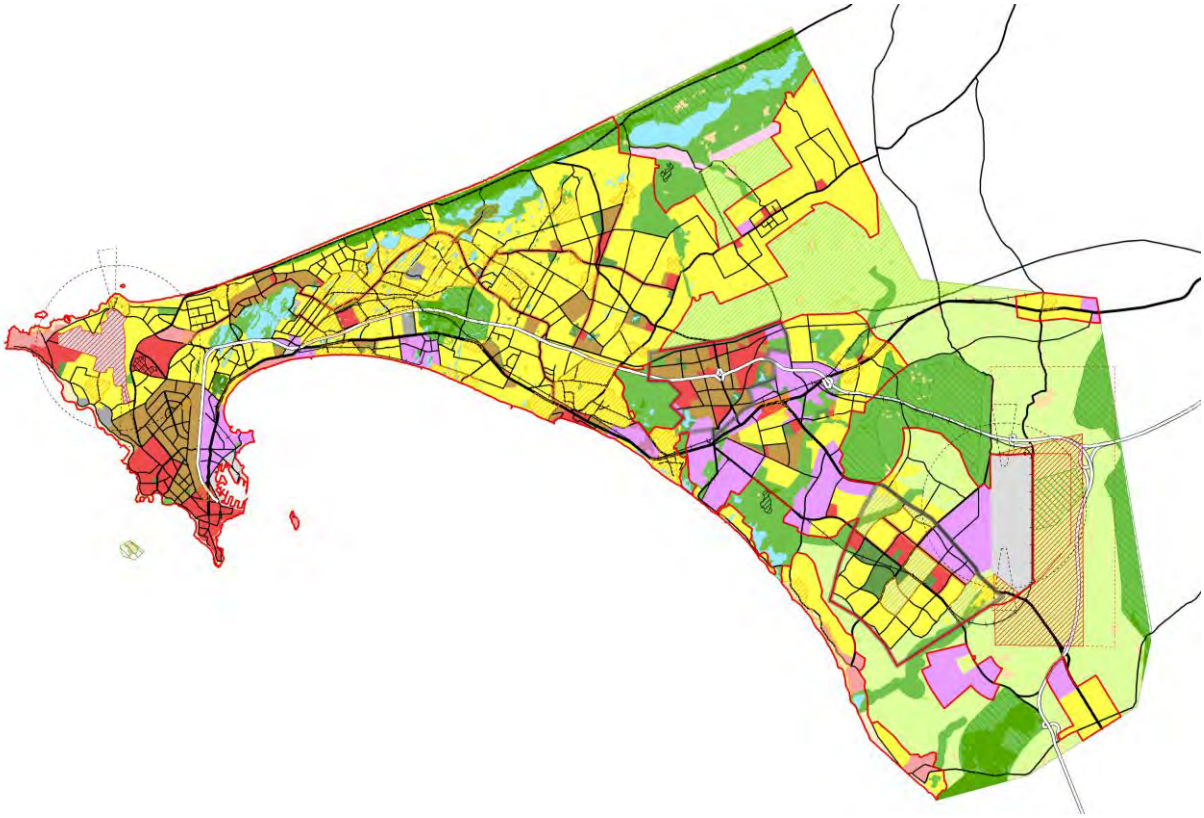
No.

Ministry of Urban Renewal, Housing and Living Environment
Republic of Senegal

Japan International Cooperation Agency (JICA)

Project for Urban Master Plan of Dakar and Neighboring Area for 2035

Final Report
Volume. II



January 2016

Implemented by:
RECS International Inc.
Oriental Consultants Global Co., Ltd.
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Abbreviations

Organization

ADEPME	Development Agency and Supervision of Small and Medium Enterprises	ADEPME	Agence de Développement et d'Encadrement des Petites et Moyennes Entreprises
ADIE	Agency for Information Technology	ADIE	Agence de l'Informatique de l'Etat
ADM	Agency for Municipal Development	ADM	Agence de Développement Municipal
ADS	Senegal Airports Agency	ADS	Agence des Aéroports du Sénégal
AEME	Agency for Energy, Efficiency and Pricing	AEME	L'Agence sénégalaise pour l'Economie et la Maîtrise de l'Energie
AFD	French Development Agency	AFD	Agence Française de Développement
AfDB	African Development Bank	AfDB	Groupe de la Banque Africaine de Développement
AFTU	Association for Funding Urban Transportation Professionals	AFTU	Association de Financement des professionnels du Transport Urbain
AGEROUTE	Agency for Road Construction and Management	AGEROUTE	Agence des Travaux et de Gestion des Routes
AGETIP	Executing Agency of Public Interest Works	AGETIP	Agence d'Exécution des Travaux d'Intérêt Public
AIBD	Blaise Diagne International Airport	AIBD	Aéroport International Blaise Diagne
ANACIM	National Civil Aviation and Meteorological Agency of Senegal	ANACIM	Agence Nationale de l'Aviation Civile du Sénégal
ANAM	National Agency of Maritime Affairs	ANAM	Agence Nationale des Affaires Maritimes
ANAT	National Agency for Regional Development	ANAT	Agence Nationale de l'Aménagement du Territoire
ANCF	National Agency of Railways	ANCF	Agence Nationale des Chemins de Fer
ANER	National Agency for Renewable Energies	ANER	Agence Nationale pour les Energies Renouvelables
ANIDA	National Agency for Agricultural Development and Integration	ANIDA	Agence Nationale d'Insertion et de Développement Agricole
ANSD	National Agency for Statistics and Demography	ANSD	Agence Nationale de la Statistique et de la Démographie
APIX	National Agency in charge of Investment Promotion and Major Works	APIX	Agence Nationale Chargée de la Promotion de l'Investissement et des Grands Travaux
APROSI	Agency for Industrial Promotion and Land Development	APROSI	Agence d'Aménagement et de Promotion de Sites Industriels
ASEPEX	National Agency for Export Promotion	ASEPEX	Agence Sénégalaise de Promotion des Exportations
ASER	Senegal Agency for Rural Electrification	ASER	Agence Sénégalaise d'Electrification Rurale
ASTP	Tourism Promotion Agency of Senegal	ASTP	Agence Senegalaise de Promotion Touristique
AU	African Union	AU	Union Africaine
AWWA	American Water Works Association	AWWA	American Water Works Association
BNCP	National Fire Brigade	BNSP	Brigade Nationale de Sapeurs-Pompiers
CADAK-CAR	Community of Dakar and Rufisque Agglomerations	CADAK-CAR	Communauté des Agglomérations de Rufisque et de Dakar
CETUD	Executive Council of Urban Transport in Dakar	CETUD	Conseil Exécutif des Transports Urbains de Dakar
COMESSA	Community for Sahel-Saharan States (Africa)	COMESSA	Communauté des Etats du Sahel-Sahara (Afrique)
COSEC	Senegalese Shippers Council	COSEC	Conseil Senegalais des Chargeurs
CSE	Ecological Monitoring Center	CSE	Centre de Suivi Ecologique
DA	Department of Sanitation	DA	Direction de l'Assainissement
DARZI	Directorate of Development and Reconstruction of Inundated Areas, Ministry of Urban Renewal, Housing and Living Environment	DARZI	Direction de l'Aménagement et de la Restructuration des Zones d'Inondation
DBRLA	Department of Catchment Basins and Artificial Lakes	DBRLA	Direction des Bassins de Rétention et des Lacs Artificiels
DCCI	Dakar Chamber of Commerce and Industry	DCCI	Chambre De Commerce Et D'Industrie De Dakar
DCSU	Urban Cartography and Statistics Division	DCSU	Division de la Cartographie et des Statistiques Urbaines
DDD	Dakar Dem Dik	DDD	Dakar Dem Dik
DEEC	Department of Environment and Classified Establishments	DEEC	Direction de l'Environnement et des Établissements Classés
DGID	Directorate General of Tax and Domains	DGID	Direction Générale des Impôts et des Domaines
DGPRE	Department of Water Resource Planning and Management	DGPRE	Direction de la Gestion et de la Planification des Ressources en Eau
DGPU	General Delegation for Diamniadio and Lac Rose Urban Poles	DGPU	Délégation Générale à la Promotion des Pôles Urbains
DOA	Division of Operation and Management	DOA	Division des Opérations d'Aménagement
DPC	Civil Defence Directorate	DPC	Direction de la Protection Civile
DPEE	Direction of the Forecast and Economic Studies	DPEE	Direction de la Prévision et des Etudes Economiques
DPN	Department of National Park	DPN	Direction des Parcs Nationaux
DPUR	Division of Urban Planning and Regulation	DPUR	Division de la Planification Urbaine et le

