatial information.

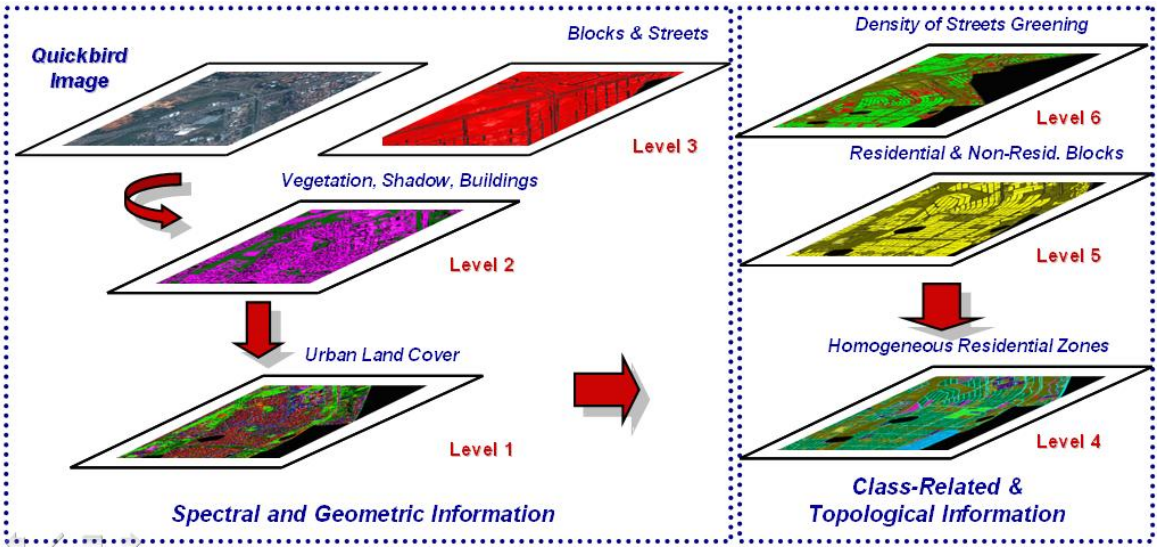


Figure 2: Levels of classification in an OBIA experiment for São José dos Campos city. Source: Almeida et al. (2007).

2.3 Urban Socio-Economic Studies

Several analyses have been conducted in recent times on socio-economic aspects of urban population using advanced spatial analysis tools available in GIS. One indicator employed for this purpose is the so-called social exclusion/inclusion index, mainly based on variables related to the dwellers income and level of education.

The Moran Local Index assesses spatial autocorrelation between polygons (in this case, census districts of the town under analysis). High values indicate areas of spatial association (either positive – social inclusion – or negative – social exclusion).

LISA stands for Local Indicator of Spatial Association, and the LISA Map shows clusters of similar values of the attribute, either social inclusion or exclusion. The Box Map, on its turn, classifies areas according to the status of their neighbours, indicating areas of stationarity, i.e. neighbours of a district present the same behaviour as

the analysed district (either positive or negative), and areas of transition, where neighbours own a disagreeing behaviour.

The Moran Map does the same as the Box Map, but considers only the statistically significant areas according to the LISA and the Box Map (Figure 3). All this information provides subsidies for social public policies and actions.

Another work in the same line concerns innovative ways of spatialising socio-economic indicators. Figure 4 shows two different ways how the human development index (HDI) developed by UNO has been spatialised for the distinct counties of Sao Paulo State. In the upper left box, the HDI was spatialised according to quantiles, i.e. in a conventional discrete form. And in the lower box to the right, the same index was spatialised in a continuous form, through a technique of statistical interpolation called ordinary kriging, generating a surface that reveals vectors and spatial trends of increasing and decreasing HDI. This is what the GIS scientists call 'social topography'.

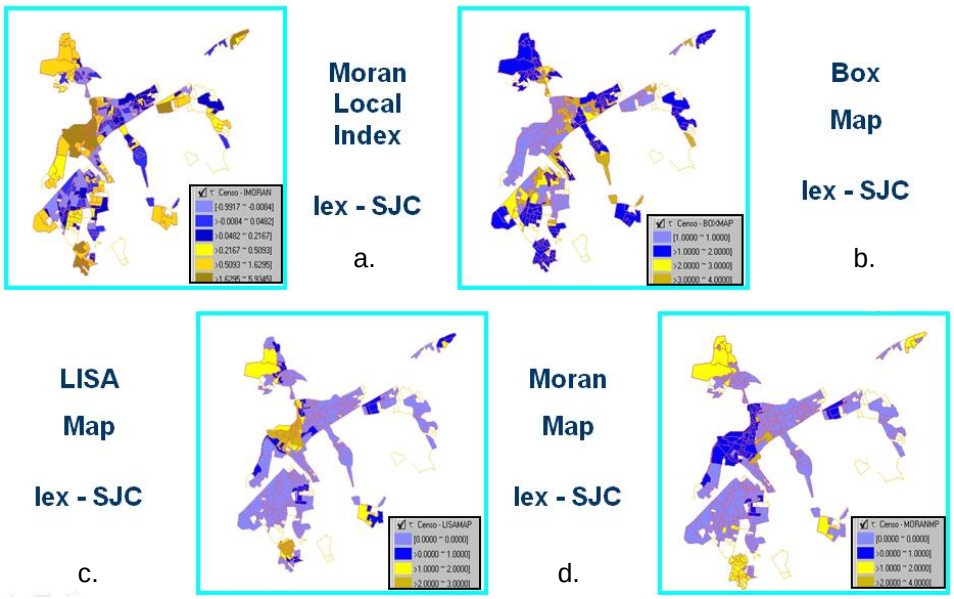


Figure 3: Different indices for the spatial analysis of the social exclusion/inclusion in the city of São José dos Campos, at the census districts level. a. Moran Local Index; b. Box Map; c. LISA Map; d. Moran Map.
Source: Genovez (2002).

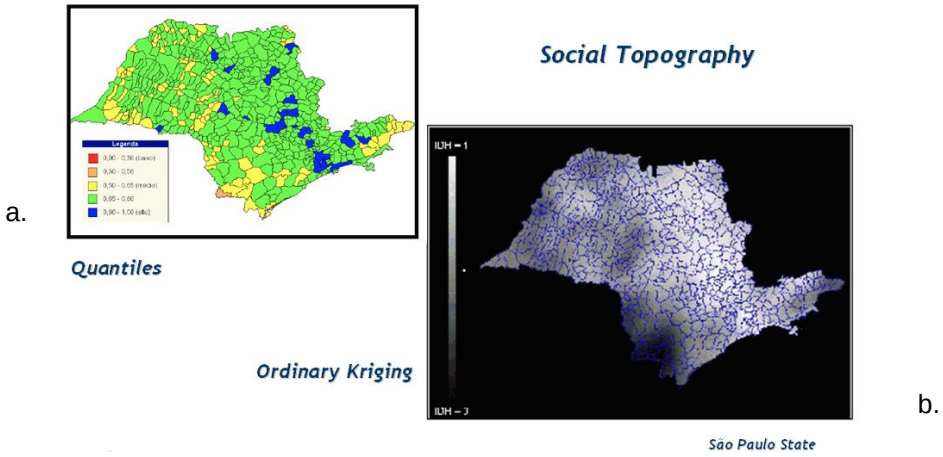


Figure 4: Spatialisation of the Human Development Index (HDI) for the counties of São Paulo State: a. quantiles; b. ordinary kriging.
Source: Ramos (2002).

2.4 Urban Population Estimates

Different techniques have been employed for estimating urban population using remote sensing and GIS. Amaral et al. (2006) used night-time satellite imagery from DMSP/OLS (Defense Meteorological Satellite Program/Operational Linescan System) to estimate the population living in urban settlements scattered through out the Brazilian Amazon Forest, taking into account the urbanised land area. The estimates were cross-checked with census data and presented an R^2 higher than 0.8. R^2 regards a statistical index, ranging from 0 to 1, which assesses the proportion of the variability in the response variable (amount of population, in this case) that is explained by the independent variable (extent of the urbanised area identified by the high brightness pixels in the night-time DMSP/OLS image).

To date, all of the studies based on measurement of urbanised land areas worked on a two-dimensional basis, i.e., flat habitable areas. But a clear future trend will be to embody the third dimension in population studies in the cases where multi-storey residential buildings are found. This is especially true in big cities of developing countries, where there are commonly tens or even hundreds of thousands of high-rise residential buildings.

Population estimates are precisely important in informal settlements, since they are seen as risky areas with respect to security aspects and conventional estimates based on field surveys are time- and money-consuming. This importance is acknowledged especially nowadays, since multi-storey buildings started being built in informal settlements in Brazil.

