### 5.3.2 Considerations

(1) Land Tenure/Ownership

All existing city roads have a right-of-way which includes the carriage-way and road reserve. The latter serves as land for future expansion of the carriage-way and for use by public utility lines such as water, sewerage, storm water, electric or telecommunications lines. All land lying within the right-of-way is for public use and is administered by the Dar es Salaam City Council. All other land uses including erection of buildings, etc., must take place outside of the right-of-way.

If road improvements require land outside a given right-of-way, the Dar es Salaam City Council must pay compensation and relocate home owners to other suitable sites. However, if any private land use encroaches on right-of-way, owners must relocate structures at their own expense. Conversely land which is required for future road development in unplanned/un-surveyed area (e.g., Manzese area) must be compensational and relocation undertaken at city council expense. However informal activities or structures, temporary in nature, encroaching on right-of-way in a surveyed or un-surveyed areas are not legally guaranteed compensation or relocation by the City Council.

(2) Compensation and Relocation/Resettlement

It is important to emphasize the following: Only property owners whose home/business is subject to demolition are eligible for compensation and not the tenants.

Compensation assessment will be based on individual property values only, and not the value of service connections or business expenses. Assessment of compensation amount must be made by a Government valuer. Demolition of housing or other property will occur only after the City Council has paid compensation, secured alternative serviced land plots and relinquished new properties to their new owners. A three month grace period will be allowed for home owners to resettle prior to actual demolition of the involved structures.

(3) Dominant Problems of Compensation and Resettlement

Present conditions for compensation does not consider cost recovery for services or business connections during compensation assessment. Existing regulations, only allow for property owners to be eligible for compensation and resettlement.

It is recommended that tenants and other occupants of affected housing should be considered for compensation based on private agreement between property owner and tenant.

# Table 5.1

## Residential Resettlement by Project

| Name of the road | Name of the Contractor | Year of construction | Number of Buildings demolished | Amount of Compensation | Number of people resettled |
|---|---|---|---|---|---|
| 1. Old Bagamoyo | UNICO | 1992-1993 | None, but 11 frontage fences were pushed back | 10.0 million sh. | NONE |
| 2. New Bagamoyo/Upanga | KONOIKE | PHASE II | None, but 3 premises (including a filling station) were pushed back | NONE | NONE |
| 3. Mpakani Extension | MECCO | 1992-1994 | None, but 2 fences will be pushed back | | NONE |
| 4. Shekilango | KONOIKE | 1992-1993 | NONE | NONE | NONE |
| 5. Kinondoni | KONOIKE | PHASE I | NONE | NONE | NONE |
| 6. Mwinjuma | KONOIKE | PHASE I | NONE | NONE | NONE |
| 7. Morogoro | NOT YET DETERMINED | PHASE III | III HOUSES | 657.8 million sh. | HOUSE OWNERS ONLY i.e 111 people |
| 8. Morocco | KONOIKE | PHASE I | NONE | NONE | NONE |
| 9. Ohio | KONOIKE | PHASE I | NONE | NONE | NONE |
| 10. Port access | MOWLEM | 1978-1980 | NO ACCESS TO RECORDS | NO ACCESS TO RECORDS | NO ACCESS TO RECORDS |
| 11. New Kigogo | MECCO | 1985 | NO ACCESS TO RECORDS | NP ACCESS TO RECORDS | NO ACCESS TO RECORDS |
| 12. Uhuru | KONOIKE | PHASE I | NONE | NONE | NONE |
| 13. Sokoine | KONOIKE | PHASE I | NONE | NONE | NONE |
| 14. Bandari | KONOIKE | PHASE I | NONE | NONE | NONE |
| 15. Gerezani | KONOIKE | PHASE I | NONE | NONE | NONE |
| 16. Chang'ombe | NOT YET DETERMINED | PHASE III | NONE | NONE | NONE |
| 17. Pugu | MOWLEM | 1975-1977 | NO ACCESS TO RECORDS | NO ACCESS TO RECORDS | NO ACCESS TO RECORDS |

Contract duration:
- Phase I from December 91 to November 92
- Phase II from January 93 to December 1993

Source: Dar es Salaam city Council (DRIMP) and Ministry of works, Communications and Transport.

## 5.4 Flora and Fauna

The survey was to identify mangrove composition; (presence of wildlife and their uses), tree species along selected roads and residential area and other public and private open spaces which could be affected by future road development.

### 5.4.1 General Description of the Surveys

(1) Mangroves

Mangroves are salt-tolerant evergreen plants found in areas between dry land and the sea in relatively sheltered areas, along estuaries, and coastal lagoons with low energy waves. Apart from trees, the mangrove ecosystem includes associated bodies of water, soil, a variety of other plants, animals and microorganisms.

Different mangrove species usually grow in distinct zones and only seldom do they grow interspersed. This zonation is due to the fact that, different mangrove species respond distinctively to varying salt levels and other environmental conditions. Based on this, mangrove types were identified in surveyed mangrove areas. (See in section 5.4.2)

(2) Green Spaces

Two primary types of public spaces and their uses have been identified and evaluated in this survey. Criterion used for evaluation were based on environmental conditions (location and vegetative cover) and types of uses for these spaces. Green spaces identified by environmental considerations were open spaces located in the Msimbazi Valley area. These spaces include Morocco green space (site no. 6); located between Kinondoni and Magomeni, Kigogo Baruti green area, (site no. 7); located between Magomeni and Kigogo green area (site no. 8); located between Kigogo and Illala and the Jangwani green area located between Magomeni and Kariakoo/Muhimbili.

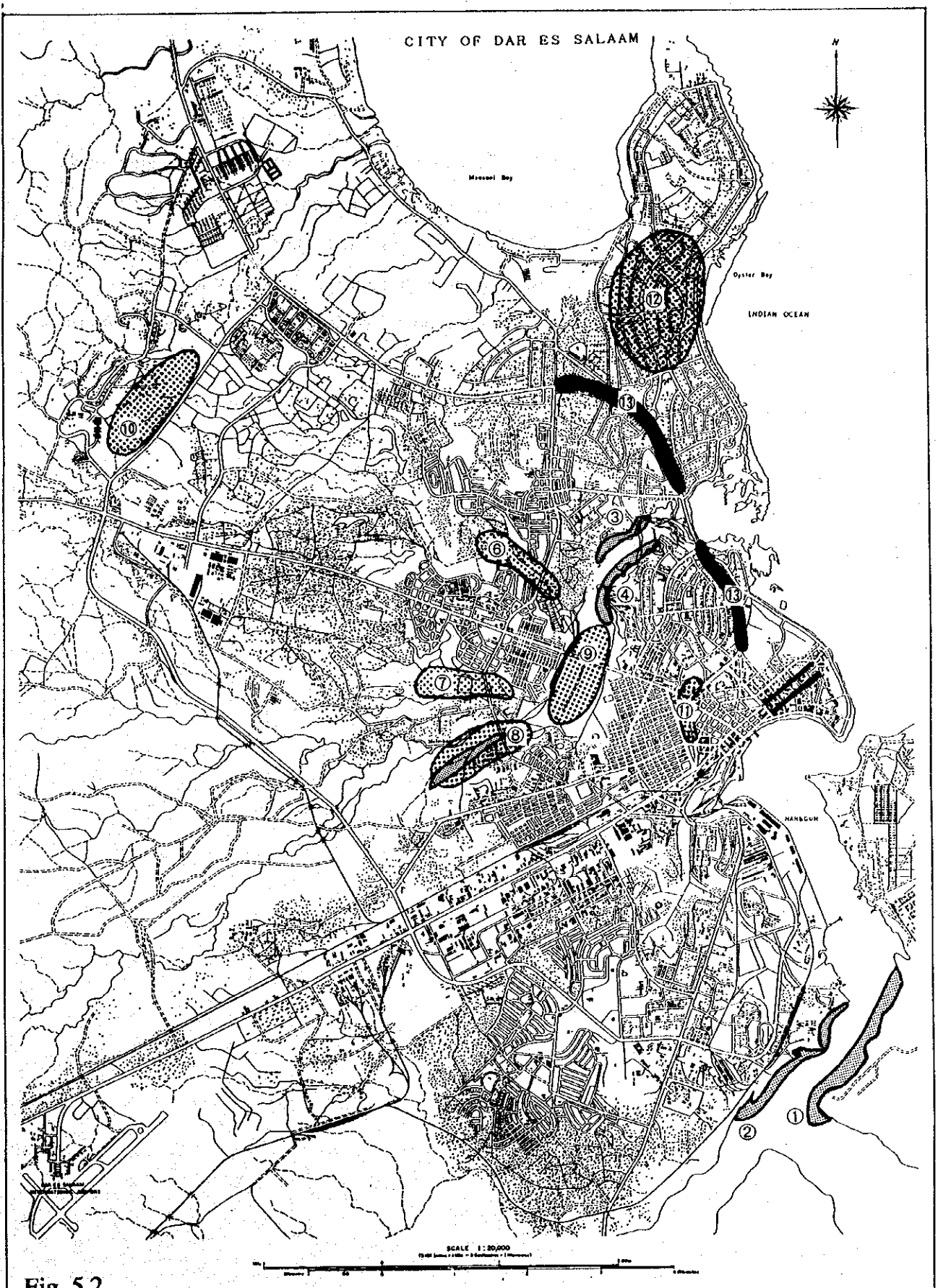



Fig. 5.2

Location Map of
**Flora and Fauna**
Survey Stations

Mangrove Survey Areas
Roadside trees
Residence trees and Green space

(3) Dominant Tree Types

A portion of the Oysterbay residential area was chosen as a site for identification of the most prevalent tree species in the city urban area. In addition to the identification of prominent tree species, it was also desirous to ascertain the function of these trees as well. Tree function was broken into four categories; visual aesthetic (leaves and flowers), shade protection, property line or boundary demarcation, and harvest or crop production.

### 5.4.2 Findings

(1) Mangrove Survey Areas

a) Survey Stations 1 & 2 (Mangrove Forests in the Kurasini Residential Area).

These mangrove forests, are dominated by Sonneratia, with Avicennia, Bruguiera or Rhizophora arteries. In addition the southern portion of survey station 1 is dominated by pure stands of Sonneratia alba. Sonneratia grows in depressions which are flooded daily by tide waters while other species associated with the area are found on slightly higher ground.

b) Survey Stations 3 & 4 (Msimbazi River mangroves)

Almost pure stands of Avicennia marina dominate these mangrove areas although there are a few Rhizophora mucronata trees located behind the Avicennia zone. On the seaward side of Selander Bridge a few trees of Sonneratia alba variety can also be seen.

c) Survey Stations 5 (Msimbazi River Mid-flow Area)

The Mangrove forest in this area no longer exist supporting strong evidence of the following:

(i) Sand accumulation from sea action or land deposits which has cut off portions of mangroves from saltwater sources.

(ii) Prolonged inundation by either freshwater exclusively or salt-water exclusively which Mangroves have the inability to tolerate.

(2) Green Spaces

Extensive green spaces have been identified as existing in the Msimbazi Valley which are used for small scale gardening; (in particular vegetables, coconut trees, sugar cane and bananas). In addition livestock owners use grassy areas for grazing their animals, while in some areas houses are being built, encroaching on the public land.

Kigogo Baruti and Kigogo green areas are composed of natural vegetation and cultivated plants. The natural vegetation consists primarily of herbs, and sedges of

which the most common is typha capensis. Crops cultivated in this area include bananas, sugar cane, and coconut trees. Jangwani green area is composed mainly of herbs and grasses on one side of Morogoro road and herbs and mangrove on the other side of Morogoro road.

The Jangwani green area, which is also in the valley has neighborhood football fields, which have recently been encroached upon by small traders and stall keepers. Other green spaces are located in the Morocco area (site no.6).

Mnazi Mmoja area, (site no.10) which is located near the City center, consists primarily of "exotic" vegetation. Most common types are trees of the Terminalia catappa L; Peltrophorum pterocarpum, Codia Sebestena, Ficus benjamina, Delonix regia and "Azadirachta indica" varieties. This area is used for a variety of activities; such as resting area during the day and petty trading, car parking, and cultural activities requiring open air, in the evening.

The only private green areas in this location belong to the University of Dar es Salaam, which consist of wooded grasslands with the following dominant tree species; Peltrophorum pterocarpum, Pongamia pinnata, Ficus benjamina, Anacardium accidentale (Cashwnuts) and Mangifera indica (Mango). The University open spaces are being used for constructing new university buildings. In addition there are a few vegetable gardens, and grazing areas used by livestock owners.

(3) Dominant Tree Types

a) Dominant Tree Species along Roadsides

Three main types of tree species appear along the roadside; Peltrophorum pterocarpum located along Sokoine Drive and Samora Avenue, Millingtonia hortensis located along New Bagamoyo Road (especially in the area between the American Embassy and Namanga area shops), and new trees of the same species replanted especially between Namanga shops and the junction with Morocco road to replace older trees which were cut during road rehabilitation.

A third tree species Cordia Sebestena is found along New Bagamoyo road between the Palm Beach Hotel and the American Embassy. More trees of the Cordia variety have been planted between the Palm Beach Hotel and Tanganyika Motors to replace others which have been cut. All three species types are also found along the Lumumba road at the Mnazi Mmoja play grounds.

b) Dominant Residential Trees

Primary dominant trees found in the Oysterbay residential area consist of the following several species. The most common types are Adenium Obesum, Jatropha spp, Deloxia regia, Peltophorum ptrerocarpum, Ficus benjamina, Thevetia peruvian, Euphorbia cuneata vahl. Cocos nucifera, Cassia siamea L. Terminalia catappa, and Millingtonia hortensis.

## 5.5 Air Pollution

The purpose of this survey was to assess the contents of automobile exhaust gas, ambient air quality along major thoroughfares and other conditions relating to the generation of particulate dust matter due to road construction. Details are provided in the following sub-sectors.

### 5.5.1 General Description of Surveys

(1) Automobile Exhaust Gas Survey

Exhaust gas densities from a total of 30 vehicles, categorized by vehicle manufacture year and type, were measured under engine idling and running conditions approximating 2000 rpm or the equivalent of 40 km/hr. This procedure was followed in order to ascertain the exhaust gas coefficient (g/m) of each automobile in the survey. Specific exhaust gas components targeted for analysis using the detector tube method were nitrogen oxides, nitrogen dioxide and carbon monoxide.

(2) Ambient Air Survey

The Ambient Air Survey was conducted at three locations at Morocco, New-Kigogo and Chang'ombe Roads. This survey was designed to measure the presence of nitrogen oxide, nitrogen dioxide and carbon monoxide chemical components in the ambient air using the detector tube method.