			Règlement
DRUL	Regional Division of Urbanization and Housing	DRUL	Division Régionale de l'Urbanisation et de Logement
DSCOS	Department of Surveillance and Control of Land Use	DSCOS	Direction de la Surveillance, Contrôle et Occupation des Sols
DSDU	Urban Development and Strategies Division	DSDU	Division de la Stratégie et du Développement Urbain
DTGC	Department of Geography and Cartography	DTGC	Direction des Travaux Géographiques et Cartographiques
DUA	Department of Urbanization and Architecture	DUA	Direction de l'Urbanisme et de l'Architecture
ECOWAS	Economic Community of West African States	CEDEAO	Communauté Economique des Etats de l'Afrique de l'Ouest
EIB	European Investment Bank	EIB	Banque Européenne d'Investissement
ENEA	National School of Applied Economics	ENEA	Ecole Nationale d'Economie Appliquée
EMASE	Warehouses Malians in Senegal	EMASE	Entrepôts Maliens au Sénégal
EU	European Union	UE	Union Européenne
FAE	African Water Facility	FAE	Facilité Africaine de l'eau
FAO	Food and Agriculture Organization of the United Nations	FAO	Organisation des Nations Unies pour l'Agriculture et l'Alimentation
GFDRR	Global Facility for Disaster Reduction and Recovery	GFDRR	Facilité Mondiale pour la Réduction des Catastrophes et de Relèvement
IAGU	African Institute of Urban Management	IAGU	Institut Africain de Gestion Urbaine
IGN	National Geographic Institute	IGN	Institut Géographique National
IMF	International Monetary Fund	FMI	Fonds Monétaire International
ISRIC	World Soil Information	ISRIC	Centre International de Référence et d'Information Pédologiques
IUCN	International Union for Conservation of Nature	IUCN	Union Internationale pour la Conservation de la Nature
JICA	Japan International Cooperation Agency	JICA	Agence Japonaise de Coopération Internationale
KEPCO	Korean Electric Power Company	KEPCO	Korean Electric Power Company
LGF	Local Government Forum	LGF	Assemblée des Collectivités Locales
MAER	Ministry of Agriculture and Rural Euipment	MAER	Ministère de l'Agriculture et de l'équipement Rural
MATCL	Ministry of Land Planning and Local Authorities	MATCL	Ministère de l'Aménagement du Territoire et des Collectivités Locales
MEDD	Ministry of Environment and Sustainable Development	MEDD	Ministère de l'Environnement et du Développement Durable
MEDER	Ministry of Energy and Renewable Energy Development	MEDER	Ministère de l'Energie et du Développement des Energies Renouvelables
MEFP	Ministry of Economy, Finance, and Planning	MEFP	Ministère de l'Economie des Finances et du Plan
MEPN	Ministry of Environment and Natural Protection	MEPN	Ministère de l'Environnement et de la Protection de la Nature
MFASA	Ministry of Foreign Affairs and Senegalese Aboard	MFASA	Ministère des Affaires étrangères et des Sénégalais de l'Extérieur
MFME	Ministry of Fisheries and Maritime Economy	MPEM	Ministère de la Pêche et de l'Economie Maritime
MGLDAT	Ministry of Local Governance and Territorial Development Management	MGLDAT	Ministère de la Gouvernance Locale du Développement et de l'Aménagement du Territoire
MIS	Ministry of Internal Affairs	MIS	Ministère de l'Intérieur de Sénégal
MITTD	Ministry of Infrastructure, Land Transport and Improvement of Accessibility	MITTD	Ministère des Infrastructures, des Transports et du Désenclavement
MOC	Ministry of Commerce, the Informal Sector, Consumption, Promotion of local products and SMEs	MCSCPP	Ministère du Commerce, Secteur informel, de la Consommation, de la Promotion des Produits locaux et des PME
MOIM	Ministry of Industry and Mines	MOIM	Ministère de l'Industrie et Des Mines
MOT	Ministry of Transport	MITTD	Ministère des Infrastructures, des Transports Terrestres et du Desenclavement
MPIPDTE	Ministry of Investment Promotion, partnerships and the development of the state Teleservices	MPIPDTE	Ministère de la Promotion des Investissements, des Partenariats et du Développement des Téléservices de l'Etat
MPT	Ministry of Post and telecommunication	MPT	Ministère des Postes et des Télécommunications
MRAZI	Ministry of Reconstruction and Development of Flooding Zone	MRAZI	Ministère de la Restructuration, de l'Aménagement des Zones d'Inondation
MRUHCV	Ministry of Urban Renewal, Housing and Living Environment	MRUHCV	Ministère du Renouveau Urbain, de l'Habitat et du Cadre de Vie
MSAS	Ministry of Health and Social Actions	MSAS	Ministere de la Sante et de l'Action sociale
MSL	Mean Sea Level	NMM	Niveau Moyen de la Mer
MTTA	Ministry of Tourism and Air Transportation	MTTA	Ministère du Tourisme et du Transport Aérien
MWFC	Ministry of Women, Family and Children	MWFC	Ministère de la Femme, de la Famille et de l'Enfance
OECD	Organization for Economic Cooperation and Development	OCDE	Organisation de Coopération et de Développement Economiques
OMVG	Gambia River Basin Development Organization	OMVG	Organisation pour la Mise en Valeur du fleuve Gambie
OMVS	Senegal River Basin Development Organization	OMVS	Organisation pour la Mise en Valeur du fleuve Sénégal