A study on population estimates was carried out for the squatter settlement (*favela*) Rio das Pedras in Rio de Janeiro. For assessing the habitable surface taking into account the multi-storey buildings, a digital surface model (DSM) was initially built using a stereo pair of IKONOS panchromatic images, using the Rational Polynomial Coefficients (RPC) method. An object-based land cover classification was carried out

for the area, so as to discriminate building and paving materials in a detailed manner. The census districts were used to calculate the projected area of the habitable surface (Figure 5). For each of the districts, all areas corresponding to classes related to the residential use were summed up (like asbestos, dark concrete). Big targets which do not relate to the residential use, shadow on streets, clay bare soil, streams, metallic roof and vegetation were excluded from the calculation.

The population of Rio de Janeiro city in 2000 was compared to the estimated population in 2006 (produced by the Brazilian Institute for Geography and Statistics – IBGE), assessed by field interviews to sampled dwellings. The increase percentage for the whole city was applied to each of the districts. The population density was calculated according to data supplied from the Pereira Passos Institute – IPP – in Rio, as a function of the inhabitants of the squatter settlement divided by its area. It was assumed the density remained constant. Finally, a height factor of 1.3 derived from the DSM was generally applied to all of the districts. This factor accounted for a 30% increase in the projected area. The value of the total population in the *favela* generated by the estimates from IBGE – which were the reference data – and the total population calculated with the aid of both the DSM and the object-based classification showed to be very close to each other.

2.5 Urban Transportation Planning and Management

As to urban transportation planning and management, an initiative worthy of mention regards the installation of GPS navigation equipments in the bus fleet of Uberlandia city, Minas Gerais State, Brazil, which allowed the monitoring and tracking of buses by a control centre subordinated to the local traffic engineering agency.

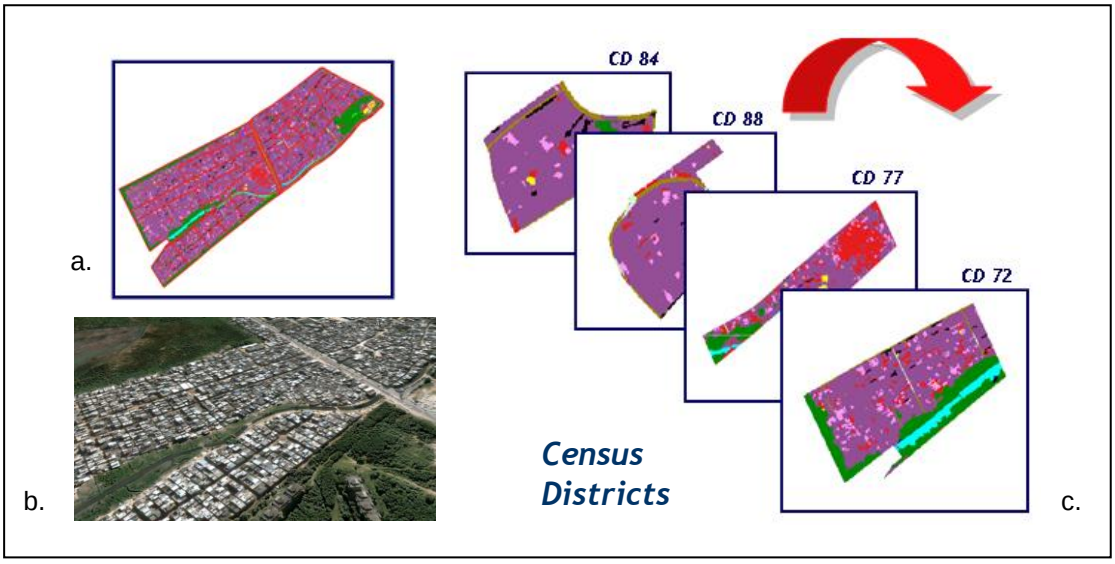


Figure 5: a. Object-based classification of urban land cover in the *Favela* Rio das Pedras, Rio de Janeiro; b. partial view of the digital surface model; c. census districts with the corresponding land cover classification: asbestos tiles (purple), metallic roof (pink), shadow (black), bare soil or French tiles (red), light concrete decks (yellow), sand or grave (brown), vegetation (green), and water streams (blue).
Source: Almeida et al. (2009).

The control centre tracks the buses along their routes and sends real-time information on the foreseen arrival time of buses from the different lines to electronic boards installed at the bus stops. The public buses users can access this information online, using the specific website of the local traffic engineering agency. This facility is especially useful in case of floods and traffic jams, since the control centre can contact the bus drivers and provide them information on alternative routes.

2.6 Urban Micro-Climate and Quality of Life

Urban micro-climate and quality of life have also been of great concern to urban remote sensing in the latest years. Fuckner et al. (2009) identified urban heat islands in central areas of São Paulo and Rio de Janeiro cities, where radiometric transforms of thermal channels of the ASTER/Terra orbital sensor, using Planck´s and other equations, generated maps of surface temperature. They were then superimposed on ASTER DEMs (Figure 6), and together with other satellite derived data, enabled to assess the relations between topography, vegetation, land cover, and surface temperature.

2.7 Natural Disasters and Environmental Vulnerability

For the first time in its history, Brazil, more precisely its southern coast, faced a hurricane in the year 2004 – the Katrina Hurricane, a fact which is ascribed to the current global environmental change.

Marcelino et al. (2007) collected hundreds of GPS points on field, assessing the intensity of damages in the affected areas. These data were further processed with the ordinary kriging interpolation method, generating a continuous surface map of damages intensity. This map was then passed on to the authorities and civil defence to support strategies planning and be used in further events, as a measure of precaution for the most vulnerable areas.

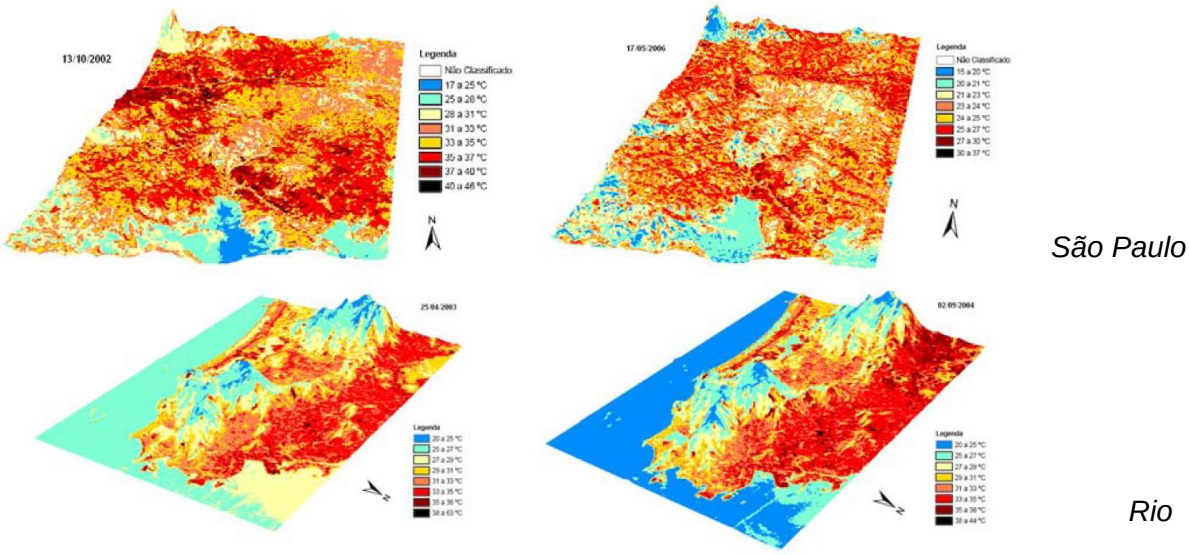


Figure 6: Surface temperature maps superimposed on digital elevation models.
Source: Fuckner et al. (2009).