(3) Dust Generated During Construction

Conditions with respect to dust generation due to road construction were visually assessed and then photographed along New Bagamoyo, at location where major road construction was taking place.

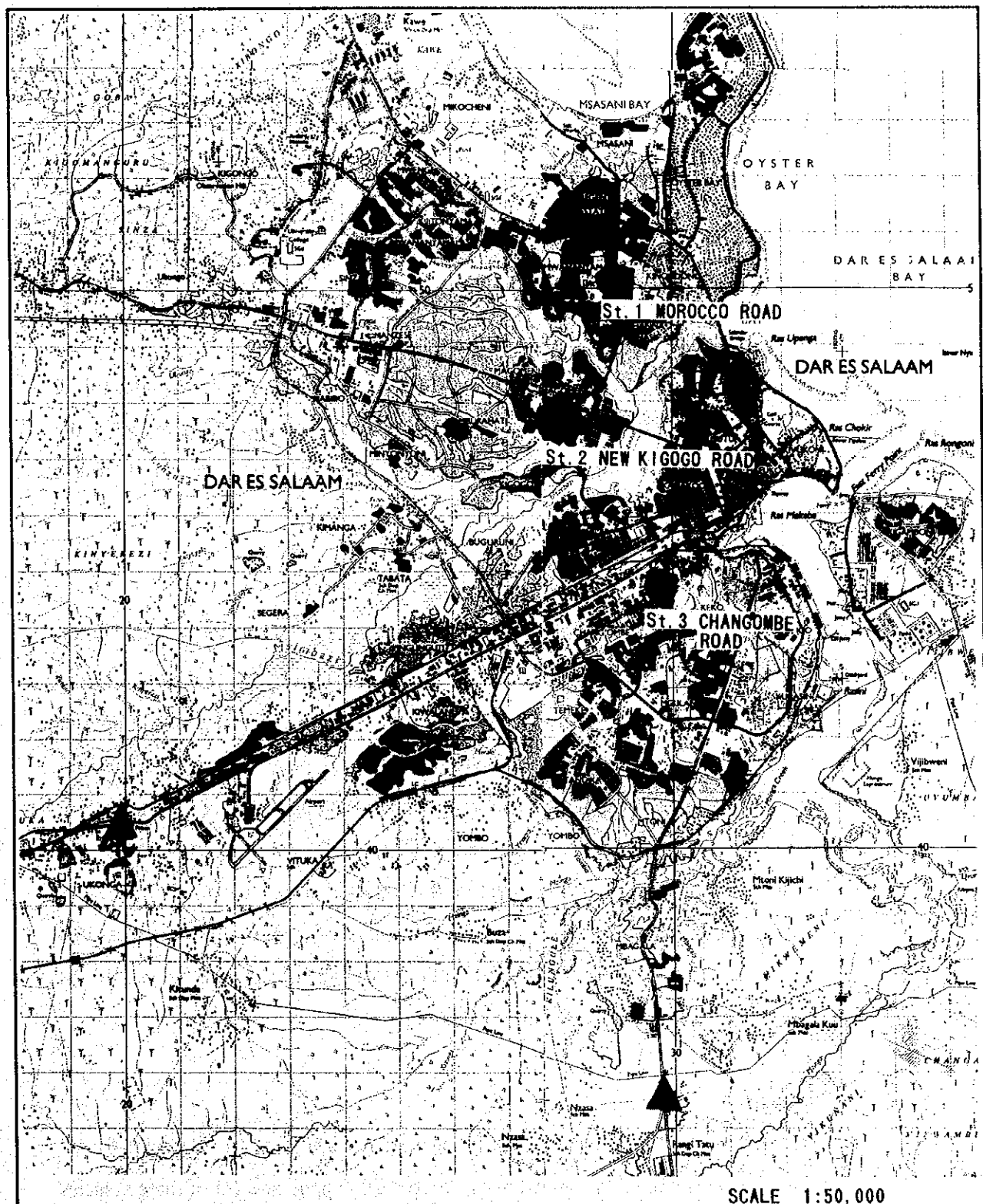



Fig. 5.3

| | |
|---|---|
| Location Map of Air Pollution Survey Stations | ● Ambient air<br>▲ Automobile exhaust gas |

### 5.5.2 Findings

(1) Automobile Exhaust Gas Survey

a) Nitrogen Oxides (NOx)

Results of the nitrogen oxide density analysis revealed that NOx densities during engine idling for all vehicles (30) ranged from 20 to > 500 ppm. In addition 21 vehicles, accounting for 70% of the total number of vehicles, exceeded 100 ppm.

The density of NOx at 40 km/hr engine conditions ranged from 8 to > 500 ppm for all vehicles while 24 vehicles, accounting for 80% of the total, exceeded 100 ppm. Also, the exhaust gas coefficient at 40 km/hr conditions ranged from 0.008-0.57 g/m for all vehicle measured.

b) Nitrogen Dioxide ($NO_2$)

Results of the nitrogen dioxide density analysis revealed that $NO_2$ density during idling conditions ranged from less than < 0.5 to > 60 ppm for all automobiles. Of these vehicles, 46.7% had an $NO_2$ density of 0.5 ppm or lower and 30.0% had a density of 60 ppm or greater with remaining vehicles ranging between 4 and 50 ppm. The $NO_2$ density for vehicles under 40 km/hr conditions ranged from < 0.5 to > 60 ppm - for all vehicles, which was approximately the same for densities under idling conditions. Vehicles which $NO_2$ densities were 0.5 ppm or lower accounted for 46.7% of the measured vehicles and those of 60 ppm or higher accounted for 13.3%. The percentage of vehicles that were measured with 60 ppm or more were few compared with the percentage of vehicles that yielded the same value when measured during idling conditions.

c) Carbon Monoxide (CO)

The results of the carbon monoxide density analysis revealed that CO densities for all vehicles during idling conditions ranged from 100 to > 2000 ppm, and 1/3 of these vehicles exceeded 2000 ppm (the upper limit of detection). Under 40 km/hr engine conditions CO densities ranged from 200 to >2000 ppm for all vehicles while 43.3% of these vehicles exceeded 2000 ppm. Exhaust gas coefficients for all vehicles at 40 km/hr conditions ranged between 0.16 to > 1.02 g/m.

Table 5.2 AUTOMOBILE EXHAUST

EXHAUST GAS COMPONENTS CONCENTRATION (ppm)

| Vehicle Type | Model Year | Idling | | | 40 km/h | | |
|---|---|---|---|---|---|---|---|
| | | NOx | NO2 | CO | NOx | NO2 | CO |
| Sedan | 1982 | 100 | <0.5 | >2000 | 200 | <0.5 | >2000 |
| | 1984 | 300 | 50 | >2000 | 100 | 30 | >2000 |
| | 1984 | 100 | 50 | 1200 | 60 | <0.5 | >2000 |
| | 1985 | 100 | <0.5 | 600 | 240 | <0.5 | >2000 |
| 1 ton Pickup/Mini-bus | 1985 | 80 | <0.5 | >2000 | 100 | <0.5 | >2000 |
| | 1987 | 20 | <0.5 | >2000 | 200 | <0.5 | >2000 |
| | 1992 | >500 | >60 | 400 | 400 | >60 | 300 |
| | 1993 | 60 | <0.5 | >2000 | 120 | <0.5 | >200 |
| 2 ton Pickup/Mini-bus | 1981 | 40 | <0.5 | >2000 | 200 | <0.5 | >2000 |
| | 1985 | 80 | <0.5 | >2000 | 100 | <0.5 | >2000 |
| | 1986 | 80 | >60 | 300 | 140 | >60 | 250 |
| | 1987 | 320 | >60 | 600 | 200 | 20 | 1000 |
| | 1989 | 280 | <0.5 | 100 | 160 | 3 | 200 |
| Station Wagon 4 Wheel Drive | 1975 | 30 | <0.5 | >2000 | 90 | <0.5 | >2000 |
| | 1981 | 40 | <0.5 | >2000 | 200 | <0.5 | >2000 |
| | 1987 | 160 | <0.5 | 200 | 8 | <0.5 | 200 |
| | 1987 | 300 | >60 | 600 | 160 | 10 | 800 |
| | 1988 | 60 | <0.5 | >2000 | 100 | <0.5 | >2000 |
| | 1988 | 120 | <0.5 | 400 | 120 | <0.5 | >2000 |
| | 1990 | 300 | >60 | 100 | 160 | >60 | 240 |
| 3.5 ton Truck/Bus | 1974 | >500 | <0.5 | 440 | >500 | <0.5 | >2000 |
| | 1988 | 160 | 14 | 600 | 160 | 14 | 600 |
| | 1991 | 300 | >60 | 600 | >500 | >60 | 800 |
| 7 ton Truck/Bus | 1972 | 160 | >60 | 400 | - | - | - |
| | 1977 | 400 | >60 | 400 | 240 | 8 | 400 |
| | 1991 | 160 | >60 | 700 | - | - | - |
| | 1992 | 140 | 7 | 400 | 150 | 7 | 300 |
| 10 ton Construction | 1982 | 160 | 4 | 200 | 360 | 10 | 300 |
| | 1991 | 300 | 15 | 600 | - | - | - |
| Truck 20 ton Construction Truck | 1982 | 160 | 4 | 200 | 360 | 10 | 300 |

| Table 5.3 COMPARISON OF EXHAUST GAS COEFFICIENTS TO STANDARDS | | | |
|---|---|---|---|
| No. | Vehicle Type | Exhaust Gas Coefficient Range (g/m) | |
| | | NOx | CO |
| 1 | 3.5 ton Truck | 0.082 to >30 | 0.307 to >1.02 |
| 2 | 2 ton Pickup | 0.05 to 0.23 | 0.26 to 1.02 |
| 3 | Station Wagon, 4 wheel drive | $8.18 * 10^{-3}$ to 0.104 | 0.16 to >1 |
| 4 | 1 ton Pickup/Mini-bus | 0.0204 to 0.22 | 0.165 to >0.84 |
| 5 | Sedan | 0.02 to 0.03 | >0.39 |
| | US Federal Standard 1974 | $8.13 * 10^{-4}$ | 0.014 |
| | 1976 | $2.5 * 10^{-4}$ | $2.13 * 10^{-3}$ |

(2) Ambient Air Survey

a) Morocco Road

Nitrogen oxide and nitrogen dioxide densities were 0.04 ppm or less for all measurements taken. A carbon monoxide density of 7 ppm was obtained at 19:00, while a measured 5 ppm was obtained for all other measuring times. Prevailing winds were in a northeasterly, direction while wind velocities were 1 m/sec or less except at 15:00, when the velocity was 1.5 m/sec, and at 17:00, when the velocity was 2.5 m/sec.

b) New-Kigogo Road

Nitrogen oxide and nitrogen dioxide densities were 0.04 ppm or less for all measurements taken. A carbon monoxide density of 5 ppm was obtained at 09:30, 12:00 and 15:00, however for other time periods densities ranged between 5-7 ppm. Prevailing winds were from a northeasterly direction and wind velocity was 1 m/sec or less at all times.

c) Chang'ombe Road

Nitrogen oxide and nitrogen dioxide densities were 0.04 ppm or less for all measurements taken. A carbon monoxide density of 5.5 ppm was obtained at 07:00, and a density of 5 ppm at 09:00 and 19:00, all other time periods yielded a ppm level of 5. The prevailing wind pattern was in a northeasterly direction with a wind velocity was 1 m/sec or less except at 15:00 and 19:00, when it was around 2.0 m/sec.

(3) Suspended Dust Particles Generated During Construction

New Bagamoyo Road recently construction to widen its two lanes to four was the location of the visual survey to estimate suspended particulate matter. A large amount of dust particulate matter is generated by strong winds or construction machinery along un sealed roads which is a temporary condition. Because of this condition water trucks periodically spray water to keep down the dust.

Table 5.4 AMBIENT AIR

| Time | St. 1 Morocco Road | | | St. 2 New Kigogo Road | | | St. 3 Chang'ombe Road | | |
|---|---|---|---|---|---|---|---|---|---|
| | NOx ppm | NO2 ppm | CO ppm | NOx ppm | NO2 ppm | CO ppm | NOx ppm | NO2 ppm | CO ppm |
| | 10 min. ave. | 10 min. ave | 10 min. ave. | 10 min. ave. | 10 min. ave | 10 min. ave. | 10 min. ave. | 10 min. ave | 10 min. ave. |
| 07:30 | <0.04 | <0.04 | 5 | <0.04 | <0.04 | 7 | <0.04 | <0.04 | 5.5 |
| 08:30 | <0.04 | <0.04 | 5 | <0.04 | <0.04 | 5 | <0.04 | <0.04 | <5 |
| 09:30 | <0.04 | <0.04 | 5 | <0.04 | <0.04 | <5 | <0.04 | <0.04 | 5 |
| 12:00 | <0.04 | <0.04 | 5 | <.04 | <0.04 | <5 | <0.04 | <0.04 | <5 |
| 15:00 | <0.04 | <0.04 | 5 | <0.04 | <0.04 | <5 | <0.04 | <0.04 | <5 |
| 18:00 | <0.04 | <0.04 | 5 | <0.04 | <0.04 | 6.5 | <0.04 | <0.04 | <5 |
| 19:00 | <0.04 | <0.04 | 7 | <0.04 | <0.04 | 6 | <0.04 | <0.04 | 5 |
| 20:00 | <0.04 | <0.04 | 5 | <0.04 | <0.04 | 5 | <0.04 | <0.04 | 5 |

## 5.6 Noise and Vibration

This survey was conducted for the purpose of understanding current DSM city conditions relating to vehicular noise source levels, road traffic noise and vibration, and noise and vibration originating from road construction. The following Sub-sections provide background and detailed information pertaining to noise and vibration.

### 5.6.1 General Description of the Surveys

(1) Vehicle Noise Sources Survey

The Vehicle Noise Sources Survey was conducted along Mpakani Road targeting two types of vehicles; large vehicles; (12-ton construction trucks) and small vehicles; (sedans with 1600-cc displacement). Maximum noise levels were measured at five different points along subject roads, at 2.5 m, 5 m, 7.5 m and 15 m from the edge of paved road surfaces, with vehicles traveling at speeds of 40 km/hr and 60 km/hr.

(2) Road Traffic Noise and Vibration Survey

The following Road Traffic Noise and Vibration Survey was conducted at five city locations, on New Bagamoyo Road, Morocco Road, Morogoro Road, New-Kigogo Road and Chang'ombe Road, on November 11, 12 and 15, 1993. Noise levels for each location were measured a total of six times for each day; at 07:00, 08:00, 10:00, 14:00, 18:00 and 20:00 measurements were taken from positions of 1 m from the paved roadside surface and at 1 m from a residential dwelling fronting subject roads.