ONAS	National Office for Sanitation in Senegal	ONAS	Office National de l'Assainissement du Sénégal
PAD	Dakar Port Authority	PAD	Port Autonome de Dakar
SAPCO	The Society of Planning and Promotion of Tourist Coasts and areas of Senegal	SAPCO	Société d'Aménagement et de Promotion des Côtes et Zones Touristiques du Sénégal
SAR	African Refining Company	SAR	Société Africaine de Raffinage
SDE	Senegalese Water Company	SDE	Sénégalaise des Eaux
SDU	Department of Urbanization Service	SDU	Département de Service Urbanisation
SENELEC	National Electricity Corporation of Senegal	SENELEC	Société Nationale d'Electricité du Sénégal
SICAP	Housing Development Company in Dakar	SICAP	Société Immobilière du Cap Vert
SNDES	National Strategy for Economic and Social Development	SNDES	Stratégie Nationale De Développement Economique et Social
SNHLM	National Middle-Class Income Housing Development	SNHLM	Société Nationale des Habitations à Loyers Modérés.
SONES	National Water Company of Senegal	SONES	Société Nationale des Eaux du Sénégal
TCC	Technical Coordination Committee	TCC	Comité de Coordination Technique
UAE	United Arab Emirates	UAE	Emirats Arabes Unis
UEMOA	West African Economic and Monetary Union	UEMOA	Union Economique et Monétaire Ouest Africaine
UHSLC	University of Hawaii Sea Level Center	UHSLC	Centre sur le niveau de la mer de l'Université de Hawaii
UNECA	United Nations Economic Commission for Africa	UNECA	Commission Economique des Nations Unies pour l'Afrique
UNESCO	United Nations Educational, Scientific and Cultural Organization	UNESCO	Organisation des Nations Unies pour l'Education, la Science et la Culture
UNICEF	United Nations Children's Fund	UNICEF	Fonds des Nations unies pour l'enfance
UNWTO	United Nations World Tourism Organization	OMT	Organisation Mondiale du Tourisme
USAID	United States Agency for International Development	USAID	Agence Américaine pour le Développement International
WB	World Bank	BM	Banque Mondiale
WHO	World Health Organization	WHO	Organisation Mondiale de la Santé

General term

AIDS	Acquired Immune Deficiency Syndrome	SIDA	Syndrome d'Immunodéficience Acquise
ALOS	Advanced Land Observing Satellite	ALOS	Satellites de pointes pour l'Observation des Terres Avancées
ATC	Area Traffic Control	CTR	Contrôle du Trafic Régional
BCR	Building Coverage Ratio	COS	Coefficient d'Occupation des Sols
BHLS	Bus with High Level of Service	BHNS	Bus à Haut Niveau de Service
BOD	Biochemical Oxygen Demand	BOD	Demande Biochimique d'Oxygène
BRT	Bus Rapid Transit	BRT	BRT (Service Rapide par Bus)
CAD	Computer Assisted Drawing	DAO	Dessin Assisté par Ordinateur
CBD	Convention on Biological Diversity	CBD	Convention sur la Diversité Biologique
CCTV	Closed-Circuit Television	CCTV	Télévision en Circuit Fermé
CCPZ	Management Unit for Cooperative Development Zone	CCPZ	Unité de Gestion de la Zone de Développement Coopératif
CD	Capacity Development	CD	Développement des Capacités
CET	Sanitary Landfill	CET	Centre d'Enfousissement Technique
COD	Chemical Oxygen Demand	COD	Demande Chimique en Oxygène
CPTED	Crime Prevention Through Environmental Design	PCAC	Prévention du Crime par l'Aménagement du Cadre
DEM	Digital Elevation Model	MNT	Modèle Numérique de Terrain
DISEZ	Dakar Integrated Special Economic Zone	DISEZ	Zone Economique Spéciale Intégrée de Dakar
DRM	Disaster Risk Management	DRM	Gestion des Risques de Catastrophes
DSM	Digital Surface Model	DSM	Modèle Numérique de Surface
DTM	Dakar-Thies-Mbour	DTM	Dakar-Thiès-Mbour
EIA	Environmental Impact Assessment	EIA	Etude d'Impact Environnemental
EIRR	Economic Internal Rate of Return	TRIE	Taux de Rentabilité Interne Economique
ENPME	National Survey of Small and Medium Enterprises	ENPME	Enquete Nationale sur les Petites et Moyennes Entreprises
FIT	Feed-in-Tariff	FIT	Tarif Subventionné
FP	Flagship Project	FP	Projet Phare
FR	Final Report	FR	Rapport Final
FS	Feasibility Study	FS	Etude de Faisabilité
GCP	Ground Control Point	GCP	Point Côté
GDP	Gross Domestic Product	GDP	Produit Intérieur Brut
GEF	Global Environment Facility	FEM	Fonds pour l'Environnement Mondial
GHG	Green House Gas	GES	Emissions de Gaz à Effet de Serre
GIRE	Integrated Water Resources Management	GIRE	Gestion Intégrée des Ressources en Eau
GIRMaC	Integrated Management Program of Marine and Coastal Resources	GIRMaC	Programme de Gestion Intégrée des Ressources Marines et Côtières
GIS	Geographic Information System	SIG	Système d'Information Géographique
GPS	Global Positioning System	GPS	Système Mondial de Localisation
GRDP	Gross Regional Domestic Product	GRDP	Produit Intérieur Brut Régional
HD	Hard Disc	HD	Disque Dur
HIV	Human Immunodeficiency Virus	VIH	Virus de l'Immunodéficience Humaine
ICD	Inland Container Depot	DIC	Dépôt Intérieur de Conteneurs