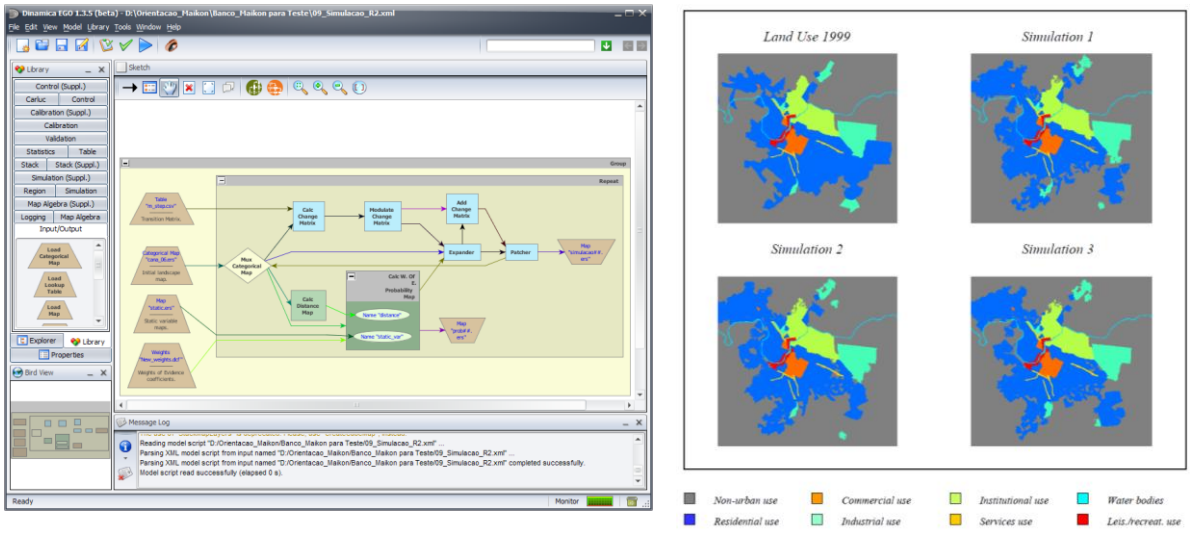
2.8 Spatial Dynamic Modelling of Urban Land Use

Spatial dynamic modelling is an important area in urban remote sensing and is designed to simulate in a virtual environment spatial dynamic phenomena observed in the urban environment. Changes in land use, traffic, pedestrian flows, floods, dispersion of air pollutants, and practically any kind of dynamic phenomenon can be modelled in urban areas by means of statistical models and specific computational platforms, driven by digital city maps, derived from and/or refined by satellite imagery.

Figure 7a shows the graphical user interface of a free modeling platform ‘Dinamica EGO’, developed by the Federal University of Minas Gerais, Brazil. The platform is open for different methods of parameterisation, Bayesian, artificial neural networks, linear and logistic regression, genetic algorithms, amongst others. Its graphical user interface is based on flow diagrams, in which each of the operators, which correspond to coloured boxes of diverse shapes seen in Figure 7a, encapsulate routines for parameterisation, calibration, and validation. Figure 7b presents examples of urban land use change simulation scenarios for Piracicaba city, São Paulo State, Brazil, for the time span from 1985 to 1999.

2.9 Epidemiology and Public Health in Urban Areas

Epidemiology and Public Health have gained greater attention in urban remote sensing. An illustrative and remarkable work in this line is the one developed by the State University of Campinas and the Federal University of Minas Gerais, Brazil, to control a tropical disease – known as 'dengue', which presents symptoms very close to malaria (high fever, muscular pain), is also transmitted by a mosquito and can lead to death in severe cases.



a. b.

Figure 7: a. Graphical user interface of the Dinamica EGO modelling platform; b. Real urban land use in 1999 and scenarios of urban land use change in Piracicaba (SP) in 2004. Source: Almeida (2003); Rodrigues et al. (2007).

Traps were distributed throughout cities with a great number of cases, to which females are attracted by pheromones. Once a female mosquito gets inside the trap, it sticks to a glue and can no longer escape.

The number of captured females is daily recorded by a GPS or a palm and is continuously inserted in a geo-database, which is then subject to processing by means of spatial analysis tools. The generated maps showing the most risky areas are submitted to the sanitary control authorities to support the due actions in the disease spread control and public awareness campaigns.

2.10 GIS Tools for Urban Applications

Some GIS have been especially customised according to the needs of local government authorities, aiming to support them in the urban and regional management activities. One of such platforms is SIGMUN, developed by the Division for Images Processing of INPE, which was particularly envisaged to fight land tax evasion in the coastal city of São Sebastião, São Paulo State, Brazil. The dwellers usually build swimming-pools and nearby roofed areas after the end of the construction of their houses and do not report on additional constructions to the town hall. Since swim-

ming-pools are taxed according to their area, SIGMUN is driven by a continuously updated orthophotos database, which helps preventing tax evasion.

3 Conclusions

As conclusive words, we can state that the information and telecommunication changes associated with an unexampled speed of information flow in an ever increasing globalized world, lead us to acknowledge the crucial role of earth observation technologies for urban planning and management, and to think up as plausible future paths in urban remote sensing the use of forefront standing data fusion techniques and advanced spatial analysis tools; of integrated 3D spatial dynamic models (coupling, for instance, climatic and physical models) and virtual reality in planning and public participation; of higher spatial, temporal and spectral resolution data, including the use of increasingly sophisticated object-based image analysis and knowledge-based systems and of unmanned aerial vehicles (UAVs) for the routine monitoring of urban environments.

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Enhancing the Local Knowledge for Improving the Infrastructure Facilities in Informal Settlements

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Abstract: Worldwide, urban areas continue to attract large number of people due to the economic opportunities they offer. Globally, the shelter conditions of the poor are deteriorating: 1.3 billion people do not have access to clean water and the same number live on less than a dollar a day; 2.6 billion people do not have access to basic sanitation, while 5 million die from diarrhea diseases every year. Poverty will clearly dominate the international development agenda of the 21st century.

Mostly in developing country like Indonesia the poor develop their informal settlements on vacant areas within the city such as under the bridge, along the railway track, on the cemetery, along the riverbanks, etc. They cannot reach the prize of formal houses developed by the government or private developer. They live in such settlements because they have no choice for living and protecting the family from local climate. Even though they live in bad environmental areas within the city, the formation of their housing areas is an integral part of the process of growth and development of a city. Therefore the development of informal settlements should be taken into account as a part of urban planning and design.

Listening to the community may provide ways to improve the understanding about the socio-culture of the people and give bright ideas how to develop their settlement. Indigenous people demonstrate great ingenuity in developing their residential neighborhoods and in organizing the open spaces and construction of housing. Therefore the local knowledge of the poor such as the ways, plans, designs and building materials is often far better suited to local needs, incomes, climatic conditions and resources than the official, legal standards demanded by governments. To improve infrastructure facilities in informal settlement it is better and more sustainable, if the inhabitants are involved at the whole process of development.

If the poor in informal settlements are given a chance to develop their houses and surrounding areas, they will show their great capability to improve their settlements, because they know exactly what they need and they know also their capabilities regarding their financial and building knowledge. Secure tenure is an aspect that should be considered in advance, because according to the field research the most dangerous situation felt by the poor in informal settlements is the implementation of eviction or demolition program in their housing areas. They are afraid of the demolition program because they do not have legal status of the land in which they built their houses. This paper will share experiences in improving the informal settlement based on exploration of both social and physical aspects of the settlement.

Key Words: Local Knowlede, Infrastructure Facilities, Informal Settlement

1 Introduction

The world's urban population is growing fast. In Asia, 2.2 billion people (one out of two) are expected to live in cities by 2020. Urban centers are also increasing in size and number. Asia now has 11 megacities, each with more than 10 million people. In addition, hundreds of towns and cities throughout the region have populations of 0.5 million to 9 million, and smaller town and cities are peopled by hundreds of millions. Urban centers are important to national economies because they are the engines of economic growth and the focal points for important activities like trade, commerce, industry, and government administration. Urban centers create opportunities for jobs, employment, and livelihood especially for the poor people. (ADB, 2004)

The development of cities in developing countries is always followed by the growth of informal settlements. Such settlements develop always around the city centre and their inhabitants mostly work in informal sector within the centre. Globally, the shelter conditions of the poor are deteriorating: 1.3 billion people do not have access to clean water and the same number live on less than a dollar a day; 2.6 billion people do not have access to basic sanitation, while 5 million die from diarrhea diseases every year. (Tebal and Ray, 2001) It is predicted that by the year 2020 three quarters of the world's urban dwellers will live in the cities and towns of developing world. It is very important to consider the growth of the informal settlements as a part of making development strategy for the city in order to reach a sustainable development planning.

In informal housing areas poor people develop their houses first with very simple materials such as pieces of cardboard, plastic, bamboo or wood. During certain times the housing area along the riverbanks grows spontaneously. Because the environmental quality within this area is poor, the government implements upgrading programs on the riverbanks which often gets rid of the spontaneous settlements and move the people to other areas. (Hardoy, 1989) Sometimes if people refuse to move, the government forces them by burning or bulldozing the settlements. Because they cannot afford the price of formal houses developed by the government or private developer, they will try to find another vacant area and then build again their huts. Demolishing the informal settlements does not solve the problems, but it stimulates the growth of informal settlements in other areas.