For the vibration segment of the survey, vibration levels were measured a total of 4 times each day from 07:00, 08:00, 18:00 and 20:00 along subject roadsides. These values were then used to obtain an 80% range for upper noise values (L10).

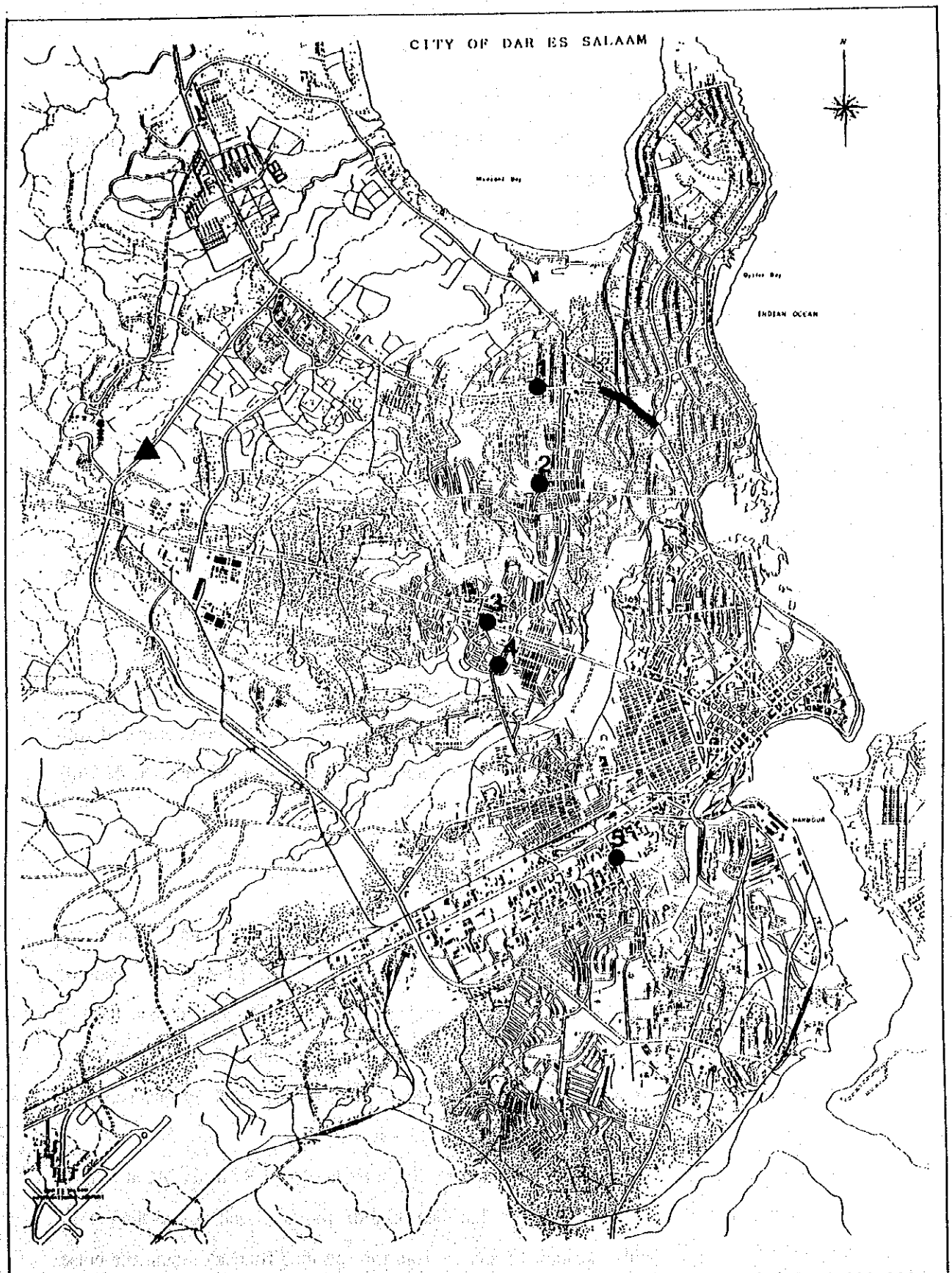



Fig. 5.4

SCALE 1:100,000

Location Map of Noise and Vibration Survey Stations

● Automobile Noise & Vibration Survey Points(5 points)

▲ Automobile Noise Survey Points for setting the average power level

Construction work Noise & Vibration Survey Road(Station)

(3) Construction Noise and Vibration Survey

The generated levels of construction noise; (maximum levels) and vibration; (maximum levels) resulting from the operation of road construction machinery were measured on November 10, 1993 at two locations: along New Bagamoyo road, near old Bagamoyo Road intersection.

### 5.6.2 Findings

(1) Noise

a) Vehicle Noise Sources

Large Vehicles*

Noise levels for a large vehicle traveling at 40 km/hr. measured at a stationery point along a given roadside yielded a level of 86.4 dB (A). In addition noise levels tend to decrease as the perpendicular distance from a roadside point increases. For example at a location 15 meters perpendicularly from a fixed point for a large vehicle traveling at 40 km/hr. a noise level of 73.2 dB is yielded. With respect to vehicles traveling at 60 km/hr., noise levels tend to decrease as distance from a roadside point increases. However,, when compared with noise levels for vehicles traveling at 40 km/hr., noise levels were generally higher, 88.9 dB (A).

Small Vehicles*

The Vehicle Noise Sources Survey also revealed that noise levels from small vehicles are generally lower than those for large vehicles, and the rate of noise decrease as a result of distance was greater. With respect to small vehicles traveling at 40 km/hr., a noise level of 82.6 dB (A) at a specified roadside point was 3.8 dB (A) lower than that for large vehicles. In addition, noise levels at 15 m from a specified roadside point for small vehicles was 61.7 dB (A), or 21 dB (A) lower than for larger vehicle noise.

With respect to vehicles traveling at 60 km/hr., the noise level was 84.6 dB (A) at a fixed roadside point, or 2 dB (A) higher than that measured for the same vehicle traveling at 40 km/hr. At a perpendicular position 15 meters from the specified roadside point, the noise level was 67.2 dB (A) or 17.4 dB (A) lower than the level measured at the roadside point for small vehicles.

measured for the same vehicles traveling at 40 km/hr. At 15 meters from the specified point, the noise level was 67.2 dB (A) or 17.4 dB (A) lower than the level measured at the roadside point.

Fig. 5.5 VEHICLE NOISE SOURCES
SMALL VEHICLE

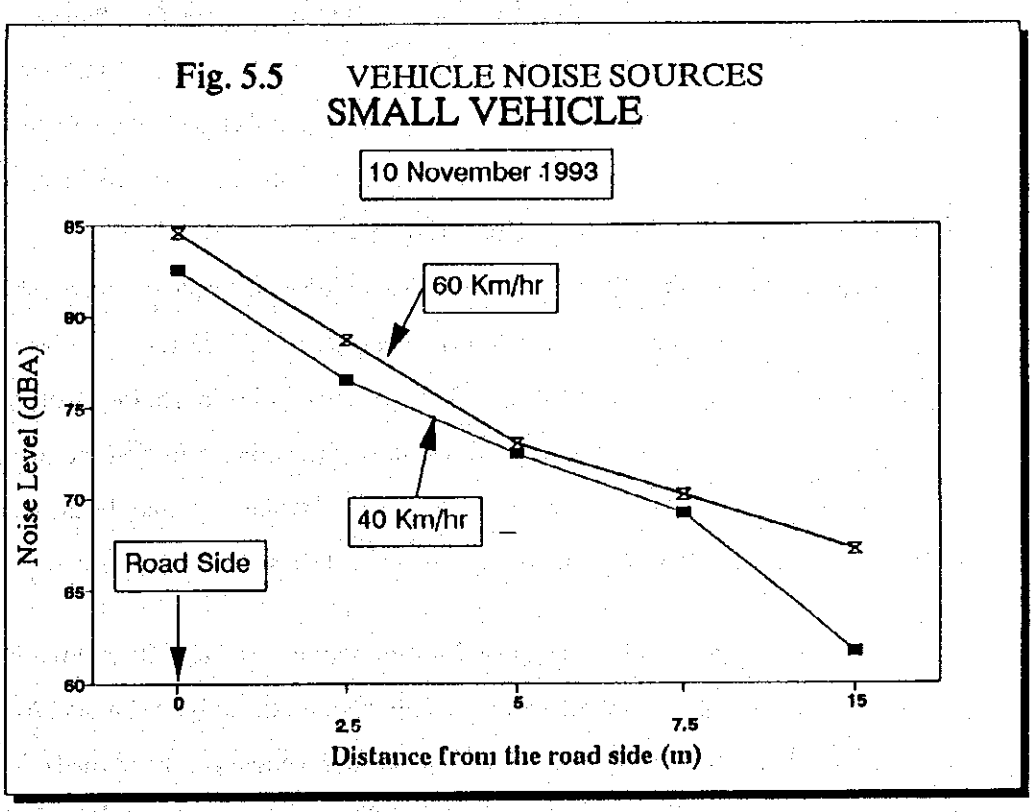
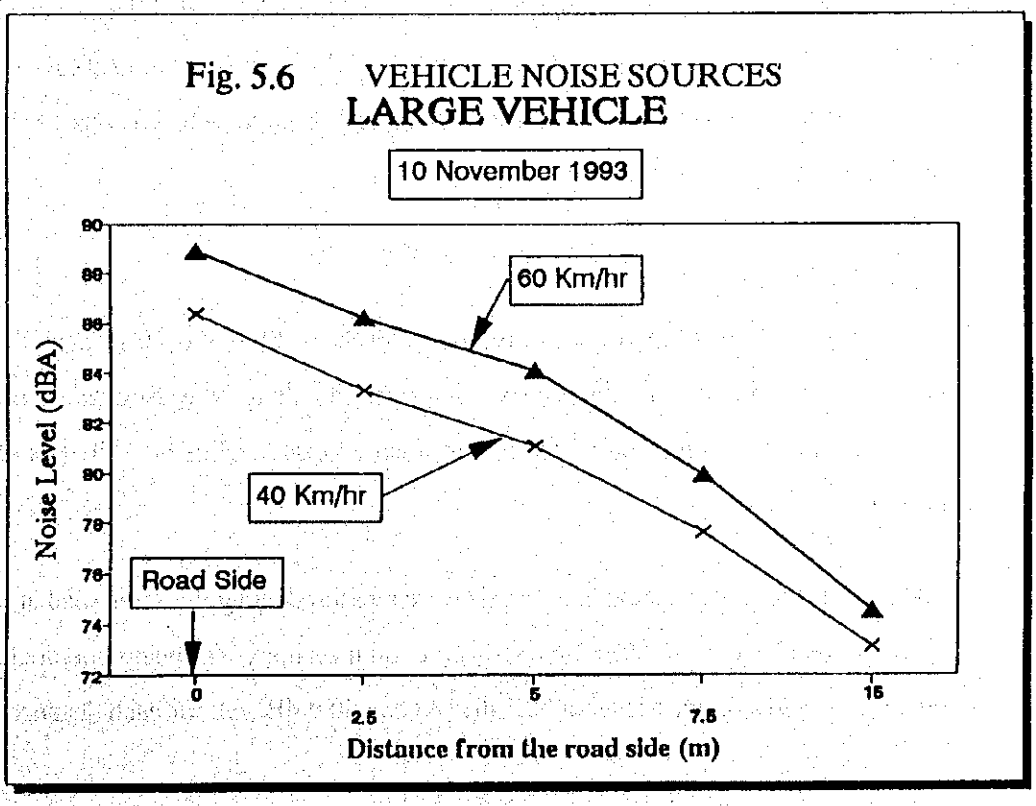



Fig. 5.6 VEHICLE NOISE SOURCES
LARGE VEHICLE



b) Road Traffic Noise

The results of the Road Traffic Noise Survey showed that the mean value (L50) for noise levels ranged from 57.7-72.2 dB (A) at all locations during all time periods of the survey. Noise levels at a roadside point along Morogoro Road (St. 3) yielded the highest values for all time periods recorded, at 70 dB (A). These levels were due to the large numbers of heavy vehicles along this road in comparison with lesser numbers at other survey locations. By contrast, the lowest noise level was recorded along New Kigogo Road (St. 4), where the average noise level at the survey point was 67 dB (A).

Noise levels measured directly 1 m in front of a residential dwelling, along subject road indicate that noise levels at many locations ranges between 55-65 (A). On New Kigogo Road (St. 4) and Chang'ombe Road (St. 5), noise from radios located in small shops and nearby houses was detectable, raising recorded noise levels thus affecting the overall noise levels for the survey. When focusing on noise levels classified by time, levels recorded at night (20:00) were the lowest in the survey, except for levels on Morocco Road (St. 2).

The number of vehicles (traffic) that passed survey stations on New Bagamoyo Road (St. 1) and Morocco Road (St. 2) during a five-minute period ranged between 60-120 vehicles, which is large compared to the number of vehicles that passed on other roads. Traffic on New Kigogo Road (St. 4) and Chang'ombe Road (St. 5) amounted to 30-70 vehicles. The largest number of vehicles, totaling 199; 112 small vehicles and 7 large vehicles was recorded on New Bagamoyo Road (St. 1) at 18:00. In contrast, the smallest number of vehicles, totaling 28 vehicles (27 small vehicles and 1 large vehicle) was recorded on Chang'ombe Road (St. 5) at 20:00.

c) Construction Noise

The Construction Noise Survey measured noise levels at 20 m and 30 m perpendicularly from where construction machinery was being operated along New Bagamoyo road, i.e., (one power shovel and four dump trucks), yielding a noise level of 90.4 dB (A) and 82.0 dB (A), respectively.

In addition, further construction noise levels were measured along the same road at 5 m and 10 m perpendicularly from where other construction machinery was being operated (a steel roller) which yielded a noise level of 90.1 dB (A) and 80.0 dB (A), for each distance.