ICT	Information and Communications Technology	TIC	Technologie de l'Information et de la Communication
IEC	Information and Education Campaign	CIE	Campagne d'Information et d'Education
IEE	Initial Environmental Examination	EEI	Evaluation Environnementale Initiale
IPP	Independent Power Producer	IPP	Producteur d'Electricité Indépendant
ITS	Intelligent Transportation Systems	ITS	Système de Transport Intelligent
KMS	Keur Momar Sarr	KMS	Keur Momar Sarr
LOASP	Law of Agricultural and Livestock Development	LOASP	Loi d'Orientation Agro-Sylvo-Pastorale
LPDS-2	Policy Letter for the Development of The Energy Sector-2	LPDS-2	Lettre de Politique de Développement de l'Energie-2
LPDSE	Policy Paper for Energy Sector Development	LPDSE	Lettre de Politique de Développement du Secteur de l'Energie
LPI	Logistic Performance Index	LPI	Indice de Performance Logistique
LSS	Dakar International Airport	LSS	Aéroport Léopold Sédar Senghor
MDG	Millennium Development Goal	MDG	Objectif du Millénaire pour le Développement
MHA	Ministry of Hydraulic and Sanitation	MHA	Ministère de l'Hydraulique et de l'Assainissement
MHSA	Ministry of Health and Social Action	MSAS	Ministère de la Santé et de l'Action Sociale
MICE	Meetings, Incentives, Conferencing and Exhibitions	MICE	Tourisme d'affaire
MINP	Madeleines Island National Park	MINP	Parc National des Iles de la Madeleine
NAS	Network-Attached Storage	NAS	Périphérique de Stockage en Réseau (NAS)
NBSAP	National Biodiversity Strategy and Action Plan	NBSAP	Stratégie Nationale sur la Biodiversité et Plan d'Action
NEPAD	New Partnership for Africa's Development	NEPAD	Nouveau Partenariat pour le Développement de l'Afrique
NGO	Non-Governmental Organization	ONG	Organisation Non Gouvernementale
NRW	Non-Revenue Water	NRW	Eaux non facturées
NSDI	National Spatial Data Initiative	NSDI	Initiative Nationale sur les Données Spatiales
NSESD	National Strategy for Economic and Social Development	NSESD	Stratégie Nationale pour le Développement Economique et Social
OJT	On the Job Training	OJT	Formation sur le Tas
PAMU	Urban Mobility Improvement Program	PAMU	Programme d'Amelioration de la Mobilite Urbaine
PAP	Priority Action Program	PAP	Programme d'Actions Prioritaires
PATMUR	Project for Supporting Transport and Urban Mobility	PATMUR	Projet d'Appui au Transport et a la Mobilite Urbaine
PCTI	Integrated Climate Plan	PCTI	Plan Climat Territorial Intégré
PCM	Project Cycle Management	GCP	Gestion du Cycle de Projet
PCU	Passenger Car Units	UVP	Unité de Voiture Particulière
PDA	Drainage and Sewerage Master Plan for Dakar	PDA	Plan Directeur d'Assainissement Liquide de Dakar
PDD	Drainage Master Plan for Pikine and Guédiawaye departments	PDD	Plan Directeur de Drainage des Eaux Pluviales de la Region Periurbaine de Dakar
PDD	Drainage Master Plan	PDD	Plan Directeur de Drainage
PDGI	10-year Flood Management Program	PDGI	Programme Décennal de Gestion des Inondations
PDNA	Post-Disaster Needs Assessment	PCEB	Post-Catastrophe Evaluation des Besoins
PDU	Urban Planning Master Plan	PDU	Plan Directeur d'Urbanisme
PDUD	Dakar Agglomeration Urban Displacement Plan	PDUD	Plan de déplacements urbains de Dakar
PEPAM	Millennium Programme for Drinking Water and Sanitation	PAPEM	Programme d'Eau Potable et d'Assainissement du Millénaire
PET	Potential Evapotranspiration	ETP	Evapotranspiration Potentielle
PFI	Private Finance Initiative	PFI	Initiative de Financement Privé
PNAT	General Plan for National Territory	PNAT	Plan Général d'Aménagement du Territoire
PNGD	National Program on Waste Management	PNGD	Programme National de Gestion des Déchets
PNIA	National Agricultural Investment Program	PNIA	Programme National d'Investissement Agricole
PPP	Public Private Partnership	PPP	Partenariat Public Privé
PR	Progress Report	PR	Rapport d'Avancement:
PRACAS	Acceleration Program of the Agriculture in Senegalese	PRACAS	Programme de Relance et d'Accélération de l'Agriculture Sénégalaise
PROGEP	Storm Water Management and Climate Change Adaptation Project	PROGEP	Projet de Gestion des Eaux Pluvialeset d'adaptation au changement climatique
PSE	Senegal Emergence Plan	PSE	Plan Sénégal Emergent
PSE-BOS	Senegal Emergence Plan-Operational Monitoring Office	PSE-BOS	Bureau Opérationnel de Suivi du plan Senagal Émergent
PTB	Petit Train de Banlieue	PTB	Petit Train de Banlieue
PUD	Detailed Urban Plan	PUD	Plans d'Urbanisme de Détails
PV	Photovoltaic Generation	PV	Photovoltaïque
QGIS	Quantum GIS	QGIS	Quantum GIS
R	Restructuring	R	Restructuration
RAP	Resettlement Action Plan	RAP	Plan d'Action de Recasement
RD	Record of Discussion	RD	Compte Rendu de discussions
RE	Renewable Energy	RE	Energies Renouvelables
RE	Land Consolidation	RE	Remembrement
ROW	Right-of-Way	ROW	Emprise
RU	Urban Renewal	RU	Rénovation Urbaine