In spontaneous housing areas poor people have to deal with minimal infrastructure facilities. They have to live with bad access to the main road, bad environmental quality, lack of playgrounds for the children, etc. This situation forces them to be creative in using the physical facilities within the housing areas. Besides, the relationships among the inhabitants are very close, so that people will help each other if one of them has a problem. The physical environment within the spontaneous housing areas has specific characteristics because people develop their houses and the surrounding environment without any plan and the developments are adjusted to their demand and capabilities. The relationship between the way the people develop their housing areas and limited facilities available creates specific characteristics. Hence there are many interesting places created spontaneously and the people use them very intensive.

The other interesting aspect of spontaneous housing is the socio-culture of the people who have to survive with minimal infrastructure facilities. They maintain their life-style in a simple way and as in their former home village, all inhabitants in the spontaneous housing know each other very well. With this life-style they can continue to exist in a bad housing situation and carry on creative activities in several places according to the limited facilities they have.

2 Understanding the Informal Settlements

Understanding the activities of the poor in architectural space within the informal settlements is very useful for arranging a development strategy based on the character of the inhabitants. By paying attention to the economical situation of the low income people living in slum areas, it can be understood that they are hard workers, who are persevering in looking for their basic necessities of life for their family. Not only the husbands work, but also the wives work to help their husband in order to have additional incomes. Their dependence to the centre in the bustle of the city is very strong, because in the centre they can get their income everyday. (Khudori, 2002)

Although the people come from different regions, they are able to live together in harmony. It can be observed when one family needs help, many other families will extend their hand to give their help. The relationship among the people living in the informal settlement is very close. It is not limited by the difference of ethnic group, religion and race. (Srinivas, 2008)

2.1 The socio-cultural character of the people

By paying attention to the socio-economic situation of the low income people living in informal settlements, it can be understood that they are hard workers, who are persevering in looking for their basic necessities of life for their family. Not only the husbands work, but also the wives work to help their husband to have additional incomes. Their dependence to the centre of city bustle is very strong, because from the centre they can get their income everyday.

Although the people in informal settlement come from different regions, they can live together in harmony. It can be showed, when one family needs help, many other families will extend their hand to give their help. The relationship among the people living in the informal settlement is very close and it is not limited by the difference of ethnic group, religion and race.

According to the field research carried out in Informal settlements along the Babura and Deli riverbank , many young men and the fathers are not available in the settlements during the day time, because mostly they are working outside the settlements in informal sectors as pedicab *(three cycles)* drivers, second hand collectors, street vendors, parking guards, etc. They are going from their house at 07.00 in the morning and coming back at 16.00 or sometimes at 18.00 in the afternoon. *[see Figure 3 below]* The mothers stay more in the settlements because they have to take care of the children and also manage household activities like cooking, washing the clothes, taking care the small children, cleaning the house, etc. (Ribbeck, 2005)

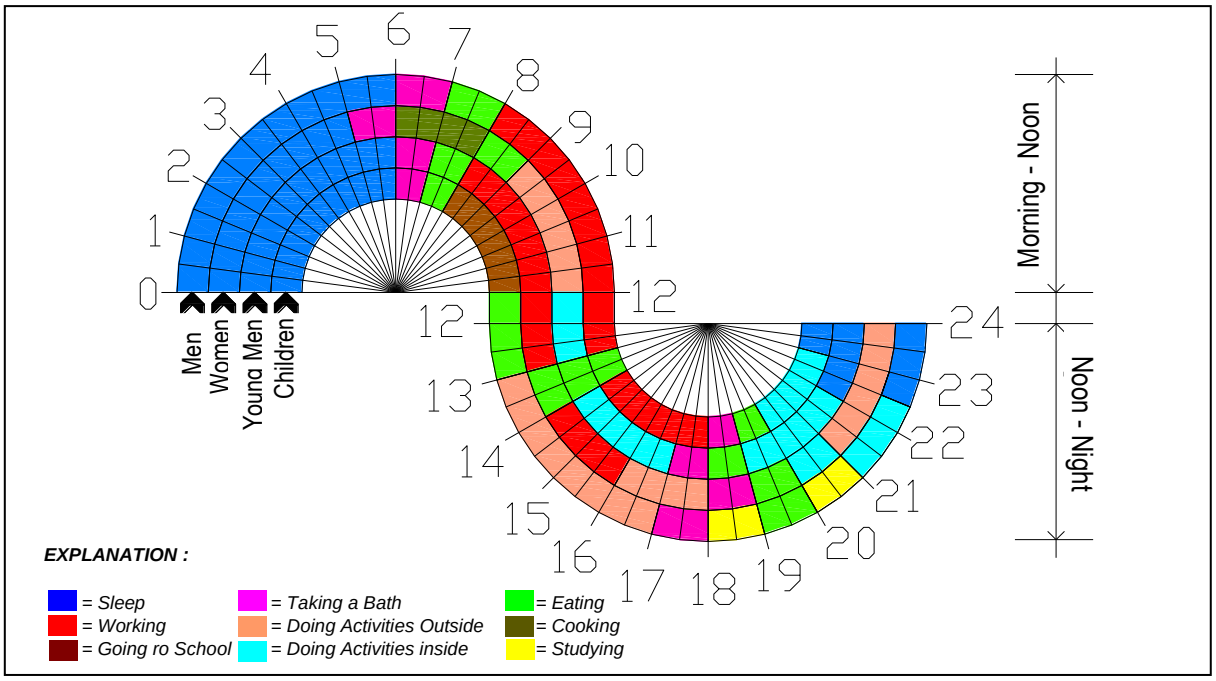


Figure 1. Daily Activities of the Adults, Young People and the Children in the Informal Settlements along the Babura Rivebank – Me

The social interaction among the inhabitants mostly happens in informal public spaces inside the settlements. Even though the public spaces available are not so wide, but the inhabitants use them very intensively by 'time sharing.' In the morning usually the mothers use the space for their interaction and meanwhile they take care of their small children. At noon after coming back from the school the children play at the same place used by the mothers before. Then in the afternoon after coming back from their work, the young people are doing their social interaction also at the same place. In the evening the fathers use the same place for their interactions with walking a. Usually the open spaces which have housing facilities like small mosque *(mushola)*, public well or public toilet, guarding post, and kiosks are used very intensively by the inhabitants for keeping their social interactions. (Bawole, 2007)

2.2 The pattern of Settlement and Character of Building Architecture

The position of the informal settlement usually cannot be seen directly from the main street, because it is behind a shopping complex or behind a housing area built formally. The building density in informal settlements is very high and the position of one house to the others is quite close. Most of the settlement patterns formed from circulation is seen as untidy. In spite of that, there are certain pathways of circulation often passed through by the inhabitants and the path can be the main circulation of the settlement. The other small pathway like alleys or alternative small ways, called "mouse path" can connect to main pathways or even to the main roads.

Houses in the informal settlement have different characteristics, even though in general they can be distinguished as permanent, semi permanent and non permanent buildings. The architectural typology of the houses in the informal settlement is relatively simple with a quadrangle ground plan and the building orientation is towards the kampong's pathway or to public open spaces. There are usually two entrances to the house; the main entrance from the front of the house and a side entrance at the back of the house.

The roof form is dominated by the simple form of "kampong" and "panggang pe" roofs. The other forms, like Limasan, Tajuk and Joglo, have been found only on a few houses. Generally a house with a complex form of roof is owned by the upper low income people or the middle class. The walls of the house have been made from very simple material, like carton, plastic and bamboo, up to bricks with good finishing. The floor is made from boards or from bamboo, cement, tiles, ceramic or maybe just from soil without finishing.