Table 5.5 Summary Results Of Road Traffic Noise Survey

| Survey Location | Distance from Road Side (m) | Noise Level L50 (d BA) 7:00 - 8:30 | 8:00 - 9:00 | 10:00 - 11:00 | 14:00 - 15:00 | 18:00 - 19:00 | 20:00 - 21:00 | Remarks |
|---|---|---|---|---|---|---|---|---|
| Station 1 | | | | | | | | Date: Friday, November 12, 1993 |
| New Bagamoyo Road | 0 | 70.0 | 66.9 | 69.5 | 67.1 | 71.6 | 66.4 | 1 to 4 cars used side per measuring time. |
| (Reagent Estate) | 20 | 61.5 | 60.0 | 60.9 | 60.6 | 61.8 | 57.7 | Only Traffic jam at 8:00 - 9:00 hours. |
| Station 2 | | | | | | | | Date: Friday, November 12, 1993 |
| Morocco Road | 0 | 69.5 | 68.4 | 70.1 | 72.2 | 69.7 | 68.7 | Traffic jam at 7:00 - 8:00 hours. |
| (Kinonidoni) | 7 | 62.0 | 61.1 | 64.0 | 63.3 | 63.3 | 61.3 | |
| Station 3 | | | | | | | | Date: Monday, November 15, 1993 |
| Morogoro Road | 0 | 71.1 | 71.0 | 70.1 | 72.2 | 69.7 | 69.6 | Fairly smooth traffic flow. 1 to 4 cars crossed |
| (Magomeni) | 18.5 | 64.9 | 65.9 | 64.0 | 63.3 | 64.1 | 62.5 | side road per measuring time. |
| Station 4 | | | | | | | | Date: Monday, November 15, 1993 |
| New Kigogo Road | 0 | 68.9 | 66.8 | 65.2 | 66.4 | 70.1 | 63.6 | Traffic flow rather slow. Noise from radio and |
| (Jaba Motors) | 13.4 | 61.6 | 62.1 | 62.1 | 59.7 | 61.9 | 59.1 | metal workshop. |
| Station 5 | | | | | | | | Date: Thursday, November 11, 1993 |
| Chang'ombe Road | 0 | 67.9 | 70.0 | 68.9 | 67.6 | 66.1 | 62.4 | Moderate to slow traffic flow condition. |
| (Keko Flats) | 10.1 | 66.6 | 66.3 | 65.8 | 62.7 | 64.5 | 60.8 | Site moved from house due to radio noise |

| | | |
|---|---|---|
| Residential noise level guide lines | Unacceptable: | Exceeds 80 dBA 60 min. in 24 hours<br>Exceeds 75 dBA 8 hours in 24 hours |
| External exposure | Normally Unacceptable: | Exceeds 65 dBA in 8 hours in 24 hours |
| US Dept. of Transport | Normally Acceptable: | Does not exceed 65 dBA more than 8 hours in 24 hours.<br>Does not exceed 45 dBA more than 30 min. in 24 hours. |

(2) Vibrations

a) Road Traffic Vibration Level

According to the Road Traffic Vibration Survey, the 80% upper end value (L10) of the vibration level ranged from 27.8-45.6 dB for all locations during each time period measured. Classification by location reveals that the highest vibration levels, ranging between 37.5-45.6 dB, were recorded along Chang'ombe Road (St. 5). The lowest measured vibration levels of 27.8-32.9 dB, were recorded along New Bagamoyo Road (St. A). Vibration levels at other locations ranged between 30-40 dB. Classifying vibration levels over time revealed that the lowest levels were recorded at night (20:00), except for levels along Morocco Road (St. 2) which revealed the lowest levels at 8:00 AM.

b) Construction Vibrations

The Construction Vibration Survey measured levels along New Bagamoyo at 20 m and 30 m from perpendicularly an area where construction machinery, (one power shovel and four dump trucks) were being operated generating levels of 38.4 dB and 28.1 dB, respectively. In addition, vibration levels measured near the New Bagamoyo Road construction site at 5 m and 10 m from where construction machinery (a steel roller) was being operated yielded levels of 88.0 dB and 78.0 dB, respectively.

Table 5.6 Summary Results of Road Traffic Vibration Survey

| Survey Location | Distance from Road Side (m) | Vibration Level L10 (dB) | | | |
|---|---|---|---|---|---|
| | | 7:00 - 8:00 | 8:00 - 9:00 | 18:00 - 19:00 | 20:00 - 21:00 |
| Station 1<br>New Bagamoyo Road<br>(Reagent Estate) | 0 | 32.9 | 30.0 | 32.1 | 27.8 |
| Station 2<br>Morocco Road<br>(Kinondoni) | 0 | 32.5 | 32.0 | 33.5 | 33.5 |
| Station 3<br>Morogoro Road<br>(Magomeni) | 0 | 36.4 | 37.4 | 36.1 | 36.1 |
| Station 4<br>New Kigogo Road<br>(Jaba Motors) | 0 | 34.2 | 35.0 | 34.8 | 31.1 |
| Station 5<br>Chang'ombe Road<br>(Keko Flats) | 0 | 44.2 | 45.6 | 43.6 | 37.5 |

## 5.7 Environmental Considerations

### 5.7.1 Environmental Considerations for Further Regional and Road Development

(1) Flood Hazards

In recent years, rapid population influx has caused land development to take two courses; rapid, unplanned development and planned development. Unplanned development constitutes 70% of Dar es Salaam's housing often occurring along environmentally sensitive land. Many of these areas, have little or no access to public utilities or needed infrastructure; such as paved roads, or drainage systems.

Often inundated roads are rendered impassable or severely damaged due to flood waters. Existing paved roads have often been constructed with little engineering and lack drainage or camber which results in standing water. Where road drainage does exist, lack of routine maintenance has rendered them useless, while other culverts etc., have keen rendered obscure because of insufficient carrying capacity. The continued rapid population influx will increase overall impermeable surfaces with resulting runoff volumes surpassing the carrying capacities and, thus increasing flooding.

Flooding on roads results in surface cracking, premature ware, and the development of potholes. Additional effects include generated soil deposits and debris along road curbs and gutters, effectively blocking drainage grates, manholes, etc. These deposits also generate suspended dust particles helping to degrade the city's air quality.

(2) Resettlement

Roads in Dar es Salaam have a road reserve which serves as land for further expansion or introduction of public utility lines. Road reserves have a specific use and other land uses or encroachment on these lands is restricted.

Several densely populated, unplanned community settlements have sprung up along sensitive land areas and in the road-rights-of-ways. Many roads in these comunity sttlements are slated for redevelopment requiring the use of road right-of-ways and/or the acquisition of additional lands.

Past procedures for land acquisition reveals that acquired land sometimes, involves house demolition, residence relocation and compensation. It was also revealed that structures encroaching on road reserves were removed at owners expense. In terms of future road development, owners rights to receive compensation whose property encroaches on a "theoretical right-of-way" in unplanned/ un-surveyed areas will need to be fully assessed. Furthermore it should be noted that present government regulations on relocation are based on:

a. Only property owner is eligible for compensation based on the value of property and not on the business, expenses or service connections.

b. Tenants who occupy a property are not eligible for relocation or compensation.

(3) Flora and Fauna

Flora and fauna which could be affected by the introduction of road development exists in three major zones and should be further studied to future impacts.

Mangroves
Open Green Spaces
Street Trees

The survey confirmed the existence of Mangrove ecosystems at four different locations in the city. Mangroves which live in a delicate balance between fresh and salt water communities have significant socio-economic, environmental, cultural and scientific importance. Apart from the tree itself the mangrove ecosystem includes associated bodies of water, soil, plants, animals and microorganisms, and impact in terms of future road development must be analyzed in detail.

The survey also identified major open spaces and primary uses associated with them. Many of the city's open green spaces are used for small scale agriculture, livestock grazing and makeshift athletics field activity. Agriculture activity is often important in serving to augment the livelihood of local residence.

However athletic activity on athletic fields has increasingly been hampered by encroaching housing and petty selling activities. Any future road development which could encroach further on these areas should be examined for impacts to cultural or community activities. Open green areas also serve another function in that of reducing storm water run-off and reducing flooding.

In built-up city areas, dominant species of residential and street trees were identified and their types of use assessed. In general trees help to shape much of the visual environment of the city and any impact due to future road development should be assessed. Broad leaf street trees also help to reduce noise pollution and dissipate suspended particulate matter. Trees that must be removed due to road widening should be readily replaced.

(4) Air Pollution

Construction machinery traveling over unpaved tracks during road construction generates suspended dust which is dispersed via wind, transversing or settling in residential areas. This particulate matter can thus pose a potential health problem to densely populated areas in proximity to road construction. To accurately assess potential impacts which could occur doing road construction an environmental impact study should be undertaken and proper mitigation measures analyzed.

A secondary source of suspended particulate matter is a direct result of flooding which generates sand and grit deposits along curbs and gutters. Automobile traffic action and wind disperse particulate matter in the air further degrading the cities air quality.

Further air quality examination revealed that, although their atmospheric densities along roadsides were not particularly high, densities for carbon monoxide (CO) and nitrogen oxides (NOx) exhaust gases from automobiles traveling within the metropolitan area were quite high. Furthermore, chronic traffic congestion has appeared in the inner-city's built-up areas, which has become a factor in degrading the city's overall air quality as well. Increases in population are predicted to accompany future increases in automobile traffic thus increasing volumes. It is thought that this may result in an increase in the overall volumes of automobile exhaust gases and the slow emergence of a major metropolitan air

pollution problems. Investigation of future auto traffic volumes and exhaust gases produced must be undertaken in further detail.

(5) Noise and Vibrations

With respect to noise and vibration associated with building construction, this survey did not detect values deemed to present a problem in terms of public nuisance. However, when construction is to be undertaken, in densely-populated residential areas or during the heaviest construction periods, an assessment of impact to human activity should be conducted to offset any adverse effects to residential areas in the vicinity of road construction.

Findings with respect to road traffic noise revealed that, although noise levels along roadsides were, deemed high, levels were not deemed so high as to create a public nuisance, cause public complaint, or adversely affect the living environment.

With respect to road traffic vibration, the survey found levels to be low causing little problem to date. Nevertheless, because of imminent future increases in traffic volumes, noise and vibration generated by passing motor vehicles are predicted to have an adverse effect on residences adjacent to roadways. Before new road development is undertaken an assessment of future impacts, cause by automobile vibration should be carried out in details in areas that are zoned for residential use.

### 5.7.2 Environmental Considerations for High Priority Road Development

(1) Project Description

a) Subject Areas

1. Widening of Trunk roads in the CBD
2. Establishing and constructing Middle Ring Road
3. Widening of New Bagamoyo Road
4. Widening of Kilwa Road
5. Widening of Uhuru Road

b) Background Information Objective of Projects

1. To ensure efficient circulation and control in the CBD
2. To reduce traffic concentrations into the CBD

3.,4.,& 5

To increase traffic capacity on trunk roads and to establish a trunk road network

c) Location

- Morocco, New Kigogo, Chang'ombe and Uhuru Roads
- Ohio, Sokoine Drive, Gerezani Roads

(For descriptions of specific environment for each road see Appendix 5.4.)

d) Executing Agencies

- Ministry of Works, Communications, and Transport (MWCT).

e) Major Components and Development Scale of Project

- Type of Project: Upgrading (Rehabilitation of function for truck road)
- Characteristics of Road: trunk road/urban area/plane area

f) Target year

- The Target year is 2000.

g) Length/Width/Lanes:

| | | | |
|---|---|---|---|
| 1. CBD (circulation) | 5.0 km | 20 m | 4 lanes |
| 2. CBD (reduce traffic) | 10.4 | 45 m | 4 lanes |
| 3. Trunk road network (increase capacity) | 13.2 | 45 m | 4 lanes |
| 4. - do - | 3.2 | 45 m | 4 lanes |
| 5. - do - | 3.9 | 45 m | 4 lanes |

(2) Environmental Items to be considered for Further Feasibility Study on Priority Projects

a) Flood Hazards

- Road construction (widening roads)

· Increasing the number of impermeable surfaces in which run-off can not penetrate promoting flooding, (especially in low lying areas).

· Increasing run-off speeds and potential for erosion, (especially around drainage outlets).

· Increase in amount of contaminants i.e., tire dust, oils, etc., discharged into water bodies.

- Road construction (river crossings)

· Lack of proper culverts, increasing changes of flooding.

· Increasing chances of river embankment erosion

b) Resettlement

- Road construction (widening roads)

· Displacement of households and need for relocation and compensation.

· Possible loss of means of employment.

- Affecting tenets or residence who are not property owners

c) Flora and Fauna

- Road construction (widening roads)

· Most likely impact will be the removal of street trees.

· Potential damage to other trees during construction.

d) Air Pollution

- Increasing traffic volumes
  - · Increase in exhaust gas volumes and photochemical air pollution
  - · Potential increase in health hazards
- Road construction
  - · Generation of suspended particulate dust matter
  - · Potential health hazards

e) Noise and Vibrations

- Increasing traffic volumes
  - · Increase in traffic noise and vibration especially in residential areas
- Road construction noise and vibration
  - · Impact to living environment

Table 5.7 Results of Initial Environmental Examination

| Environmental Issues | Potential Signification Environmental Impacts (Potential SEIs) | Evaluation | Evaluation Bases |
|---|---|---|---|
| Flood Hazards | - Dirt roads rendered impassable<br>- Storm runoff mingles with raw sewage contaminating drinking water<br>-Paved road surfaces resulting in cracking, premature ware and potholes | (Yes)<br>No<br>Unknown | Inundation and flooding<br>River bed degradation<br>Sedimentation |
| Resettlement | - Need for resettlement due to road alignments<br>- Residents who are not land owners could be displaced.<br>- Possible loss of livelihood of resettled residents<br>- Compensation based on property value only could be inadequate | (Yes)<br>No<br>Unknown | Planned Residential resettlement<br>Involuntary resettlement<br>Substantial change of lifestyle |
| Flora and Fauna | - Loss of roadside trees due to road construction<br>- Loss of visual integrity due to loss of street vegetation<br>- Damage of trees due to roadside construction | Yes<br>(No)<br>Unknown | Changes in vegetation |
| Air Pollution | - Generated particulate matter during road construction<br>- Increased auto traffic along certain road corridors because of increased traffic, resulting in trapped automobile pollution | (Yes)<br>No<br>Unknown | Increased photochemical pollutants<br>decreased air quality |
| Noise and Vibration | - Increased noise and vibration due to road construction activity<br>- Increased noise and vibration due to increased traffic volumes, especially that for some larger vehicles along some corridors | (Yes)<br>No<br>Unknown | Impact to residential and working environments |
| Over all Evaluation | - Further in-depth investigation of future potential impacts brought on as a result of road of road construction must be further assessed. | (Yes)<br>No<br>Unknown | Definition of each environmental impact and possible mitigating measures |

### 5.7.3 Other Considerations

Other factors having a potential effect on the living environment are discussed below. It has been noted however that these items will have a lesser impact on human activity and further in depth assessment may not be necessary.