SC	Steering Committee	SC	Comité de Pilotage
SCS	Soil Conservation Service	SCF	Service de la Conservation Foncière
SDAU	Master Plan for Urban Planning and Development	SDAU	Schéma Directeur d'Aménagement et d'Urbanisme
SDF	Skills Development Fund	FDC	Fonds de Développement des Compétences
SEA	Strategic Environmental Assessment	EES	Évaluation Environnementale Stratégique
SEZ	Special Economic Zone	ZES	Zone Economique Spéciale
SHM	Stakeholder Meetings	SHM	Réunions des Acteurs
SNH	National Hygiene Service	SNH	Service National de l'Hygiene
SPC	Specific Power Company	SPC	Specific Power Company
SRA	Regional Service of Sanitation	SRA	Service Régional de l'Assainissement
SRAT	Regional Territorial Management Scheme	SRAT	Schéma Régional d'Aménagement duTerritoire
SRTM	Shuttle Radar Topography Mission	SRTM	Shuttle Radar Topography Mission
SS	Suspended Solid	SS	Solides en Suspension
SSA	Sub-Saharan African Countries	SSA	Pays Africains au Sud du Sahara
STP	Sewage Treatment Plant	STP	Station de Traitement des Eaux Usées
SWOT	Strengths, Weaknesses, Opportunities and Threats	FFOM	Forces, Faiblesses, Opportunités, Menaces
TAH	Trans-African Highway	TAH	Autorité de la Route Transafricaine
TCM	Technical Coordination Meetings	TCM	Réunions de Coordination Technique
TCM	Poor Flush Toilet	TCM	Toilette à Chasse Manuelle
TCM	Transportation Control Measures	MCT	Mesures de Contrôle du Transport
TCO	Waste Collection Tax	TCO	Taxe sur la Collecte des Ordures
TER	Regional Express Train	TER	Train Express Régional
TOD	Transit-Oriented Development	DATP	Développement Axé sur le Transport Public
TOR	Terms of Reference	TOR	Termes De Référence
TVET	Technical and Vocational Education and Training	EFTP	Enseignement et Formation Techniques et Professionnels
UCA	Urban Control Area	ZCU	Zone de Contrôle Urbain
UGB	Urban Growth Boundary	LCU	Limite de Croissance Urbaine
UPA	Urban Promotion Area	ZPU	Zone de Croissance Urbaine
UPS	Uninterruptible Power Supply	UPS	Alimentation Sans Coupure
VDN	North Bypass Road	VDN	Voie de Dégagement Nord
VIP	Ventilated Improved Pit Latrine	VIP	Latrine à Fosse Améliorée
ZAC	Cooperative Development Zone	ZAC	Zones d'Aménagement Concerté

Unit of Measurement

Area	
m^2	square meter
km^2	square kilometer
ha	hectare (= 10,000 m^2)
Length	
mm	millimeter
cm	centimeter
m	meter
km	kilometer
Weight	
µg	micro gram
mg	milligram
kg	kilogram
t	ton (=1,000 kg)
MT	metric ton
kt	kilo ton
Volume	
l	liter
m^3	cubic meter (= 1,000 liter)
MCM	million cubic meter
BCM	billion cubic meter

Time	
sec, s	second
min	minute
h, hr	hour
d	day
y	year
Energy	
W	watt
kW	kilowatt
kWh	kilowatt-hour
MW	megawatt
GWh	gigawatt-hour
cal	calorie
J	joules (=4,18 cal)
kj	kilo Joules
Other	
%	percent
ppm	parts per million
degree	degree Celsius
cap	capita
dB	decibel
mil.	million
TEU	Twenty-Foot Equivalent Unit

Currency

JPY	Japanese Yen
FCFA	CFA Franc
€	Euro
US$	United States Dollar
Intl$	International dollar

CHAPTER 7 SECTOR DEVELOPMENT PLANS FOR 2035

7.1 Economic Development

7.1.1 Agriculture and Fishery Development

(1) Objectives and Strategies

For the Study Area, conservation and protection of the agricultural land is indispensable. An urban-based farming system should also be pursued, focusing on fruits, flowers and vegetable production in consideration of environmental sustainability. Since the expansion of farms is almost impossible due to limitation of land resources, production in existing farmlands should be enhanced. As for fishery, high value-added products should be increased through prevention of post-catch losses.

The strategies or directions for agriculture and fishery sector development in the Study Area are summarized as follows:

Strategy 1: Conservation and protection of agricultural land

- Need for conservation and protection of agricultural land from urban sprawl

Strategy 2: Effective management system for reduction of risks, support for marketing and environmental sustainability

- Improvement of risk management to reduce the vulnerability of agricultural activities
- Marketing of agricultural and horticultural products
- Compliance with environmental sustainability

Strategy 3: Preparation of fishery-related facilities for the increase of high value-added products

- Need for establishment of a fully-fledged fishing port with processing units

(2) Establishment of Development Target

As an economic framework for the primary industry of the Study Area in 2025 and 2035, the gross regional domestic product (GRDP) and the number of employees are estimated as shown in Table 7.1.1.

Table 7.1.1 Economic Framework for Agriculture and Fishery

Items	Unit	2013	2025	2035
GRDP	FCFA billion in 1999 prices	10	14	17
Employment	1,000	21	14	11
Labor Productivity (value-added/worker)	FCFA 000	476	1,000	1,545

Source: JICA Study Team

(3) Development Plan

1) Conservation and Protection of Agricultural Land, especially Niaye

The urban sprawl of Dakar leads to losses of agricultural land in the Niayes area, which is known for its agricultural potential and active production of fruits and vegetables. To allow the Niayes area to maintain agricultural use and productivity, the area should be protected by law or regulation.

The following specific strategies are recommended to strengthen horticulture production in the Niayes area:

- Strengthening of producers' organizations for planned production and marketing according to demand (including storage construction) with the establishment of a market information network;
- Research and development of water-saving cultivation technology (protected horticulture with ICT) for high productivity agriculture;
- Promotion of high-value crop production with organic agriculture; and
- Establishment of integrated agriculture system for environment conservation (combination of agriculture and livestock activity (biogas plant construction to produce liquid organic fertilizer and methane gas for power generation).