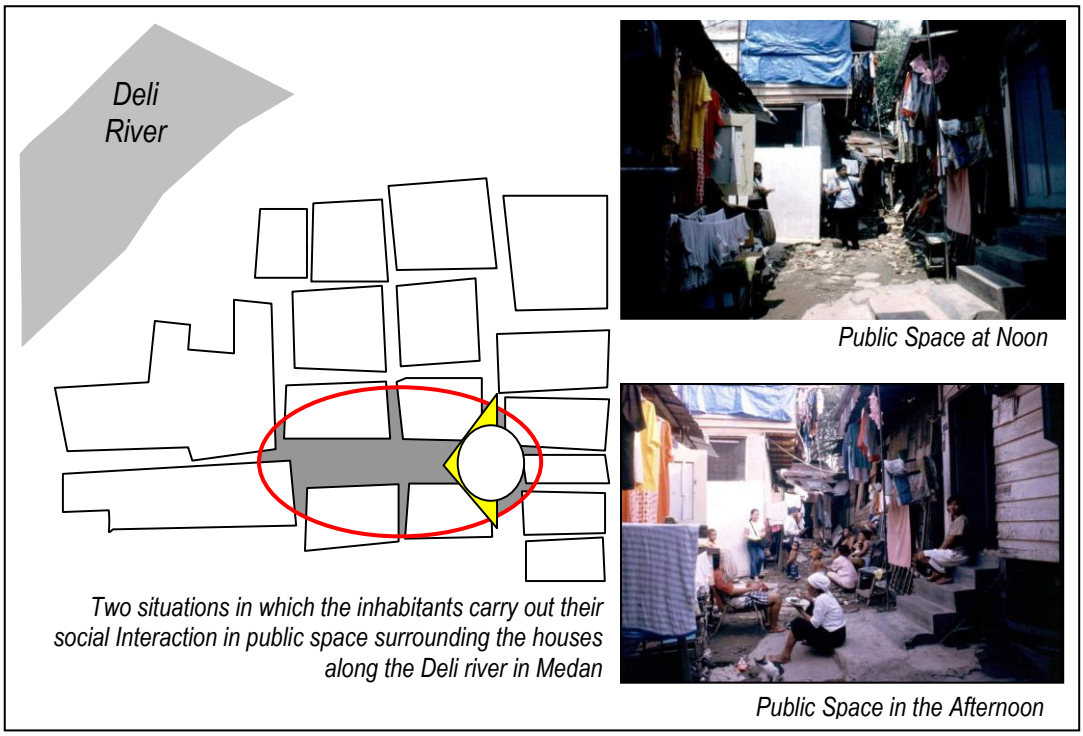
Rooms inside the house are varied from a house having one room up to houses with the rooms divided complexly. Generally the room arrangements are a public room, like a terrace, and a guestroom on the front side; the bedroom, the workroom and dining room in the middle part; the kitchen, bathroom and washroom located in the back side of the house. Grass roots people use the rooms in their house in a very flexible way. Middle to upper income people, when they have many family members, will use the rooms more intensively and very flexibly like the grass-root people.

2.3 The Character of Open Space and Circulation

The open space in informal settlements has been formed spontaneously, because the houses are developed without any planning. The spaces do not have certain patterns and form, but the inhabitants use the open spaces very effectively. From field observation, it has been obtained that there are some circumstances which stimulate the activity of the inhabitants in open spaces or on the kampong's pathway. One of them is the availability of open space used as an orientation of the houses. By facing an open space, communication and social interaction among the families living in the houses can be involved. Generally an open space will be used effectively by the inhabitants: children, young people and adults.*[see figure 2. explaining spontaneous public spaces]* They use the open space within the settlements with time sharing or by turns. The other activity stimulation is the available technical infrastructure facilities in the space, like a public water tap, public well and also social infrastructure facilities like a guarding house, food stall, *small mosque*, etc. Those facilities can stimulate the people to carry on social interaction and communication.

Based on the field observation, the open space in the settlement is very important for the social life of the people. Observing the socio-culture of the people living in the informal settlement, all of the members of society, the children, youth, women and men, always have social interaction there. If no open space exists, they will have social interaction on the public pathways near their houses. Especially for children, the public open space has a special meaning for them to play and express their creativity. Besides, the open spaces are very necessary for the settlement with dense built-up areas, because they function as a place for air circulation.(Bawole, 2010)

The facilities closely related to open space are the kampong's streets connecting the houses and available open spaces. Like open spaces, the streets have also been formed spontaneously because of the sporadic development of the houses. The streets have no certain form and size. Nevertheless the street most often used by the inhabitants can be categorized as a local kampong's main street. It is usually wider than other connecting pathways or mouse paths. The width of the main street is about 1.5 – 3 meters.



Two situations in which the inhabitants carry out their social Interaction in public space surrounding the houses along the Deli river in Medan

Figure 2. Spontaneous Public Spaces within Informal Housing Areas along the Deli Riverbanks

2.4 Infrastructure Facilities in Informal Settlements

Even though the infrastructure facilities are very poor, many families have electricity. Only the poorest families do not use electricity. They use oil lamps as an illumination. Since many families have electricity, electronic commodities like radio, tape recorder, television, etc. are mostly available. As street illuminations usually the family whose house is facing the street will provide electricity.

The other infrastructure facilities available are public taps, public well, public toilet and drainage. Several families in informal settlements have their private clean water facility. If they don't have such facility, they can take clean water from public well or public taps. Those infrastructure facilities can stimulate the social interactions among the inhabitants, if the facilities are laid down in public open spaces. (Herrle, 2005).

In several cases the waste water from the city flows through closed or open drainage to the river. If the informal settlements develop along the riverbanks, the waste water flows through them. Afterwards the people from outside see and think, that the poor throw away their waste water directly to the river.

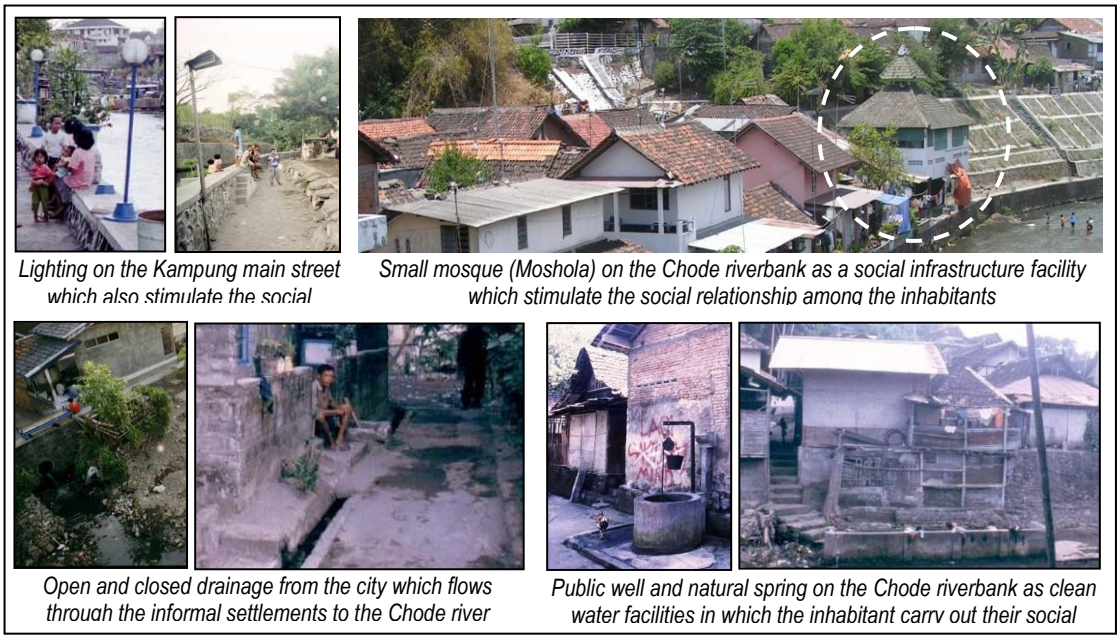


Figure 3. Social and Technical Infrastructure Facilities within the Informal Settlements along the Chode Riverbanks in Yogyakarta

3 Understanding the Activities of the Poor

According to the field observation, almost all inhabitants carry on their social interactions in public spaces available in the settlements. As it mentioned before that they use the spaces intensively by time-sharing. If there is no open space in the settlement, they will use the pathway as a playground. In the afternoon, usually they will do their activity in open spaces covered by the shadow of the building or trees. Open space is very important for the settlements, because it can be used as both a kampong pathway and spaces for air circulation within the kampong settlements. It is very interesting to see the daily activities of the inhabitants in informal settlements along the Chode riverbanks, Yogyakarta. *[see Figure 2]*

Figure 2. Two Types of Public Open Spaces Used by Inhabitants for Their Social Interactions

The inhabitants use the public spaces as a facility for maintaining their social relationship. In the morning between 07.30 –10.00, usually the woman use public open spaces for chatting and also taking care their small children who play around. At the same time the men go to work out side the settlements and the big children have to go to school. Therefore woman's activities dominate the use of public open spaces. The children spent their activities in public spaces after coming back from the school at 12.00.

Young people use the public open spaces for their social relationships in the afternoon at 15.30 up to 17.30. They share their daily experiences, play music, sport or sometimes they play chess. Activities of the young people inside the house are only sleeping, eating and in the evening, they are watching TV. Usually after watching television the young people carry on their activities outside the house up to 24.00 late night. Adult people are seldom to use the public open spaces for their social interactions, because mostly they work all day long in informal sector outside the settlements.