(1) Strong Government Legislation

The Tanzanian government must stay on the right course with its economic recovery program to accelerate economic and social progress. Additionally in order to ensure further higher living standards, the government must establish long-term viable development and conservation programs in conjunction with development priorities.

All segments of poverty alleviation, population control, environmental protection, and sustainable natural resources should be developed and nurtured in concert with each other as a whole. Through proper planning, legislation, regulations and most importantly enforcement; along with the proper policy instruments of pricing, taxation, promotion of a more efficient use of natural resources and implementation of measure for mitigation can be realized.

(2) Emissions Testing

There must be strong incentives to combat the mis-use of natural resources and air pollution, coupled with strong government enforcement of periodic testing and or regulating all emissions from automobile traffic. The need for future mitigating measures for air quality can be reduced by implementing testing, collecting fees and continuously enforcing all legislation concerning emission standards.

(3) Visual Considerations

Alternation to the physical environment and the introduction of engineering works, i.e., roads and bridges have an impact on the city's visual environment. This is particularly true of new road construction carried out along hilly areas in a city or of bridges along a seashore.

Therefore road and bridge design should direct sufficient consideration to maintaining visual harmony with regards to the surrounding landscape. In addition, the widening of roads in built-up urban areas, should strive to create a favorable road scopes by preserving

existing wooded areas (glades) and increasing roadside greenery via the planting of trees and shrubbery.

(4) Traffic Safety

At present, carriageways and sidewalks for most roads in the city area are not physically separated, and problems exist with respect to pedestrian safety. Moreover, traffic control amenities, such as traffic signposts and signals are inadequate, which is a factor in traffic accidents.

If the volume of auto traffic continues to increase with the population, traffic safety standards will continue to drop. It is thus necessary to formulate a comprehensive road plan that directs sufficient consideration to pedestrian safety such as the introduction of physical barriers separating pedestrian and automobile traffic.

## 5.8 Conclusion

(1) Terms of the Assessment

Evaluation is required to carry out a further Environmental Impact Assessment for high priority road development in the Dar es Salaam urban area.

The environmental components for the Environmental Impact Assessment have been selected through the screening of the Initial Environmental Examination for the following concerns:

Flood Hazards
Resettlement
Air Pollution
Noise and Vibration

Regarding Flora and Fauna, further detailed examination will not be undertaken for the following reasons: One, mangroves which are considered the most important of these issues exist outside of potential high priority road areas. Two, street trees which are in conflict with road development will be replaced with new trees, or preserved by altering impending road alignments.

(2) Targeted Survey Works

The required survey works will involve the following potential environmental impact areas:

* Inundated roads and other flooding conditions during annual rainy seasons
* Air pollution, noise and vibration generated from running automobile traffic
* Impact to local inhabitants and businesses based on the need for potential resettlement due to road construction and land acquisition for new roads.

(3) Establishing Environmental Preservation Target

Establishing targets for environmental preservation and mitigation measures will be based on data obtained from Initial Environmental Examination, residential resettlement needs, and Tanzanian Government environmental standards and regulations

(4) Evaluation of Survey Components

a) Flood Hazards

Estimations of total potential for roadside flooding and road submergence which could occur during and after road construction has taken place based on information obtained from I.E.E.

b) Air Pollution

Ascertaining total amounts of automobile emissions, their impact to the environment and possible mitigation measures to be introduced to high priority roads is essential. In addition investigation of mitigating measures to combat excessive particulate matter during road construction will be done.

c) Resettlement

Issues arising from resettlement of residents along targeted high priority roads and the need for mitigation will take the following into consideration:

* Possible social and cultural tensions between newly arrived residents and residents living in adjacent areas.

* Possible cultural anxieties among resettled residents due to loss of livelihood or inability to continue livelihood in new areas

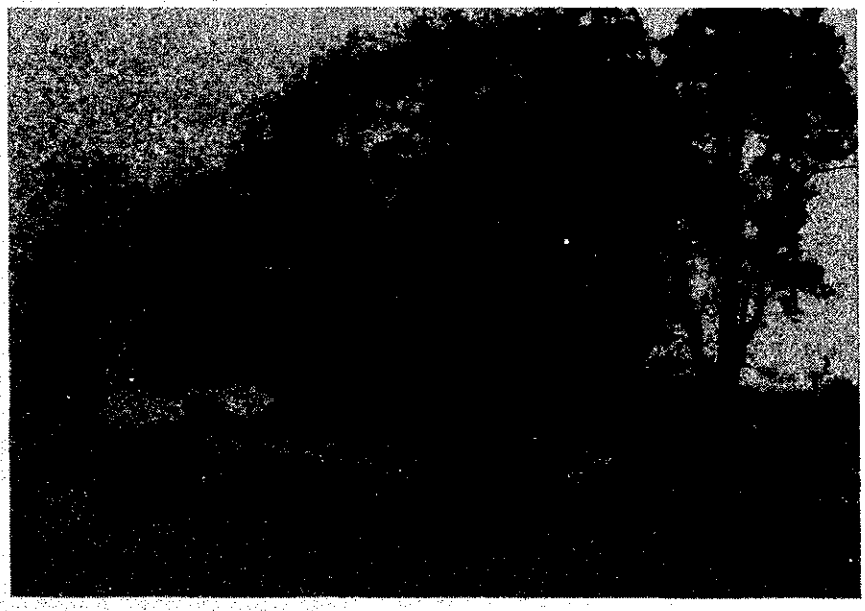
d) Noise and Vibrations

A qualitative assessment of noise and vibration generated from automobile traffic and road construction machinery along targeted high priority roads to adjacent residential areas must be done. Based on qualitative assessment proper mitigation targets can thus be estimated.

e) Comprehensive Evaluation

Based on results of the Environmental Impact Assessment for targeted environmental conditions of the survey area, incorporating probable physical changes as a result of road construction, and their effects on the living environment will be elaborated as fully as possible.

# CHAPTER 6 FORMULATION OF URBAN TRANSPORTATION STRATEGIES



# CHAPTER 6 FORMULATION OF URBAN TRANSPORTATION STRATEGIES

## 6.1 Urban Development Strategies

### 6.1.1 Projection of Socio-economy

(1) Population Projection

a) General

The time span covered by this Study is the seventeen-year period from 1993 to the year 2010 which is the target year of the road development master plan, while the year 2000 is the target year for the establishment of the implementation plan. It is therefore imperative to be able to estimate the rate at which the urban population will continue to grow during this time period. For the purposes of this Study an estimation of population growth for the city of Dar es Salaam was made using projections of past data and planning experience.

The population of Dar es Salaam is broken into two categories as in the Dar es Salaam Master Plan:

- Urban population
- Rural village population

The future growth of the urban population, which constitutes approximately 92% of the total Dar es Salaam region population, was estimated for the Study in terms of:

(i) The natural increase of the existing urban population as a result of the difference between births and deaths.

(ii) Migration into the DSM regional areas from rural areas in Tanzania outside of this region.

For the purposes of this Study, the growth of the rural population in the Dar es Salaam regions area is assumed to follow the same growth trends as the national population.

The natural annual increase of the urban population was based on the Dar es Salaam Master Plan value of 1.7 per cent. This rate of growth is not expected to change significantly up to the year 2000. The increase in the urban population due to inward migration is dependent on the relative attractiveness of living conditions in Dar es Salaam compared to other areas in Tanzania. The continued population increase will be affected to some degree by the government decentralization policy. As one example the Dodoma new capital development scheme which is still in progress will help to decrease the attractiveness of migration into Dar es Salaam.

b) Population Projection

Population growth in Dar es Salaam has almost remained linear since 1967, which had an estimated urban population of 316,000 for that year. The expected exponential population growth, which was based on the Dar es Salaam Master Plan of approximately 6.2% per annum, has not materialized. Comparisons with later census data show an incremental growth between: 1967 - 1978 of about 41,000 persons/year; and between 1978 - 1988 about 49,000 persons/year for urban populations.

More recently urban population has been estimated 1,515,000 persons for 1992 by the Urban Sector Engineering Project with an incremental growth rate from 1988 to 1992 of 65,000 persons/year following the significant growth of the country's economic recovery.

The urban population by the year 2000 has thus been estimated to be around 2.0 million. This projection assumes a growth rate of about 62,000 persons/year, a figure obtained from 1988 census levels of 1.26 million which is almost linear incremental growth in reference to past trends.

The urban population by the year 2010 has been estimated at 2.8 million people with an assumed linear growth rate of about 82,000 persons/year obtained also form estimated population of 2.0 million for the year 2000. The average annual growth rate is also assumed to be at 4.0% and 3.5% for population based on 1988 data projections for the

years 2000 and 2010 respectively, taking into consideration a decreasing rate of inward migration and a probable restricted city water supply.

The rural population by the year 2000 and the year 2010 are also estimated to be 140,000 persons and 180,000 persons, applying the same linear growth trend for Tanzania at 2.4% per annum.

Results of projections for the future total regional population of Dar es Salaam is estimated to be 2.14 million for the year 2000 and 3.00 million for the year 2010 respectively. The future population share for Dar es Salaam with respect to that of Tanzania will be growing 7.0% for the year 2000 and 7.8% for the year 2010 in comparison to the existing share of 5.9% (refer to Table 6.1).

Table 6.1 Future Population Projection

| | | Actual/Provisional | | | | Future | | |
|---|---|---|---|---|---|---|---|---|
| | | 1967 | 1978 | 1988 | 1992 *1 | 2000 | 2002 *1 | 2010 |
| Population ('000) | Dar es Salaam | 356.3 (2.9) | 843.1 (4.8) | 1,360.90 (6.9) | 1,631.00 (6.5) | 2,140 (7.0) | | 3,000 (7.8) |
| | Urban | | 763.1 (4.4) | 1,255.90 (5.4) | *1 1,515.00 (6.0) | 2,000 (6.5) | *1 2,000 (6.2) | 2,820 (7.3) |
| | Rural | | 80.00 (0.5) | 105.00 (0.5) | 116.00 (0.5) | *2 140 (0.5) | *2 147 (0.5) | 180 (0.5) |
| | Tanzania | 12,313 (100.0) | 17,512 (100.0) | 23,174 (100.0) | 25,100 (100.0) | 30,460 (100.0) | 31,800 (100.0) | 38,600 (100.0) |
| Annual Average Growth ('000) | Dar es Salaam | | 44.3 | 51.8 | 67.5 | 65 | | 86 |
| | Urban | | 40.6 | 49.3 | *1 64.8 | 62 | *1 48.5 | 82 |
| | Rural | | | 2.5 | 2.8 | 3 | 3 | 4 |
| | Tanzania | | 473 | 566 | 481 | 670 | 670 | 814 |
| Annual Average Growth Rate (%) | Dar es Salaam | | 7.8 | 4.8 | 4.6 | 3.8 | | 3.4 |
| | Urban | | 8.3 | 5.1 | 4.8 | 4.0 | *1 2.8 | 3.5 |
| | Rural | | | 2.7 | 2.5 | *2 2.4 | *2 2.4 | 2.4 |
| | Tanzania | | 3.2 | 2.8 | 2.4 | 2.4 | 2.4 | 2.4 |

Source : Population census, 1967, 1978, 1988 and Provisional Figure of Planning Commission

*1 : Estimated by "Urban Sector Engineering Project", December 1992

*2 : Estimated by "Dar es Salaam Urban Passenger Transport Study", July 1991

Others : Estimated by the Study Team

(2) Sector Employment

Based on projected populations for the Dar es Salaam Region, employment volumes are estimated and divided into 3 industrial sectors. It is assumed that employment proportion to total population do not change and that rural employment grow at a constant rate of 2.4% per anum, towards the year 2010. Table 6.2 shows the results of employment projection.

In the break-down of total employment characteristics it is presumed that Primary Sector employment in urban areas has become stagnant and that in rural areas it is increasing at the same rate of population growth. Other Sectors will grow at and maintain their same contribution ratio as at present. Results of employment break down are also shown in Table 6.2.

In the year 2000, Primary Sector employment will be 149 x $10^3$ and the Secondary Sector will have 130 x $10^3$; while in the year 2010, Primary Sector will have 167 x $10^3$ and Secondary Sector will have 190 x $10^3$. Between the years 2000 and 2010, the employment contribution of Primary and Secondary Sectors will be reversed. Tertiary Sector employment will continue to have the dominant employment volumes for the Dar es Salaam Region.

Table 6.2 Employment in Dar es Salaam Region

Unit: $10^3$

| Employment | 1988 (Actual) | 1992 (Provisional) | Projection 2000 | Projection 2010 |
|---|---|---|---|---|
| Urban | 473 | 574 | 760 | 1,078 |
| Rural | 67 | 73 | 89 | 112 |
| Region Total | 540 | 647 | 849 | 1,190 |
| of which: | | | | |
| Primary Sector | 132 | 138 | 149 | 167 |
| Secondary Sector | 76 | 95 | 130 | 190 |
| Tertiary Sector | 332 | 414 | 570 | 833 |

(3) Income Level

For long-term projections of real-term GDP, an annual average growth rate of 4.0% is applied, based on the following major reasons:

(a) Past Performance of the National Economy:

During 1985 to 1992, GDP at market prices grew at 4.6% per annum, while GDP at factor costs had an average annual growth rate at 4.0%. During the same 7 year period, Agriculture, Forestry, and Fishing had a growth rate of 4.9% and an approximate 60% contribution to the GDP.

(b) National Planning Target:

The first Rolling Plan and Forward Budget for Tanzania (1993/94 - 1995/96) has expected GDP growth during the 1993/94 - 1995/96 period to be 4.5% on average. This has been set forth by the Planning Commission, during the review of Economic Recovery Programs-I and II (2 Programs which targeted an average growth rate of 5%, but the performance of the economy was 4.0% as communicated by the Planning Commission performance of the economy).

Table 6.3 shows the GDP projection towards the year 2010, together with GRP for the Dar es Salaam Region. The GRP was obtained, assuming the Dar es Salaam Region contribution would remain at 1990 economy levels (16.1%) of the GDP. Conversion of both GDP and GRP at 1985 constant prices to those at 1993 constant prices was conducted, using multiplication factor of 6.68; which was derived from the retail price index and the wage index; 1985 and 1992 in Dar es Salaam.

Based on the projected GDP and GRP, Per Capita production was calculated for the Tanzania mainland and Dar es Salaam Region. Actual/projected production was divided by actual/projected population. The results are indicated in Table 6.4 which figures are at 1985 constant prices, and conversion to 1993 prices should be multiplied the same factor of 6.68 as above.