2) Strengthening of the Management System of the Agriculture Sector

The management system of the agriculture sector, which consists of improving risk management to reduce the vulnerability of agricultural activities against instable weather conditions and price fluctuations, supporting the marketing of agricultural and horticultural products and complying with environmental sustainability, should be strengthened through dialogue between the central and local governments and farmers' organizations and the implementation of an agricultural development plan such as PRACAS, which specifically aims to strengthen food security and restore the trade balance affected by food imports. In relation to this point, PSE stresses the importance of i) water control and management, ii) enhancing the quality of soil, iii) the modernization of equipment, iv) improving access to quality inputs, land, markets and finance, v) development of value chains, and vi) technical support.

3) Establishment of a Fully Fledged Fishing Port with Processing Units

There are 13 fishing ports located in the Dakar and Thiès regions. However, Port Autonome de Dakar (Mole 10) is the only port for commercial vessels. To increase values of fisheries and aquaculture products and to reduce post-catch losses in sea fishing, the establishment of a fully fledged fishing port with processing units will be taken into account.

7.1.2 Industrial Development

(1) Objectives and Strategies

In response to objective and target of the production sector in Master Plan as discussed in Chapter 6; (i) the annual average growth rate of the secondary sector will be estimated at 8.9% in terms of GRDP during 2013-2035 and (ii) the investment environment should be improved, the industry sector in the Study Area is expected to be a booster of the economy as a whole.

The strategies or directions for industrial development in the Study Area are summarized as follows.

Strategy 1: Development of industrial sites or zones for relocation

- Development of new industrial sites or zones with factory units for relocation of the existing industries in the center of Dakar or other places, which may cause environmental damage in particular

Strategy 2: Rehabilitation of the infrastructure in the existing industrial sites and zones

- Rehabilitation of the infrastructure system (internal and external to zones) comprising road, power supply, telecommunications, water supply, sewerage, drainage, and solid waste in the existing industrial sites or zones

Strategy 3: Development of new industrial zones with integration of SEZs

- Establishment of new industrial zones with integration of SEZs in consideration of the prioritized industries as discussed later

Strategy 4: Formulation of rules and regulations

- Completion of rules/regulations including provision of incentives on foreign direct investment and development of industrial zones and SEZs
- Promotion of quality management and international/global standardization

Strategy 5: SME development

- Development of industrial cluster through enhancement of linkages especially among SMEs and craft industries
- Formalization of SME and informal sector through appropriate policies, guidance and training with financial assistance
- Appropriate technology transfer
- Provision of appropriate infrastructure and utility services for enterprises

Strategy 6: Human resource development

- Enhancement of technical and vocational education and training (TVET) in response to the demand for a skilled labor force in industries such as the agro-based industry, apparel, electrical and electronics, transport equipment, maintenance of building equipment and so on, through provision of diversified and customized training courses
- Preparation of TVET facilities in industrial zones and SEZs in cooperation with private sector

(2) Establishment of Development Target

As an economic framework for the secondary industries of the Study Area in 2025 and 2035, the GRDP and number of employees are estimated in Table 7.1.2. In addition, the framework of land use for the secondary industries by block in the Study Area is estimated at about 4,800 ha in 2035, as shown in Table 7.1.3.

Table 7.1.2 Economic Framework for Industries

Items	Unit	2013	2025	2035
GRDP	FCFA billion in 1999 prices	838	2,357	5,449
Employment	1,000	302	514	775
Labor Productivity (value-added/worker)	FCFA 000	2,775	4,586	7,031

Source: JICA Study Team

Table 7.1.3 Land Use Framework for Industries in 2035

Unit: ha

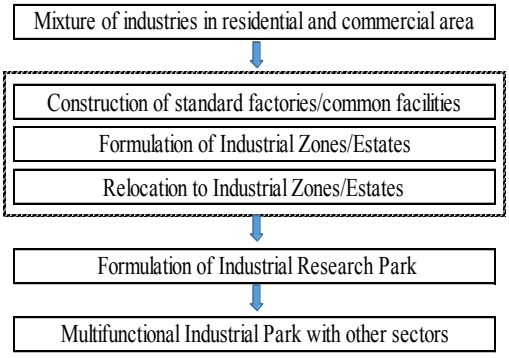
Land Use	Dakar	Suburban	Rufisque	Diamniadio	Daga Kholpa	Others	Total
1) Industrial area as part of "Industrial and Logistic" in Figure 6.5.4	441	267	164	1,969	1,310	328	4,479
2) Industrial area as part of "Mixed Use" in Figure 6.5.4	135	48	45	114	0	0	343
Subtotal: 1) & 2)	**576**	**315**	**209**	**2,083**	**1,310**	**328**	**4,822**
Others	7,136	8,434	11,585	4,525	6,645	38,759	77,084
Total	7,712	8,750	11,795	6,608	7,955	39,088	81,906

Source: JICA Study Team

(3) Development Plan

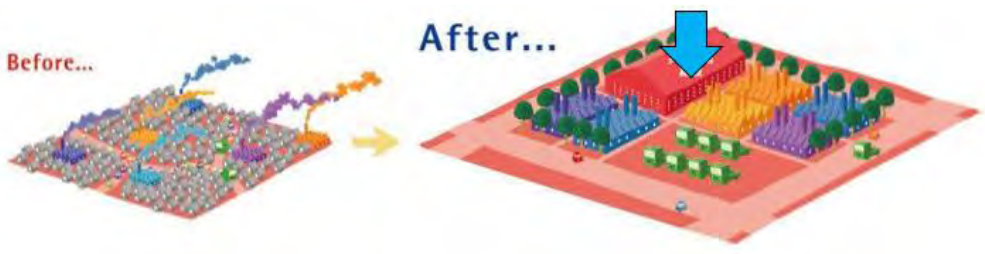
1) Development of New Industrial Site or Zone for Relocation

The Senegalese government has taken a step toward formulating the industrial zones and SEZs to attract investors and to be a booster for the economic growth stated in the PSE. As shown in Figure 7.1.1, the stages of industrial location are gradually shifted from "mixture of industries in residential and commercial area" to "multifunctional industrial park", according to the experiences in many countries. In Dakar, a considerable number of industries, mainly SMEs, are mixed in with residential areas. As a result, relocation of these industries to the designated industrial zones will be an effective measure for urban renewal, as shown in Figure 7.1.1. Figure 7.1.2 shows that the relocated enterprises are consolidated to a factory apartment or ready-made factory.