4 Enhancing the Local Knowledge for Upgrading the Informal settlements

Knowing the local knowledge created by the low-income people is better for developing strategies for settlement improvement. To understand the daily life of low-income people in informal settlements, it can be very helpful to live together with the people, because with living together it is easier to understand how the poor could struggle with their living environment. They will know how the people create the public spaces and use them intensively for social relationship. The creativity in designing architectural forms is stimulated by the limitation facilities they have within the settlements. (Cody, 1996)

Poor people demonstrate great ingenuity in developing their residential neighborhoods and in organizing the open spaces and construction of housing, even if the government regards them as illegal. They do not have a chance to live in formal settlement, because they are too poor to reach the formal housing prize. In other word it is quite difficult for them to save their money for their future better live. Since they live in informal settlement with minimal infrastructure facilities, they have to be creative and used the facilities within the settlements effectively. Therefore their ways, plans, designs and building materials are often far better suited to local needs, incomes, climatic conditions and resources than the official, legal standards demanded by governments. (Nierman, 2005).

Enhancing the local knowledge makes the development process easy, because the inhabitants are already familiar with their creativities in developing the settlements. There are several circumstances that have to be prepared in order to enhance the local knowledge for improving the living standards of the low-income people.

Those circumstances are:

4.1 Changing the Appreciation of Informal Settlements in the City

To regard the poor not as a problem but as a solution requires an honest good motivation, because it is quite difficult to appreciate the poor activities and creativities positively. If the inhabitants improve their surrounding environment as well as their living quality with their own effort, they will maintain the environment very well and the development of the informal settlements will be sustainable too.

There are many institutions can involve in urban upgrading program in informal settlements like funding institutions, private developer, government institutions, academic institutions, NGO's, etc. The first step to appreciate the informal settlements is that all participants interested in helping the poor must have a great honest heart. Besides, all participants should not take any profits or any self advantages of development plan in informal settlements. They should have a positive thinking in regards to face the reality in informal settlements. Afterwards there are two main actions should be implemented concerning the development of informal settlements in the urban areas: *preventive actions and helping actions.*

The preventive actions should be implemented by the government or any other institutions in order to anticipate the development of informal settlements in the city. The most important thing of these actions is to develop other small centers in suburb and develop as soon as possible any vacant areas inside the city especially around the city centers. Through these actions the distribution of populations in the city can be separated evenly up to suburb and the poor people do not have a chance to develop their huts in vacant areas in the city, because the government or other institutions will develop the areas in advance.

Since demolishing houses in informal settlements cannot solve the problems of the poor settlements, the government and other institutions should help the poor in order to develop environmental qualities of their housing areas. They have to change their negative opinions about facing the living qualities in informal settlements. The most important action for helping the poor in informal settlements is to give guarantees that the governments or other institutions do not destroy the houses in informal settlements. They have to carry on land consolidation programs in informal settlements, so that the poor can improve their housing areas as well as their living qualities without being afraid of demolishing programs.

4.2 Doing the Total Participation

Concerning the sustainable urban upgrading in informal settlements, from the beginning the planning program should involve the inhabitants. Total participatory must be carried on in order to compile the idée and thinking of the inhabitants about how to develop their housing areas. An alternative approach for urban upgrading in informal settlements is "Advocacy Development Planning for and with the Poor" In this approach all institutions interested in helping the poor people together with local inhabitants should discuss and establish teams for doing the research, making a development plans and also implementing them. The team will be divided into two groups:

team for Field Research and People Participatory. These teams will prepare everything regarding the preparation of the research, the whole research, workshop with the poor people, making development plans for the informal settlements and implement them.

The field research team will observe the physical aspects of informal settlements especially the open spaces in which the inhabitants carry on their daily activities. Through the observation of the physical aspects, it can be understood how the people carry on their activities in available open spaces intensively. Besides there are also special form of pathways, alleys and also other types of open space developed spontaneously. The information above will be compiled and analysed carefully, because it will be transformed into the basic strategy for making urban upgrading program in informal settlements. (Wilcox, 1994)

Research about people participatory will be done in order to find out how the poor people thinking about good environment around their housing areas, if they have a chance to improve their living qualities. According to the experiences, if the poor people think about having enough money, they will have also an ideal housing areas for their daily live. Usually the data got from the participatory research are ideal ideas and thinking that have a contradiction with the real situation of informal settlements. Those data will be record carefully because serial workshops they will be cross checked with the real situation gotten from the research of physical aspects. (Munt, 2008)

The further process is to carry out the serial workshops for making an urban upgrading plan. This process will be done several times until the compromises of development strategies of urban upgrading plan can be reached. The discussion in serial workshops will be focused on finding out the spatial form of informal settlements that can be transformed into the strategy of urban upgrading plan. With involving the poor people who live in informal settlements, they can be aware of the environmental quality within their housing areas. Afterwards they will also aware about how important to improve their living quality including the environment around the settlements. If the implementation of urban upgrading plan in informal settlements can also involve the inhabitants, the development program in informal settlements will be sustainable.

4.3. Transforming the Spatial Experiences of the Poor to the Urban Upgrading Program

Spatial form in informal settlements can be seen as a public open space and pathways in which many people carry on their daily activities. After finding out the spatial forms including inhabitants' activities inside, It is necessary to choose several active open spaces within informal settlements and then use them as an orientation of the plan for urban upgrading program. The active open space is chosen because it is a centre of human activities in the settlements. The circulations connecting the open spaces available should be considered as a pattern of the settlements. Afterwards the houses developed along the circulations or pathways should be improved step by step individually.

Technical infrastructure facilities like clean water supply, electricity, and drainage are very important for the families in informal settlements. If it is possible the technical infrastructure facilities should be installed in advance, because these facilities are needed for their daily live. The development of infrastructure facilities follows the settlement patterns formed by the open spaces and circulations. Social infrastructure facilities are also needed by inhabitants, because usually these facilities are used for social inter-actions among the inhabitants. The social infrastructure facilities like guarding post, local government offices, religious building and any other facilities are developed around the public open spaces.

To improve the environment qualities in informal settlements, several types of vegetations should be planted. In public open spaces some intermediate trees should be planted for creating the shadows in public open spaces in which many inhabitants carry on their daily activities. Decorative vegetations can be planted in pots and put them in front of th house or hang them up on the roof structure. If there is no place for planting the vegetations, every family should have pots and plant the small vegetations in the pots.

5. Conclusions

After discussing the informal settlements in Indonesian cities and the developments strategies with enhancing the local knowledge, the conclusions will be explained in the last part of this paper. Decent housing and living conditions are the most basic needs of each individual. Gaining secure access to adequate accommodation is often a pre-requesit for exercising many of the fundamental rights which form the foundation of all decent societies, and should be enjoyed by everyone. These include the right of access to education, the right to work, the right to social protection, the right to healthcare, the right to personal privacy and to family life, as well as the right of access to basic services such as water and electricity.

Implementing the ecological approach in improving the informal settlements can help the poor people to live in environmental friendly housing areas. If the poor are given a chance to develop their houses and surrounding areas, they will show their great capability to improve their settlements, because they know exactly what they need and they know also their capabilities regarding their financial and building knowledge. Therefore secure tenure is an aspect that should be guaranteed before the ecological approach is introduced to the people, because according to the field research the most dangerous situation felt by the poor in informal settlements is the implementation of eviction or demolition program in their housing areas.

Given the problems faced by the urban poor living in informal settlements there are many people and institutions who advocate that the provision of tenure through ownership is fundamental to poverty reduction. It is argued that ownership will :

- remove the possibility of arbitrary eviction;
- provide households with an asset which can be used as security for credit;
- provide a possibility for the poor to express their capabilities and knowledge in order to improve their living standard

- provide space for home-based economic activities;
- foster better living conditions, a better environment (especially space, sanitation and water) and improve personal security – particularly freedom from violent crime; and
- provide the conditions for the development of communities as residents have a sense of ownership.

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Community Participation in Slum Upgrading Projects
The Case of PAC – *Complexo de Favelas do Alemão*[17] in Rio de Janeiro – Brazil

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Abstract: The main objective of this paper is to discuss the relevance of community participation in infrastructure development projects implemented in slums. As a case study it will present a slum upgrading project, part of the Brazilian Federal Government Program called Growth Acceleration Program (known in Brazil by its initials PAC). This project is now being implemented in *Complexo de Favelas do Alemão* – one of the biggest slums in Rio de Janeiro. The infrastructure intervention of PAC has been changing, since 2007, the slum space configuration through huge interventions that include: construction of new housing unities, water, sewage, drainage and public lightening infrastructure, widening streets, construction of a cable-car system to improve accessibility and mobility and the implementation of social equipment. Although, in conceptual terms, the description of this project does not differ from other slum upgrading projects, Brazilian Government included, since 2007, the participation topic as an obligatory component when implementing social-urban infrastructure in precarious settlements. Participation is part of a process that must count on the involvement of different actors to contribute for the territory`s local development and its people education by the establishment of common objectives. The methodology to execute the social work includes the involvement of different segments of the community in meetings to discuss the infrastructure projects and to participate on the elaboration of a Participative Sustainable Development Plan. There is no doubt that the obligation of executing the social work has generated great opportunities for the community and also for the Government, but there are still some challenges to be faced by the next professionals who will be involved with slum upgrading projects and those who will work in some other participative planning. Some of the difficulties concern to local violence, voluntary participation, expectations and the execution period of infrastructure projects and social work. By reviewing the theory, presenting the methodology used, analyzing the results and the main challenges found in the project, this paper aims to professionals, who are working with infrastructure development in developing countries, especially in slums, aware of the importance of community participation.