Table 6.3 GDP and DSM-GRP

Unit: $10^6$ Tshs.

| Description | 1992 (Base Figure) | Projection | |
|---|---|---|---|
| | | 2000 | 2010 |
| GDP at 1985 Prices | 142,175 | 194,576 | 288,020 |
| GDP at 1993 Prices *) | 949,729 | 1,299,768 | 1,923,974 |
| Dar es Salaam Region | | | |
| GRP at 1985 Prices | 22,890 | 31,327 | 46,371 |
| GRP at 1993 Prices *) | 152,905 | 209,264 | 309,758 |

Remark: *): Multiple Factor = 6.68 (Price escalation during 1985-1993)

Table 6.4 Per Capita Production

Unit: Tshs.

| Area | 1992 | 2000 | 2010 |
|---|---|---|---|
| Tanzania Mainland | 5,664 | 6,119 | 7,462 |
| DSM-Region | 14,034 | 14,639 | 15,457 |

Remarks: (1): At 1985 Prices.
(2): Results of division of actual/projected production by actual/projected population corresponding in the area.
(3): DSM-Region magnification ratio over the Mainland: 1992 - 2.48, 2000 - 2.39, 2010 - 2.07.

### 6.1.2 Urban Development Strategies

For the formation of an integrated road development master plan, it is essential to formulate urban development strategies for future growth. The Dar es Salaam Master Plan which was prepared in 1979 although expansive in scope is proposing fundamental principles to guide future growth. Some basic tenents prescribing future urban development and development strategies proposed in the Dar es Salaam Master Plan are reviewed in the following.

(1) Basic Philosophy

The basic development philosophy embodied in the Dar es Salaam Master Plan is to reduce the city's overall densities and improve the level of services available to future residents in Dar es Salaam. The density of new residential development outside of the existing urban area will be reduced to less than 100 person per ha. via the incremental increase in the number of large plots provided. Future residential development based on a reduction in density and, more importantly, on improvement of services within proposed development areas should include community facilities and services for a desirable urban environment.

Of initial concern is availability of suitable land for future development, its location, division into unified areas by natural features, existing development, and the capacity of these unified areas should be evaluated in order to accommodate a suitable combination of land uses.

In conjunction with these areas, the nature of existing and on-going planning schemes on the periphery of and within the existing urban areas must be considered as well as the potential extent of urban development, servicing constraints and the economics of servicing distant to development areas.

(2) Community Concept and Planning District

a) Community Concept

Basic Community facilities such as schools, clinics and market, provided within an acceptable walking distance of the residents they serve, will form an integral part of the

urban structure of the new residential area. As with basic services, the daily work trip represents a major factor in directing the nature of future urban structures. In an effort to reduce the demands placed on both private and public transportation facilities, job opportunities will be dispersed throughout the urban area to assist in creating a more favorable relationship between the locations of employment and residence.

Each community accommodates a population of approximately 40,000 people and will be self-contained with respect to the basic day to day needs of its residents.

b) Planning District

Planning Districts will accommodate populations ranging from 200,000 to 300,000 people consisting of five to seven communities which will require overall planning and coordination to ensure that the provision of facilities and servicing parallels the staging of residential and industrial development.

As a focal point, each planning district will have a major center that will provide services and facilities complementary to the city center.

The major center will also provide office and commercial space as well as limited accommodation. Major recreational facilities to serve the district will be located adjacent to the district center.

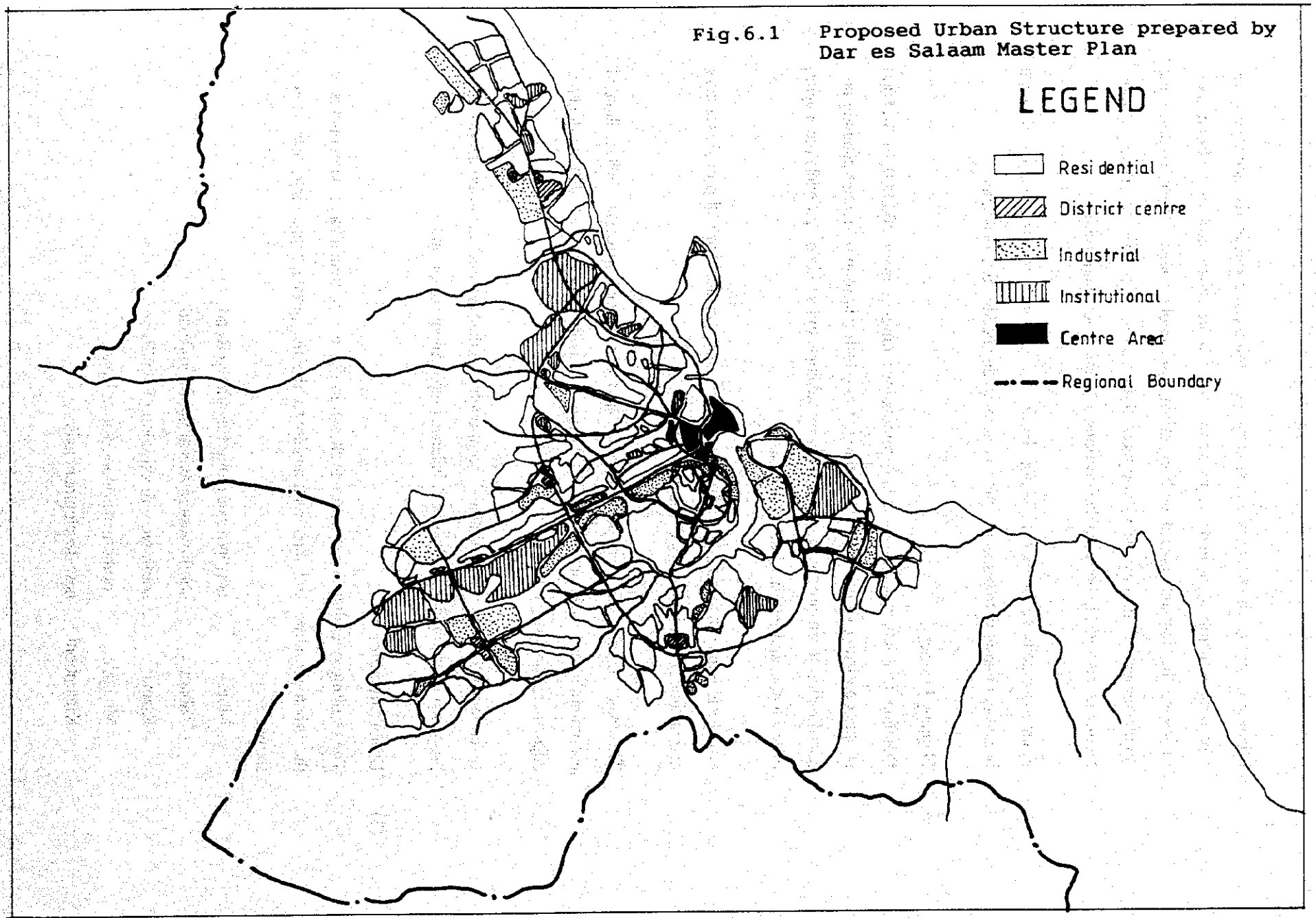
In conjunction with the residential components, industrial and institutional uses are proposed in each planning district to balance employment opportunities.

(3) Urban Structure

The resulting overall urban structure is shown in Fig. 6.1, in which basic components of the urban structure and their relationship to the five primary planning districts are shown.

- Mbezi: northern axis along Bagamoyo Road
- Tabata: south-western axis along Pugu Road
- Kizina: south-western axis along Pugu Road
- Mbagala: southern axis along Kilwa Road
- Kigamboni: new development axis

Fig.6.1 Proposed Urban Structure prepared by Dar es Salaam Master Plan



These development areas represent plausible growth for Dar es Salaam and encompass most of the potential development area as shown in Fig. 6.2 based on the natural land features, social servicing constraints and the economics services distance.

### 6.1.3 Future Urban Trends and Land-Use Prospects

(1) Development Schemes and Urban Trend

As mentioned in chapter 2.3, existing regional development schemes are now on going referring to the basic concept established in the Dar es Salaam Master Plan. These development schemes consist mainly of new large scale residential developments, new industrial developments and urban area redevelopment plans. (see Fig. 6.3).

Some of these new development schemes have already been begun in addition to continued unplanned growth which are summarized in the following proposed five growth axis.

(a) Northern Axis along Bagamoyo Road

- Ongoing new residential development of medium/low density at Mbezi, Kawe, Kunduchi and area around Wazo Hill Cement Factory.
- Further north residential development at Tegeta, Boko, Mbweni areas linking up with Bunju settlement.

(b) Western Axis along Morogoro Road

- Ongoing unplanned residential and mixture development of Kimara and Mbezi area with substantial in-fill within existing farm homestead anticipated.

(c) Southwestern Axis along Pugu Road

- Ongoing new residential development at Tabata in conjunction with the extension of the road.
- Further new residential development at Segerea north to Pugu Road, at Kizinga south of the Airport and further new heavy industrial development at Kitunda, south-west of the Airport.

Note: Development along this axis requires new access roads.