Source: JICA Study Team

Figure 7.1.1 Stages of Industrial Location



Source: JICA Study Team. The image above is taken from the website of Small & Medium Enterprises and Regional Innovation of Japan (http://www.smrj.go.jp/howtokodoka/image/032402.html)

Figure 7.1.2 Image of Industrial Relocation

Consequently, it is recommended to develop new industrial sites or zones for relocation with factory units, especially for SMEs, to accept the existing industries from the center of Dakar or other places, of which the major corresponding areas are shown in Figure 7.1.3. The candidate sites for the new industrial zones will be allocated in Diamniadio or Daga Kholpa. According to APROSI, Sébikhotane may also be a candidate area. To promote relocation, the government should provide an incentive package for enterprises. The construction of standard factories or readily available and fully serviced industrial apartments with land tenure in the industrial zone is an option. Provision of incentives such as exemption or reduction of taxes for a certain period is also another option to promote smooth relocation. In Japan, there is a relocation promotion program for SMEs, which provides soft loans if they formulate an association with 10 or more firms. In accordance with smooth relocation, the following steps taken through workshops and meetings with stakeholders will be needed:

Source: JICA Study Team

Figure 7.1.3 Areas of Industries and Mixed Land Use with Industries Located in Residential Areas

- Clarification of benefits of relocation (land tenure or land title, developed infrastructure, common facilities, cooperative marketing, vocational training, etc.)
- Formulation of the association
- Formulation of the implementation plan including acquisition or rent of land/standard factory
- Financial arrangement
- Formulation of sales and marketing plan of the products

The following types of industries will be the first candidates for relocation:

- Manufacturers that produce environmentally hazardous chemical products such as gas
- Manufacturers that cause ecological and physical damage to other resources such as air, land/soil and water and to quality of life of residents
- Manufacturers that have the storage facility of hazardous waste

Other industries, such as craft industries or typical urban industries that survive only in the center of the city, may stay in the existing sites or zones for a certain period.

2) Rehabilitation of the Infrastructure in the Existing Industrial Sites and Zones

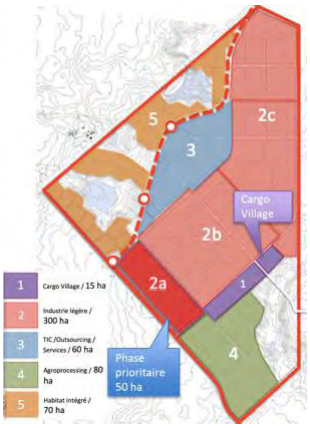
The infrastructure system (internal and external to zones) comprising road, power supply, telecommunications, water supply, sewerage, drainage and solid waste in the existing industrial sites or zones such as the hinterland of the Dakar Port, Pikine and Rufisque should be rehabilitated for enhancement of industrial activities.

3) Development of New Industrial Zones with Integration of SEZs

Besides Diamniadio, new industrial zones should be developed in the Daga Kholpa area. Based on the land use plan by the JICA Study Team, industrial land in Daga Kholpa will amount to about 1,310 ha in 2035, as shown in Table 7.1.3.

Since a development plan for the DISEZ Site (1: 718 ha) adjacent to the new airport is being prepared by APIX, as shown in Figure 7.1.4 and Figure 7.1.5, industrial development in DISEZ and urban development in Daga Kholpa should be promoted in an integrated manner. Based on Figure 7.1.4, APIX has a plan to introduce a cargo station, processing industries, ICT industries, agro-based industries, etc. To make full use of good access to the new airport, provision of a free zone for the industrial zone in Daga Kholpa will be needed.

According to Table 7.1.4, the locational advantage of this site (good access to airport) will be the ability to attract logistic-related light industries such as packaging and parts, support services, electric/electronics industries and high-tech industries.



Source: APIX

Figure 7.1.4 Layout Plan of DISEZ: Site 1

4) Utilization of Mbeubeuss Site after its Closure

Developing a green industrial area in Keur Massar after the closure of the Mbeubeuss garbage dumping site would be a possibility, as recommended by ANAT in the SDADT of Dakar-Thiès-Mbour area.

Source: APIX

Figure 7.1.5 Development Plan for DISEZ and its Surrounding Area

Table 7.1.4 Industrial Location Factors

Type of Industry		Industrial Sub-sector	Market & Transportation						Utilities & Local resources						Accumulation of Industries & Colleges	
			Access to Market	Access to Transportation/Logistics	Sea Port	Airport	Trunk Road & High Way	Accumulation of Urban Functions	Land (a large area)	Water Supply	Electricity	Access to Raw Materials	Labor Force (Intensive)	Qualified Engineers/Experts	Accumulation of Support Industries	University/College, Research Institutes
Light Industry		Food	X	X			X	X								
		Beverage	**X**	X			X	X				X				
		Textile	X	X												
		Wearing Apparel	X	X				X					X			
		Wood & Wood Product		X	X				X							
		Furniture		X	X			X								
		Rubber		X			X									
		Leather	X									X				
		Printing	**X**	X				**X**								
		Precision machinery						X							X	
Heavy Industry	Industrial sub-sectors that may not cause a large impact on environment	Ceramic & Construction Materials	**X**	**X**	X		X		X		X	X				
		General Machinery & Equipment		X			X						X	X		
		Electrical/Electronic Machinery		X		**X**	X						X	X	X	
		Transport Equipment	X	X	X		X	X	X		X		X	X	X	
		Paper & Paper Product		X	X					X	X					
		Plastic	X	X												
	Industrial sub-sectors that may cause a large impact on environment	Basic Metal (Iron & Steel)	X	**X**	X		X		X	X	X					
		Basic Metal (Non-ferrous Metal)	X	**X**	X		X		X	X	X	X				
		Fabricated Metal Products		X												
		Oil & Coal Product	X	X	X				X	X	X			X		
		Chemical Product	X	X					X	X	X			X	X	
High-tech Industry		High-tech Industry		X		**X**								**X**		X
Logistics-related		Packaging/Parts and Service Support		**X**	X	**X**										

Source: JICA Study Team based on various issues in the Industrial Survey of Japan
Note: **X**: Strongly Applicable Factors, X: Applicable Factors

5) Formulation of Rules and Regulations for Attraction of Investment

Completion and clarification of rules or regulations (or decrees) on the development of the industrial zones and SEZs, including incentives and one-stop services, are imperative.