Key Words: infrastructure projects, community participation and social work.

[17] In english: Alemão Slum Complex.

1 Introduction

Traditional researches might say that community participation does not play a role in the implementation of infrastructure projects. This is because community people are not considered to be planners. In fact, the local community citizens are the ones who face everyday problems and can help finding solutions, especially when planning for a slum area where complexity is higher.

Moreover, by participating in the process these people can exercise their citizenship and be considered part of the society like those who live in the "formal city".

The main objective of this paper is to discuss the relevance of community participation in infrastructure development projects implemented in slums. As a case study it will present a slum upgrading project, part of the Brazilian Federal Government Program called PAC (Growth Acceleration Program). This project is now being implemented in *Complexo de Favelas do Alemão* – one of the biggest slums in Rio de Janeiro.

By reviewing the theory, presenting the methodology used, analyzing the results and the main challenges found in the project, this paper aims to professionals, who are working with infrastructure development in developing countries, especially in slums, aware of the importance of community participation. The motivation to write this paper was because of the participation of the author as a professional who worked in the project[18] and the belief that community participation contributes to better results.

2 Community participation and planning

Before discussing community participation in slum upgrading projects, it is important to discuss the concept of participation. The focus here will be only in political participation in democratic regimes; once it can be easily associated with public policies implemented in Brazil which objective is to reduce the country's social disparities.

Since 1988, citizen participation is established in Brazilian Federal Constitution which has marked the transition from an authoritarian regime to a democratic one. However it is important to emphasize that there is a difference between political participation and electoral participation. Participation is much more than just voting (Azevedo, 2007; Freire, 1980; Tenório, 2007). According to these authors participation broaches the possibility of discussion, promotes educational spaces in search of rights and citizenship exercise.

In Brazil and in other complex societies, participation cannot be limited to institutional representation of the official channels (right to vote and be voted), it demands other democracy forms, especially in local levels, as the right of citizenship (Azevedo, 2007).

Tenório (2007) says that although the representative democracies have become successful, they do not request for much knowledge from citizens, who should just do a minimum effort. The author believes that the participation act goes beyond voting

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and that integration between representative democracy and participative democracy must exist. In his opinion, participation should guarantee an involvement among the civil society, the public sector and the private sector in order to actively take part in the deliberative process.

Freire (1980) says that preparing to democracy does not mean to convert an illiterate into a voter. By working with popular education in Brazil, Freire created the liberation pedagogy with the purpose of making low income people aware of the importance of participating actively in politics through an educational process. The author believes, there should be knowledge integration among educators and people. The educator should not just work to people, but along with them.

The participation process can be considered one component of an entire educative procedure where there is not right or wrong. In order to have a participative process, the representatives of the public sector and population must work together, part of a mutual learning process. “Integrated intervention projects demand a new professional profile interested in gaining knowledge and changing behaviors, what remains is only to know if this challenge must be faced by the academy or just by the professional practice”. (Andrade and Toledo, 2010)

It is important to stress that participation can neither be forced nor accepted as charity once it cannot be seen as a concession. Individuals should understand the process and be aware of their own acts and, last but not least, participation should be a voluntary act. (Tenório and Rozenberg, 1997)

By including participation in a public policy which aims to develop an area and improve the quality of its population; participation is restricted to a geographically defined territory. So, the objective of the policy can also be related to the local development concept.

Local development is a process focused on a physical territory where the protagonists are a plurality of actors who play certain roles in society and who also establish relations of common objectives and projects. (Tenório, 2007)

Participation can be seen as a voluntary act, part of a process that must count on the involvement of different actors to contribute for the territory`s local development and its people education by the establishment of common objectives. In order to include participation in local development projects, a new political culture must be built to change traditional attitudes, behaviors and procedures into a new type of planning, much more concerned with people’s wishes, respect and transparency.

If a classical planning is done by a group of experts who seeks a desirable future reality, using sophisticated languages through institutionalized processes, on the other hand a participative process is about a qualitative phenomenon which brings community involvement, intensity, educational impregnation and construction of a cultural identity; that can represent new challenges to the usual scientific quantitative planning. In fact, a really participative planning is very difficult to be executed in large scale projects, once it takes much time, even more than a government mandate. Because of that, what governments usually consider as a participative planning is just a technical planning with some participative strategies such as: consulting local asso-

ciations, involving expert people related to the area and sharing responsibilities with local organizations. (Demo, 1985)

By being aware of the importance of community participation, the challenge of mixing technical knowledge with popular understanding and the need to insert qualitative information into a planning, Brazilian government included, since 2007, the participation topic as an obligatory component when implementing social-urban infrastructure in precarious settlements.

Participation included in slum upgrading projects in Brazil is considered important at all stages of the project. “It is a process of social mobilization which represents at the same time a specific targeted objective as well as a way to achieve other project objectives. Therefore, popular participation has its own strategic dimension. It is a process of collective learning designed to strengthen the citizenship status of those involved. It also possesses an operational dimension, embracing the procedures incorporated in the agreements relating to the implementation of the different actions, works and services to be developed in the places where the beneficiaries of such actions reside”. (Ministério das Cidades / Aliança das Cidades, 2010, p. 77)

It cannot be forgotten that in Brazil there is not a tradition of participative practices and this lack of tradition is much more significant in slum areas, where an organized civil society rarely exists. According to Demo (1985), there are four requirements to check if a community organization can be considered valid: the representativeness of their leadership, elected by their community members, the legitimacy of the associative process where all members follow the same rules and have the same rights, keep the commitment and control on the basis of the organization and execute an effective participative planning to prove organization`s capacity of the community.

3 The Growth Acceleration Program (PAC)

The Growth Acceleration Program (known in Brazil by its initials PAC) was initiated in 2007 by the Federal Brazilian Government in order to overcome the main infrastructure deficits in Brazil. The investments are concentrated in three strategic areas: logistic (roads, rails, seaports, waterways and airports), energy (generation and transmission, oil, natural gas and renewable energy sources) and social-urban infrastructure (electricity, sanitation, housing, subway system and water resources). (Ministério das Cidades – Secretaria Nacional de Habitação, 2010a)

An important part of the investments designated to the social-urban infrastructure area, is being invested in different precarious settlements[19] around the country. The resources designated for the project come from the Federal Government and are transferred to the State Government and the Municipality; which are responsible for

[19] “Areas possessing one or more of the following features: tenure/ titling or urban irregularities; deficient or dilapidated infrastructure; danger of flooding, landslides or other types of hazard; high density of buildings; precarious building quality of housing units; long distances between housing and workplaces; insufficient transport systems…; non-existent or less than satisfactory public services…; a set of social problems engendering situations of extreme vulnerability; a social order based on violent crime”. (Ministério das Cidades / Aliança das Cidades, 2010,p.11)

the execution of the projects. *Complexo de Favelas do Alemão* was one of the first slums to be chosen because it could meet the guideline for selection which gave priority to huge complex of slums[20].

4 General context of *Complexo de Favelas do Alemão*

The occupation of the hills and mountains that today form the Alemão Complex of *Favelas* started around 1920. This was the solution of many workers who could not afford buying or renting a house close to Rio de Janeiro city center. They needed a place to live, even though they had to construct their houses and infrastructure by themselves.

Although, since 1993, Alemão Complex of *Favelas* is considered an official district of the city of Rio de Janeiro, its houses continued to be constructed without following the effective rules and the majority of them do not have any regularization title.

Today there are 27,624 houses in the Complex, located in 12 different communities where 89,912 people live[21]. Women are the majority of the population (52%) and responsible for 51% of the houses, which indicates that in some houses they are the head of the family, raising their sons and daughters. Children and teenagers represent 35% of the total population of the Complex.

In regard to the population considered as a work force, almost half of them are unemployed or have informal jobs, consequently earning inconstant incomes. It must be said that more than 90% of the local market of *Complexo de Favelas do Alemão* is informal. Even though it is possible to find there all kinds of shops and services such as bars, construction materials, clothing stores, drugstores, markets, mechanics and internet cafes.