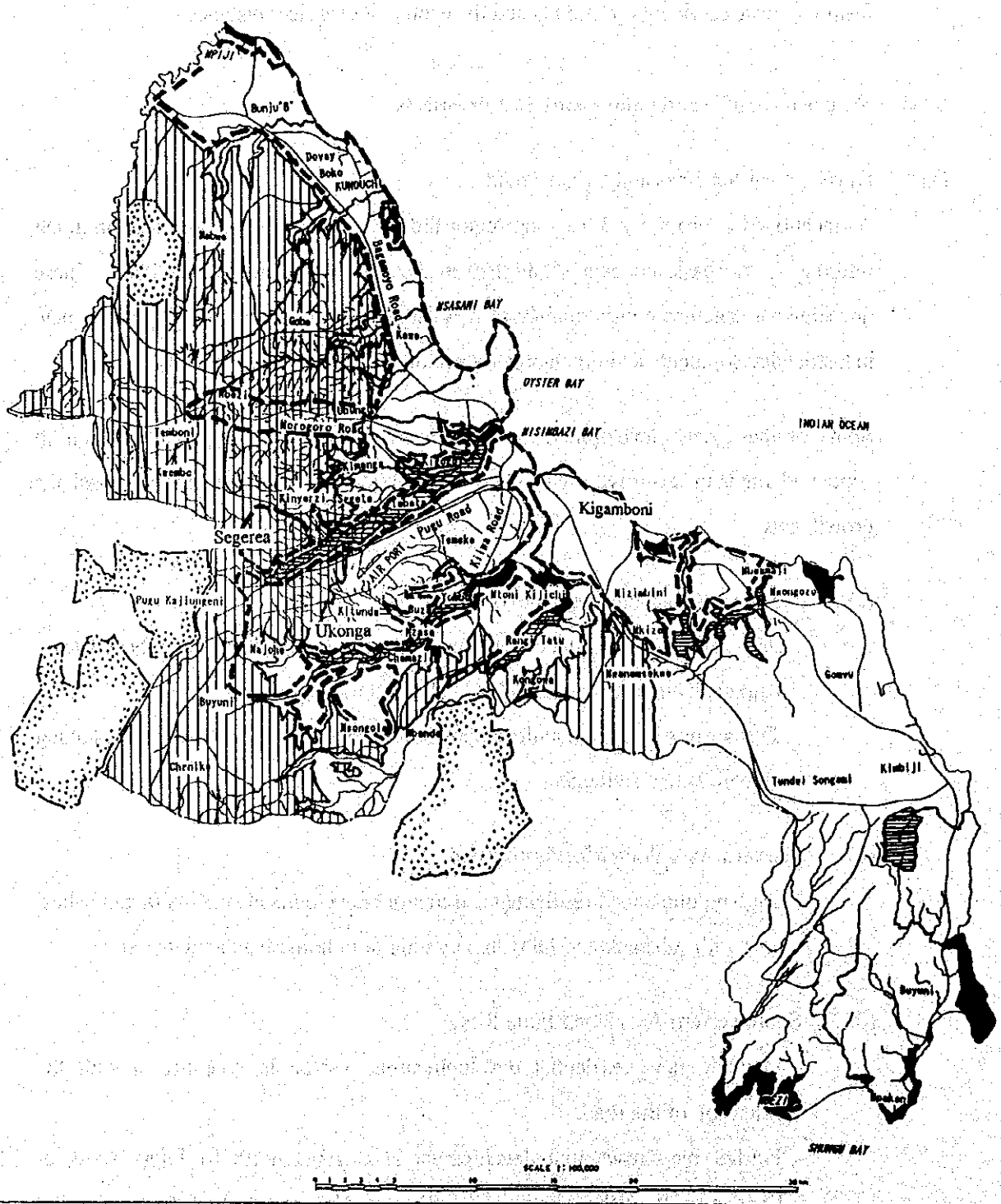



Fig. 6.2 Potential Area for Future Urban Development

THE STUDY ON DAR ES SALAAM ROAD DEVELOPMENT PLAN

Forest Reserve

Water Course & Swamp

Mangrove Swamp

Mountainous Terrain

Potential Are for Future Urban Development

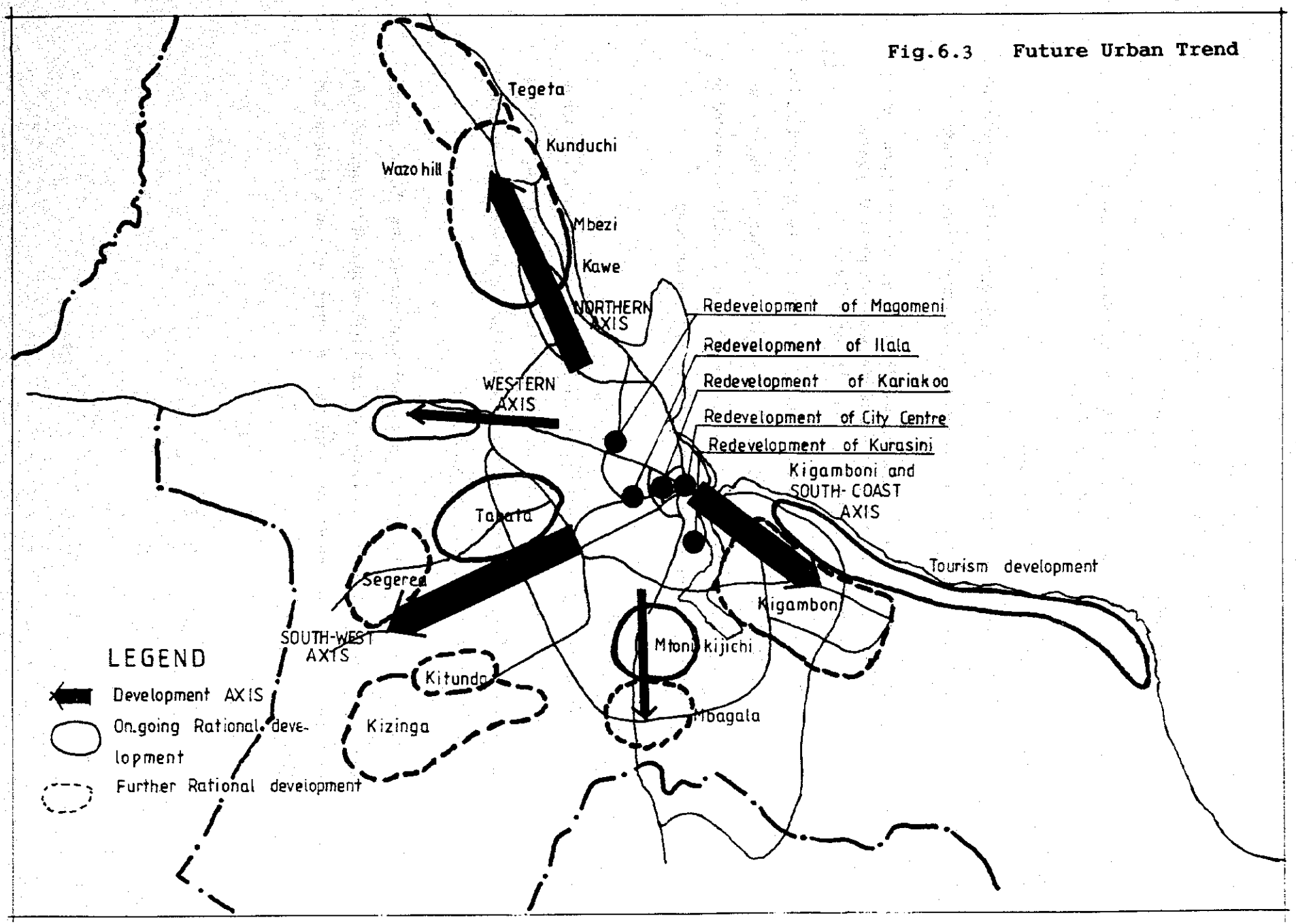



Fig.6.3 Future Urban Trend

(d) Southern Axis along Kilwa Road

- Ongoing residential development at Mtoni Kijichi
- Some development expected around Mbagala.

Note: Development along this axis is sluggish mainly due to the critical constraint of inadequate water supply.

(e) Kigamboni and South-Coast Axis

- Development of the Kigamboni area is now pending but could be enhanced by an efficient creek or harbor crossing from the city center to the peninsula.

Note: Detailed layout plans have been made by the Ministry of Land, Housing and Urban Development for Kigamboni, Mjimwema (Residential), Vijibweni (Industrial), and Nunge (Industrial and Residential) areas.

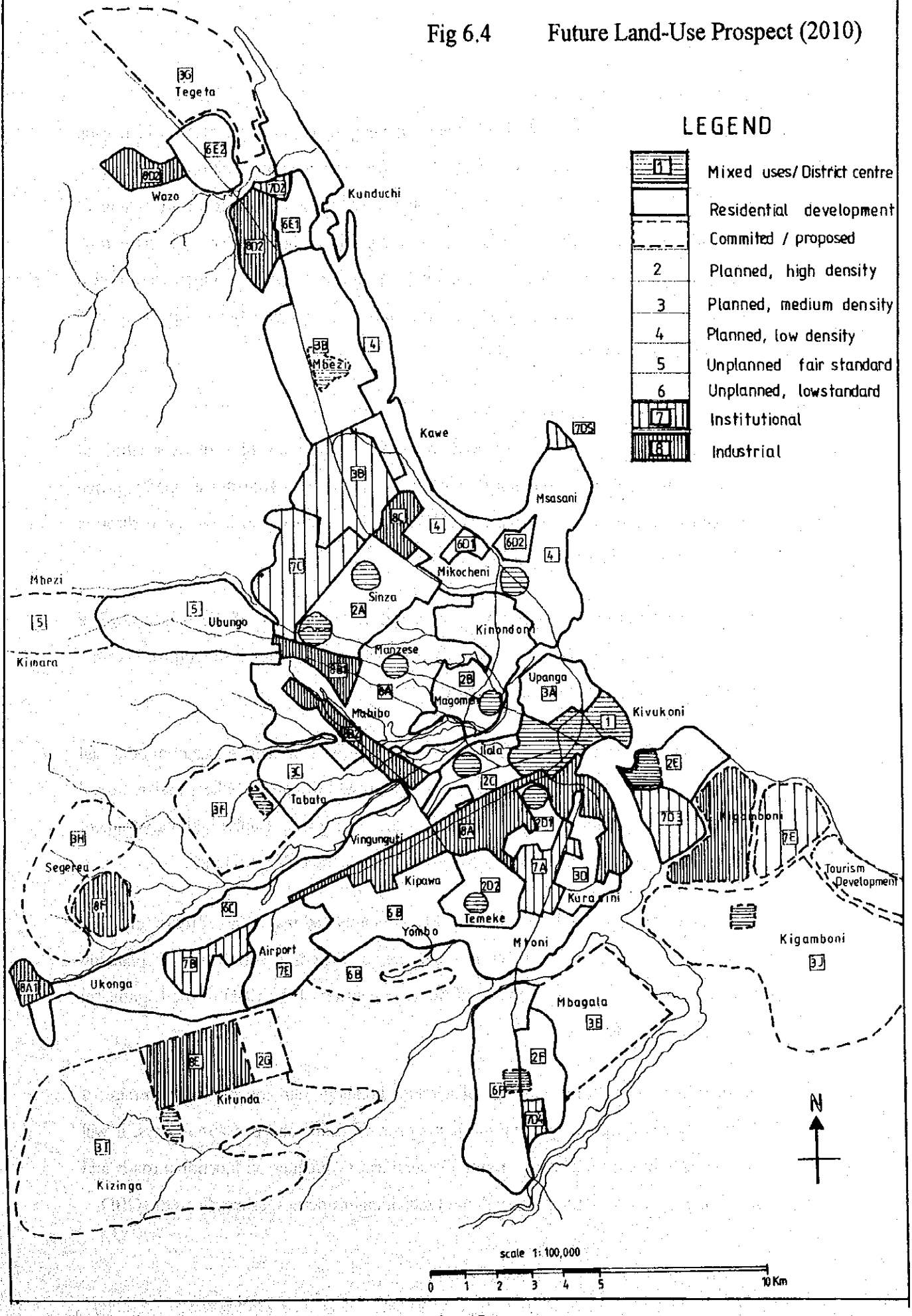
- Planned tourist facilities along the coast from the north-east of Kigamboni to Kimbiji (about 70 km south-east of Kigamboni), is likely to trigger other considerable development in and around Kigamboni which is expected in conjunction with the strengthening of ferry service at Kivukoni.

(2) Land-use Prospects

Based on the above urban trends and population projections for Dar es Salaam, future urban land-use prospects have been prepared for the year 2010, embodying the basic development philosophy of the Dar es Salaam Master Plan and analysis of potential land areas for future urban development (see Fig. 6.4).

Furthermore, urban redevelopment schemes have been prepared for the city center, Kariakoo and Kurasini areas. In addition residential redevelopment schemes are now being prepared for Ilala and Magomeni areas by the Ministry of Lands, Housing and Urban Development.

# Fig 6.4 Future Land-Use Prospect (2010)



a) Central Business District (CBD)

With regards to the CBD, plans for urban redevelopment were prompted by increasing pressure to secure business space in city the center. The need for additional space began to gain momentum in the second half of the 1980's, primarily, due to positive signs of economic recovery and the associated favorable business climate which was created by the liberalization of the countries economy. The aim of the plan is to increase business space through vertical development and creating a metropolitan city atmosphere as well as renovating the areas infrastructure.

b) Dispersion of the Function of CBD

Considering the huge amount of funds required for the renovation of over-saturated infrastructure and the budgetary constraints of the government, it might prove impractical to redevelop the existing CBD in order to create business space through vertical development within this limited area.

It is assumed that future population growth and the urban scale of Dar es Salaam will continue to increase even after the year 2010. Following this trend, the functions of the CBD will be expected to be strengthened.

Considering the limited space of the existing CBD, it is difficult to accommodate all demands within the existing CBD land area. At present this area is where massive retail and wholesale outlets, almost all branches of Government Banks and Government Offices, most of which are suited to be located outside the CBD, are found.

With respect to daily needs of residents, it is recommended that some of these functions be relocated to existing sub-cores in urban areas. Proposed sub centers in planning districts and/or applying the concept of future expansion of the CBD to the Kigamboni area should be considered.

Furthermore, considering existing substandard buildings and the chronic shortage of parking spaces with auto parking infringing on road traffic and pedestrian ways, it will be necessary to introduce new parking management techniques on functional roads and new building codes for the preservation of individual properties, especially in the CBD.

### 6.1.4 Development Potential and Future Population Distribution by Traffic Zone

(1) Future Land-use Demand

The total Future land-use demand for the Dar es Salaam regional area is projected as shown in Table 6.5. These projections follow future trends for population and employment expansion in the city.

Total future residential land requirement is projected to be approximately 28 thousand hectares by the year 2010. This projection is double of existing residential land areas, which is needed to reduce the city's total residential densities.

Future total industrial area requirement is projected to be approximately 3,800 hectares by the year 2010; which amounts to a distribution rate of around 20 ha./1000 industrial employees.

Future total mixed-use area requirement is projected to be around 1,700 hectares by the year 2010. This requirement targets business and commercial industries using 2.1 ha./1000 employees as a guide, the same level of distribution for employees in tertiary industries in 1992.

(2) Future Population Distribution by Traffic Zone

In reference to primary tenets of the Dar es Salaam Master Plan along with future urban trends outlined in previous section, future population distribution are described as following.

Numbers for future total populations and future total residential area requirements have been assigned to each residential area as foreseen in the Future Land-use scheme. The plan takes into consideration appropriate densities for each residential area and the magnitude of each residential population along each development axis in the hope of formulating a future concept for community development and distinct planning.

Table 6.5 Future Land-use Demand

| Type of Land-use | | Year | | | |
|---|---|---|---|---|---|
| | Units | 1988 | 1992 | 2000 | 2010 |
| DSM Regional Population | ('000) | 1,360.9 | 1,631.0 | 2,140 | 3,000 |
| (a) Urban Population | ('000) | 1,255.9 | 1,515.0 | 2,000 | 2,820 |
| (b) Rural Population | ('000) | 105.0 | 116.0 | 140 | 180 |
| DSM Regional Employment | | 539.8 | 647.0 | 849 | 1,190 |
| (c) Primary Industry | ('000) | 132.8 | 138.0 | 149 | 167 |
| (d) Secondary Industry | ('000) | 75.6 | 95.0 | 130 | 190 |
| (e) Tertiary Industry | ('000) | 331.4 | 414.0 | 570 | 833 |
| Total Urban Area | (ha.) | | | | |
| (f) Residential Area | (ha.) | | 14,025 | 17,280 | 28,470 |
| (g) Industrial Area | (ha.) | | 2,145 | 2,600 | 3,800 |
| (h) Mixed-use Area | (ha.) | | 890 | 1,200 | 1,700 |
| (I) Institutions | | | 2,670 | 2,670 | 2,670 |
| (f)/(a) | (ha./1000) | | 9.5 | 8.6 | 10.1 |
| (a)/(f) | (person/ha.) | | 108 | 116 | 99 |
| (g)/(d) | (ha./1000) | | 22.6 | 20.0 | 20.0 |
| (h)/(e) | (ha./1000) | | 2.1 | 2.1 | 2.1 |

Population distribution methodology for total future population was based on the same methodologies applied in the "Urban Sector Engineering Project" for Infrastructure Rehabilitation. The project plan considers densities and in-fill capacities for planned and unplanned residential areas.

Results of this application show the magnitude of future population distribution along each development axis, as indicated in Table 6.6.

Detailed population distribution trends are shown in Appendix 6.1, while future populations assigned to each traffic zone are shown in Table 6.7.

In order to formulate a planning district for each development axis, industrial land-use areas as well as district sub-centers will be established as shown in Table 6.6.

(3) Future Employment Distribution by Traffic Zones

In Dar es Salaam no reliable figures for employment volume at working places are available from either Population Census Data or any other sources of statistical data, apart from data which was obtained from the Person-Trip Survey conducted by the study team.

Due to this, an analysis of the relationship between the number of working, employment and each type of land-use in each traffic zones was conducted, applying existing employment data for each type of industry.

The total number of future projected employment by industry type was assigned to each traffic zone as can be seen in Table 6.8.