Although more than 90% of the houses are constructed with masonry, result of a consolidated occupation which counted on progressive investments of its population, almost all the houses have problems in its interior as cracks, gutters, lack of natural light or ventilation. Most of the houses have access to electrical light but, more than one third of them have illegal electrical connections, made by their owners.

In regard to the public infrastructure, the same thing happens with public light, where one fourth of the pathways count with private wooden lampposts and not with public lampposts. More than 90% of the population has access to sewage system and water system; but it has to be considered that 28% of the houses have just one external faucet for the residents. Many of them say that they suffer from water supply irregularity.

The waste collection, in some parts of the Complex, is done directly in the houses by the Municipality (36%), in some other parts the garbage is thrown in public garbage containers (41%) and in some others the community sweeperers take charge of that

[20] In Alemão Complex of *Favelas* the State Government has the biggest volume of intervention and resources, because of that, all the results and experiences presented in this paper are related to the State Government intervention.

[21] All data presented in this part are results of a Household Census and a Business Census done in the Complex, as part of the project. Data were collected from July 2008 to June 2009.

(16%). But still, there are people who throw waste in green areas that have been turned into illegal waste disposals.

The local geography of the Complex restricts access to vehicles. Cars can only run in 30% of the streets. The access to the rest of the houses is done through narrow streets, stairs or pedestrian streets. The geography also contributes for the installation of drug dealing in the slum. Today, *Complexo de Favelas do Alemão* is one of Rio de Janeiro's most violent slums.

5 The PAC-*Complexo de Favelas do Alemão*

The infrastructure intervention of PAC has been changing, since 2007, *Complexo de Favelas do Alemão* space configuration through huge interventions that include: construction of 920 new housing unities, water, sewage, drainage and public lightening infrastructure, widening streets, construction of a cable-car system to improve accessibility and mobility with seven stations inside the Complex and the implementation of social equipment such as youth center, professional center, school, library, first-aid clinic and a shopping mall. (Ministério das Cidades – Aliança das Cidades, 2010 b)

Although, in conceptual terms, the description of this project does not differ from other slum upgrading projects, the Cities Ministry has incorporated the social work as an obligatory component in the project, which must be executed by a contracted firm under the supervision of the building contractor. In every slum upgrading project the social work must initiate in the diagnosis phase, follow the execution of the works and con-tinuing for a period of six to twelve months after the work conclusion. Together with actions of land and property regularization, the social work corresponds to 4-8% of assets invested in each slum. The value varies depending on the number of families living in risk areas that have to be resettled.

Some of the specific objectives of the social work are: ensure conditions for community involvement promote activities to improve the quality of life of beneficiary families, foster and enhance capabilities of social groups, strengthen family and community bonds, enabling participation of beneficiaries in decision-making and promoting participative management aimed at ensuring the sustainability of the enterprise. As a general guideline: "community participation should be understood as a pedagogical process of building citizenship and citizen's right". (Brasil, 2009)

6 Social work methodology

The methodology presented by the Government of Rio de Janeiro State to execute the social work has defined two main actuation areas: the Impact Management and the Sustainable Development.

The Impact Management Area intends to minimize the negative impacts and maximize the positive ones resulting from the physical interventions. By realizing community meetings, the Government intends to guarantee transparency during the work phase and maintain, for a longer period, the conservation of the new infrastructures implemented. The participants are responsible for informing other inhabitants every service interruption occurred by the works, new front works, next families to be reset-

tled and benefits of the new equipment. All this have a close relation with building contractor and to the present transformation of the slum.

The objective of Sustainable Development Area is the community organization strength, through constructing and implementing a Sustainable Development Plan elaborated in a participative way. The structure of the plan consists of five phases described below:

1) Entrance in the territory, which main tasks are related to the recruitment of local people to integrate the local field team and organization of the central team; characterized by multidisciplinary professionals (social assistants, psychologists, architects, engineers, geographers, economists, lawyers and graphic designers), mapping the territory, identifying and inviting local leaders, community association members, NGO`s leaders and young people;

2) Strategic knowledge which consists of knowledge production about the local reality through survey activities such as: household census and business census, focal groups with different segments of the community (local NGO`s, local businessmen, professionals involved with local education, health, culture and sports, environment and infra-structure) and a local NGO`s survey done by young people from the community who received a training capacity for that.

3) Future vision that consists on the construction by the participants of a common future vision for the slum considering a fifteen-year period of time. The input data come from the results of the surveys;

4) Action plan is the definition of the people needs projects and actions from different areas in order to reach the future vision established. They will be listed in a “Map of Projects”;

5) Implementation of some of the projects and actions in partnership with local NGO`s[22].

7 Participation results

Participation in slum upgrading projects can be analyzed from two different points of views: the benefits from participating and the benefits that participation brings to the project itself. But it must be said that, it is difficult to analyze them separately; once the first one can be considered a pre-requisite for the second. In other words, if people are not aware of the importance of participation and do not occupy the space destined in the project for them, the project itself cannot receive the benefits from participation of community.

In *Complexo de Favelas do Alemão*, it was clear that people had some difficulty to comprehend the entire Sustainable Plan actuation area, especially when they were

22 The three main projects that are being already implemented are related to: work qualification to the job market (professional courses), environmental and sanitation education (waste selection and recicllying campaign, illegal waste disposal cleanness, construction of a community organic garden, reforastation campaign in Misericórdia Mountain) and a creation of a Reference Center for the Local NGO`s (fund-raising, development of partenerships and common projects).

asked to think about the future. People are not used to planning or thinking ahead, even more when their wishes are nothing but live with dignity and have their basic rights attended by the public sector. The Government has the obligation to provide basic services for all, as it is written in the Brazilian Constitution, but unfortunately, the reality is quite different. Because of that, many of the times participants have brought some topics different from those that were being discussed. As for a long time they could not have the chance to be heard by the public sector, they wanted to show that they have voice and much to say about their reality. Some of the questions were about individual problems. They did not have the capacity to think collectively; this capacity was gained through the development of the project. Another difficulty was related with the voluntary participation. At the beginning, some people could not recognize why they were invited to dedicate their evening time, on week days or an entire Saturday, when the meetings occurred, to a project without earning any money for that. Some others were already tired of contributing for surveys, without noticing any upgrade from them.

On the other hand, by using the participative spaces, people from different communities had the opportunity to know each other, perceive that they have common wishes and that together they can be even stronger to struggle against their problems and claim for their rights. For some groups the opportunity of participating was stronger noticed and better used than from others. For instance, it was visible to see the determination of the local younger researchers when surveying the local NGO`s. For the majority of them, it was the first work opportunity that they had. Moreover, for some boys it was an option instead of working for the criminality. The families who received a new house to live could understand and make difference between public and private limits in order to respect the neighbours and maintain their unit blocks well kept.

The building contractor and the Government hope that the community members also develop a sense of belonging to the renewed *Complexo de Favelas do Alemão* in order to keep the new public equipments perfectly installed and effectively in use for a long period.

8 Brief conclusions

There is no doubt that the obligation of executing the social work has generated great opportunities for the community and also for the Government. Community has gained through exercising their citizenship, establishing collective objectives and awaken themselves to see that together they could be stronger than if they were alone. The Government could do the operational dimension of the project better and count on the cooperation of the local people to divulge and to preserve the new investments that have been done. Furthermore, now the Government has a Sustainable Development Plan with the needs and priority projects for the communities and recent data collected by the Census – this has never occurred before in a slum.

It must be admitted that citizen participation in infrastructure projects is very recent, once before 2007 did not exist any consistent practice in this field. So, there are still

some challenges to be faced by the next professionals who will be involved with slum upgrading projects and those who will work in some other participative planning.

A participative planning usually takes a long time to bring some results. So, in addition to the political time and the technical time, there is also the social time to be aligned together. Besides that, it was clear that in order to reach better results, the social work, (here representing the social time) has to start to be implemented together with the technical time, contributing to the working drawings and not only to the execution. And, it could not be missed to state that unexpected facts should be considered in the project schedule delay. One clear example is the crime and violence that usually interfere in the daily routine project.

The lack of responsibility with precarious settlements by previous Governments and the discontinuation of public projects could have contributed for an uneffective participation. Local social work teams should invest a significant time with mobilization and project promotion.

Another key point that can be more emphasized is the relation with private sectors in other to implement some of the listed projects more efficiently. Private sector should know that slums are a potential market to be explored, as shown in Census data. Moreover, after participating in the project and living a new reality after the physical works conclusion, there will still be many people, but now, much more conscious and aware of their citizenship power to plan the future time they always dreamed of.

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