Table 6.6 Population Distribution by Development Axis

| Axis | Area (ha) | | | Population Density (person/ha) | | | Population | | | Industrial Area (ha) | | | Mixed uses/District centre (ha) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1992 | 2000 | 2010 | 1992 | 2000 | 2010 | 1992 | 2000 | 2010 | 1992 | 2000 | 2010 | 1992 | 2000 | 2010 |
| Existing Urbanized Area | 7,445 | 7,440 | 7,440 | 161 | 165 | 165 | 1,198,000 | 1,233,000 | 1,233,000 | 1,645 | 1,650 | 1,650 | 890 | 1,000 | 1,075 |
| Northern Axis | 2,145 | 3,650 | 4,550 | 20 | 55 | 71 | 44,000 | 200,000 | 324,000 | 500 | 600 | 600 | 0 | 100 | 150 |
| Western Axis | 1,135 | 1,135 | 2,000 | 38 | 61 | 70 | 43,000 | 69,000 | 140,000 | 0 | 0 | 0 | 0 | 0 | 0 |
| South-Western Axis | 1,870 | 2,720 | 7,145 | 74 | 104 | 85 | 139,000 | 283,000 | 613,000 | 0 | 750 | 900 | 0 | 50 | 200 |
| - North of Puga Rd. | 1,060 | 1,710 | 2,260 | 75 | 81 | 85 | 79,000 | 138,000 | 193,000 | 0 | 300 | 300 | 0 | 50 | 100 |
| - South of Puga Rd. | 810 | 1,010 | 4,885 | 74 | 143 | 85 | 60,000 | 145,000 | 420,000 | 0 | 450 | 600 | 0 | 0 | 100 |
| Southern Axis | 1,060 | 1,960 | 1,960 | 57 | 84 | 106 | 61,000 | 164,000 | 208,000 | 0 | 250 | 250 | 0 | 50 | 75 |
| Kigamboni | 375 | 375 | 5,375 | 80 | 135 | 56 | 30,000 | 51,000 | 302,000 | 0 | 0 | 500 | 0 | 0 | 200 |
| Sub total | 6,585 | 9,840 | 21,030 | 48 | 78 | 75 | 317,000 | 767,000 | 1,587,000 | 500 | 1,600 | 2,250 | 0 | 200 | 25 |
| Total | 14,025 | 17,280 | 28,470 | 108 | 116 | 99 | 1,515,000 | 2,000,000 | 2,820,000 | 2,145 | 2,600 | 3,800 | 890 | 1,200 | 1,700 |

Table 6.7 Population Distribution by Traffic Zone

| | | Existing | | 2000 | | 2010 | |
|---|---|---|---|---|---|---|---|
| Zone | Area (km2) | Population ('000) | Density (Person/na2) | Population | Density | Population | Density |
| 10 | 1.2 | 20,000 | 166 | 20,000 | 166 | 20,000 | 166 |
| 20 | 1.8 | 30,000 | 166 | 30,000 | 166 | 30,000 | 166 |
| 30 | 2.5 | 5,000 | 20 | 9,000 | 36 | 9,000 | 36 |
| 40 | 3.9 | 20,000 | 51 | 20,000 | 51 | 20,000 | 51 |
| 50 | 1.9 | 20,000 | 105 | 20,000 | 105 | 20,000 | 105 |
| 60 | 2.2 | 41,000 | 186 | 45,000 | 205 | 45,000 | 205 |
| 70 | 6.1 | 50,000 | 82 | 50,000 | 82 | 50,000 | 82 |
| 80 | 6.7 | 103,000 | 154 | 103,000 | 154 | 103,000 | 154 |
| 90 | 5.7 | 34,000 | 60 | 34,000 | 60 | 34,000 | 60 |
| 100 | 3.6 | 25,000 | 69 | 25,000 | 69 | 25,000 | 69 |
| 110 | 3.6 | 20,000 | 56 | 20,000 | 56 | 20,000 | 56 |
| 120 | 3.8 | 75,000 | 197 | 75,000 | 197 | 75,000 | 197 |
| 130 | 3.7 | 50,000 | 135 | 50,000 | 135 | 50,000 | 135 |
| 140 | 4.1 | 75,000 | 183 | 75,000 | 183 | 75,000 | 183 |
| 150 | 1.7 | 60,000 | 353 | 60,000 | 353 | 60,000 | 353 |
| 160 | 2.5 | 60,000 | 240 | 60,000 | 240 | 60,000 | 240 |
| 170 | 5.4 | 55,000 | 102 | 75,000 | 139 | 75,000 | 139 |
| 180 | 5.8 | 50,000 | 86 | 50,000 | 86 | 50,000 | 86 |
| 190 | 24.0 | 57,000 | 24 | 67,000 | 28 | 67,000 | 28 |
| 200 | 46.0 | 65,000 | 14 | 135,000 | 29 | 149,000 | 32 |
| 210 | 38.6 | 75,000 | 19 | 90,000 | 23 | 90,000 | 23 |
| 220 | 9.1 | 49,000 | 54 | 102,000 | 112 | 102,000 | 112 |
| 221 | 60.7 | 3,000 | 0.5 | 4,000 | 0.6 | 46,000 | 8 |
| 230 | 5.2 | 36,000 | 69 | 52,000 | 100 | 56,000 | 108 |
| 240 | 10.4 | 72,000 | 69 | 72,000 | 69 | 72,000 | 69 |
| 250 | 56.2 | 57,000 | 10 | 88,000 | 16 | 166,000 | 30 |
| 260 | 5.9 | 100,000 | 169 | 100,000 | 169 | 100,000 | 169 |
| 270 | 2.1 | 43,000 | 205 | 43,000 | 205 | 43,000 | 205 |
| 280 | 25.6 | 54,000 | 21 | 127,000 | 50 | 167,000 | 65 |
| 281 | 76.4 | 6,000 | 0.8 | 7,000 | 0.9 | 8,000 | 1.0 |
| 282 | 16.4 | 21,000 | 13 | 26,000 | 16 | 54,000 | 33 |
| 283 | 13.6 | 15,000 | 11 | 65,000 | 48 | 191,000 | 140 |
| 290 | 44.8 | 7,000 | 1 | 8,000 | 2 | 10,000 | 2 |
| 291 | 12.4 | 3,000 | 2 | 4,000 | 3 | 65,000 | 52 |
| 300 | 12.0 | 3,000 | 2 | 14,000 | 12 | 108,000 | 90 |
| 310 | 88.0 | 26,000 | 3 | 122,000 | 14 | 248,000 | 28 |
| 311 | 29.4 | 2,000 | 1 | 2,000 | 1 | 13,000 | 4 |
| 312 | 99.8 | 11,000 | 1 | 23,000 | 2 | 39,000 | 4 |
| 320 | 54.0 | 5,000 | 1 | 35,000 | 6 | 54,000 | 10 |
| 321 | 120.6 | 19,000 | 2 | 23,000 | 2 | 39,000 | 3 |
| 330 | 59.5 | 7,000 | 1 | 8,000 | 1 | 20,000 | 3 |
| 331 | 28.0 | 15,000 | 5 | 18,000 | 6 | 90,000 | 32 |
| 340 | 35.2 | 32,000 | 9 | 64,000 | 18 | 146,000 | 41 |
| 341 | 121.6 | 7,000 | 0.6 | 8,000 | 0.7 | 21,000 | 2 |
| 342 | 67.8 | 3,000 | 0.4 | 4,000 | 0.6 | 5,000 | 0.7 |
| 343 | 254.8 | 7,000 | 0.3 | 8,000 | 0.3 | 10,000 | 0.4 |
| | | | | | | | |
| Total | | 1,674,000 | | 2,140,000 | | 3,000,000 | 3,000,000 |

Table 6.8 Employment Distribution by Traffic Zone

| Zone | Primary Industry | | | Secondary Industry | | | Tertiary Industry | | |
|---|---|---|---|---|---|---|---|---|---|
| No. | 1992 | 2000 | 2010 | 1992 | 2000 | 2010 | 1992 | 2000 | 2010 |
| 10 | 7,400 | 7,300 | 7,100 | 8,300 | 8,300 | 8,300 | 42,300 | 45,200 | 49,800 |
| 20 | 7,400 | 7,300 | 7,100 | 6,800 | 6,800 | 6,800 | 43,600 | 46,000 | 49,800 |
| 30 | 7,600 | 7,600 | 7,200 | 5,600 | 5,600 | 5,600 | 26,100 | 28,300 | 31,800 |
| 40 | 2,100 | 2,100 | 2,100 | 3,100 | 3,100 | 3,100 | 22,600 | 23,100 | 23,800 |
| 50 | 5,500 | 6,700 | 6,600 | 2,200 | 2,200 | 2,200 | 9,000 | 20,400 | 38,300 |
| 60 | 1,000 | 800 | 800 | 2,700 | 2,700 | 2,700 | 20,900 | 19,800 | 19,400 |
| 70 | 1,900 | 5,700 | 5,600 | 7,800 | 7,800 | 7,800 | 14,100 | 20,000 | 29,100 |
| 80 | 1,200 | 1,200 | 1,200 | 700 | 700 | 700 | 9,400 | 11,400 | 14,600 |
| 90 | 2,100 | 2,000 | 2,000 | 4,300 | 4,300 | 4,300 | 19,700 | 19,800 | 19,900 |
| 100 | 5,900 | 5,800 | 5,700 | 5,400 | 5,400 | 5,400 | 15,000 | 20,000 | 27,800 |
| 110 | 2,100 | 2,100 | 2,000 | 200 | 200 | 200 | 5,100 | 5,200 | 5,300 |
| 120 | 4,800 | 4,700 | 4,600 | 3,000 | 3,000 | 3,000 | 5,100 | 5,200 | 5,300 |
| 130 | 2,700 | 2,700 | 2,600 | 500 | 500 | 500 | 11,500 | 14,800 | 19,900 |
| 140 | 2,300 | 2,300 | 2,200 | 1,000 | 1,000 | 1,000 | 9,400 | 15,300 | 24,400 |
| 150 | 3,400 | 3,400 | 3,300 | 1,000 | 1,000 | 1,000 | 12,400 | 14,100 | 16,800 |
| 160 | 500 | 500 | 500 | 2,400 | 2,400 | 2,400 | 11,500 | 15,900 | 22,700 |
| 170 | 4,300 | 3,900 | 3,800 | 3,700 | 3,700 | 3,700 | 13,200 | 18,700 | 27,400 |
| 180 | 1,800 | 1,800 | 1,800 | 400 | 400 | 400 | 5,600 | 6,600 | 8,100 |
| 190 | 6,200 | 6,100 | 6,000 | 2,400 | 2,400 | 2,400 | 12,800 | 17,100 | 23,900 |
| 200 | 2,400 | 7,400 | 7,200 | 4,200 | 12,000 | 17,800 | 5,600 | 15,600 | 31,100 |
| 210 | 2,400 | 2,300 | 2,300 | 9,500 | 9,500 | 9,500 | 11,100 | 11,300 | 11,600 |
| 220 | 2,100 | 4,600 | 6,600 | 600 | 600 | 600 | 1,300 | 11,600 | 27,600 |
| 221 | 2,600 | 2,500 | 2,400 | 0 | 7,800 | 22,600 | 0 | 300 | 800 |
| 230 | 2,000 | 1,700 | 1,600 | 5,300 | 5,300 | 5,300 | 6,800 | 8,100 | 10,200 |
| 240 | 2,000 | 2,000 | 1,900 | 4,400 | 4,400 | 4,400 | 15,400 | 15,600 | 16,000 |
| 250 | 2,500 | 2,400 | 7,300 | 900 | 900 | 35,500 | 2,600 | 13,800 | 31,200 |
| 260 | 5,000 | 4,900 | 4,800 | 6,800 | 6,800 | 6,800 | 33,800 | 35,200 | 37,300 |
| 270 | 800 | 800 | 800 | 700 | 700 | 700 | 9,400 | 13,300 | 19,400 |
| 280 | 2,400 | 2,100 | 5,700 | 400 | 400 | 400 | 4,300 | 13,400 | 27,500 |
| 281 | 2,600 | 2,500 | 2,500 | 0 | 0 | 0 | 0 | 0 | 100 |
| 282 | 2,500 | 2,400 | 2,200 | 0 | 19,400 | 33,800 | 0 | 1,200 | 3,100 |
| 283 | 2,500 | 2,100 | 1,300 | 0 | 0 | 0 | 300 | 5,900 | 13,300 |
| 290 | 2,600 | 2,500 | 2,500 | 0 | 0 | 0 | 0 | 100 | 200 |
| 291 | 2,600 | 2,500 | 2,100 | 0 | 0 | 0 | 0 | 0 | 4,900 |
| 300 | 2,500 | 5,000 | 4,300 | 0 | 0 | 0 | 0 | 4,900 | 22,700 |
| 310 | 2,500 | 2,400 | 7,300 | 700 | 700 | 700 | 0 | 12,100 | 31,000 |
| 311 | 2,600 | 2,500 | 2,500 | 0 | 0 | 0 | 0 | 0 | 400 |
| 312 | 2,600 | 2,500 | 2,500 | 0 | 0 | 0 | 0 | 0 | 400 |
| 320 | 2,600 | 2,500 | 2,400 | 0 | 0 | 0 | 0 | 400 | 900 |
| 321 | 2,600 | 2,500 | 2,500 | 0 | 0 | 0 | 0 | 0 | 300 |
| 330 | 2,600 | 2,500 | 2,500 | 0 | 0 | 0 | 0 | 0 | 300 |
| 331 | 2,500 | 2,500 | 2,200 | 0 | 0 | 0 | 0 | 0 | 3,000 |
| 340 | 2,500 | 2,400 | 9,700 | 0 | 0 | 22,900 | 0 | 18,200 | 46,500 |
| 341 | 2,600 | 2,50 | 2,500 | 0 | 0 | 0 | 0 | 0 | 200 |
| 342 | 2,600 | 2,500 | 2,500 | 0 | 0 | 0 | 0 | 0 | 0 |
| 343 | 2,600 | 2,500 | 2,500 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| Total | 138,000 | 149,000 | 167,000 | 95,000 | 130,000 | 190,000 | 414,000 | 570,000 | 833,000 |

a) Primary Industry

As the number of farmers working in fields will be steadily decreasing due to urbanization and the loss of agricultural land, the number of workers who are involved with agricultural production and marketing will be proportional to total market volumes.

Based on factors, future numbers for employment in primary industries at given locales will be assigned to each traffic zones applying the following formula obtained from the analysis of existing data.

$$\frac{E1(i)}{\Sigma E1(i)} \times 100 = a\,PD(i) + b\,MA(i) + C$$

then

$$E1(i) = 100 \times \Sigma E1(i) \times \{a\,PD(i)\ b\,MA(i)C\}$$

where,

E1(i): Future number of employment of primary industry working in zone i

ΣE1(i): Future total number of employment projected on Primary Industry in DSM

PD(i): Future population density assigned in zone i (unit: person/ha.)

MA(i): Future Area assigned for Mixed Land-use in zone i (unit: ha.)

a: Parameter: -0.01
b: - do - : 0.06
c: - do - : 3.0

The detailed calculation results are shown in Appendix 6.2.

b) Secondary Industry

Future totals for increasing employment in the city's Secondary Industry Sector were assigned to each traffic zone applying increasing areal magnitude of future industrial area assigned for each traffic zones.

The detailed calculations results are shown in Appendix 6.3.

c) Tertiary Industry

An amount of local service sector employment in Tertiary Industries will be directly related to a population in its residential area. In addition a population in its number of business employment of Tertiary Industry will be proportioned to areal magnitude for businesses and commercial industries.

Future numbers for employment in Tertiary Industries at specified locales were assigned to each traffic zone using the following proportional model obtained through the analysis.

$$\frac{E3(i)}{\Sigma E3(i)} \times 100 = a\,PD(i) + b\,MA(i)$$

then

$$E3(i) = 100 \times \Sigma E3(i) \times \{a\,PD(i) + b\,MA(i)\}$$

where,

E3(i): Future number of employment of Tertiary Industry working in zone i

ΣE1(i): Future total number of employment projected on Tertiary Industry in DSM

PD(i): Future population density assigned in zone i (unit: person/ha.)

MA(i): Future Area assigned for Mixed Land-use in zone i (unit: ha.)
a: Parameter: 0.02
b: - do - : 0.06

The detailed calculation results are shown in Appendix 6.4.