Specific incentives for targeted industries, longer periods of concessions, exemption of customs duties on equipment and raw materials, exemption of income tax, employment of foreign staff and discount on utility fees should be taken into account.

6) Comprehensive SME Development Program

Based on ENPME 2013, or National Survey for SMEs, issues of regulation (tax and incentives), access to raw materials, access to loan and credit and interruptions of electrical supply are raised

among SMEs. These issues are difficult to solve independently. Thus, a comprehensive SME development program, which consists of (i) informal sector development policies, (ii) development of industrial clusters to enhance linkages, networks or value chains, (iii) appropriate technology transfer, (iv) legal and institutional reforms, and (v) provision of appropriate infrastructure and utility services, should be formulated.

7) Human Resource Development for Industries

It is important to enhance technical and TVET to increase the skilled labor force for various types of industries such as the agro-based industry, apparel, electrical and electronics, transport equipment, ICT, chemical and pharmaceutical industries, etc., through provision of customized training in response to demand from the private sector. Consequently, TVET facilities should be developed in new industrial zones and SEZs in cooperation with the private sector.

Establishment of a SDF, which aims to provide financial assistance to employers in SMEs to encourage them to train and upgrade the skills of their employees/workers in TVET facilities, is an option to provide technical training. Financial resources for SDF may be supported by the government and large private companies.

7.1.3 Tourism Development

While the tourism sector is a sub-sector in the service industry, it is presented here independently in consideration of its importance in economic development and as representing the service sector in the Study Area.

(1) Objectives and Development Strategy

1) Development Objectives

Tourism, as one of the important service industry sectors in the Study Area, is expected not only to promote economic development, but also to enhance and encourage the culture in the Study Area. The following are the development objectives for the tourism sector in the Study Area:

- To contribute to economic growth through foreign currency earnings and job creation by tourism sector development
- To enhance historical and cultural attractiveness
- To contribute to the protection of the natural environment

2) Development Strategies

The tourism development strategies for the Study Area are shown below.

<u>Establishing key tourism destination image</u>

- Formulation of a tourism market strategy to integrate and guide relevant tourism industries in the Study Area, taking into account diversification of tourism products and market
- Establishment of a Dakar brand image, reflecting both the existing and potential and undeveloped tourism resources in the Study Area

<u>Strengthening international gateway function for Senegal tourism</u>

- Enhancement of the capacity of transportation gateways for international air transport and sea port for international cruise

- Development and enhancement of tourism nodes for information, tourist services, places for events and performance, etc.
- Development and strengthening of tourism network through tourist mobility improvement (transportation services, tour route formation, access improvement, etc.)
- Formulation of appropriate accommodation capacity to meet visitors' needs, taking into account the quality of service and facilities
- Enhancement of tourist services such as tour guide, tourist police, travel agents, etc.

Developing and promoting various tourism products

- Diversification and development of tourism products by establishment of certain brand images
- Utilization of local tourism resources for product development in line with PSE Action Plan by "micro-tourism" and "medical tourism" development, for example, local agriculture products in Rufisque Department, handicraft products in Pikine and Guédiawaye, medical facilities and services in Dakar Plateau and Diamniadio
- Development and promotion of cultural festivals and performances not only at local level but also regional level in West Africa

Formulation of attractive destination environment in association with urban development

- Formulation of safe and comfortable walkway network and/or alternative means (e.g., electronic tourist coach, bicycle, horse-cart, etc.)
- Introduction of destination management for traffic access with parking provision and access control
- Introducing site development control and regulation to protect destination environment
- Development and promotion of sports and recreational facilities and services including parks and gardens, not only for citizens but also for international tourists

(2) Target Tourism Development Framework

1) Target Visitor Arrivals to Senegal

The target visitor arrivals to Senegal in 2035 are set based on a number of assumptions, as shown below.

- Visitor arrivals to West African countries including Senegal are to grow at 5.7% per year until 2035, as predicted by UNWTO
- The target share of Senegal of the total visitor arrivals in West Africa is set at around 20% until 2035

Table 7.1.5 Target Future Visitor Arrivals to Senegal (2015-2035)

Unit: thousand visitors

	2014	2020	2025	2030	2035	Reference/Note
West Africa	5,700	8,300	10,800	14,000	18,300	UNWTO forecast
Senegal	1,130	1,600	2,100	2,790	3,700	20% of West Africa

Note 1: Growth rates of West Africa and Senegal are taken from Tourism towards 2030 Global Overview/ UNWTO.
Note 2: UNWTO estimates that future total visitor arrivals to West African & Central African countries including Senegal by 2030 would grow at annual average growth rates of 6.5% (2010-20) and 5.4% (2020-30).
Source: JICA Study Team based on data of UNWTO and MTAT/DEP-DS

2) Target Accommodation Guests in the Study Area

The number of accommodation guests in the two Regions of Dakar and Thiès relevant to the Study Area are estimated based on the following assumptions:

- The target accommodation guests out of the target visitors to Senegal in 2035 who would stay at accommodation facilities in Senegal are set at around 50% of the national visitor arrivals, based on the past achievement and trend. The remaining 50% includes visitors to Senegal for home-stay, cruise-stay and day-trip visitors from neighboring countries.
- The accommodation guest growth for Dakar is set at 5.8% per year, the same level as the total growth.
- Thiès is assumed to grow at 6.7% per year until 2035, taking into account the potential of resorts development as promoted by the government (SAPCO).
- The remainder is to visit other regions such as Saint-Louis and Zugichor.

Table 7.1.6 Target Accommodation Guests to Two Regions (2015-2035)

Unit: thousand visitors

	2014*	2020	2025	2030	2035	Reference/Note
Dakar	250	350	470	630	820	5.8% /year growth
Thiès	195	305	410	560	760	6.7% /year growth
Others	120	145	170	210	270	Other regions in Senegal
Total	565	800	1,050	1,400	1,850	50% of the national visitors

Source: JICA Study Team based on data of MTAT/DEP-DS

Target accommodation guest nights in two regions

- The target guest nights as the basis for accommodation facilities requirement are estimated, applying the following equation:
  Guest Night (GN) = (number of target visitors x LoS)/OCR, where
  GN: guest night,
  OCR: occupancy rate, and
  LoS: length of stay in days

The following are the assumptions:

- The target OCR in Dakar Region is set to reach 50% in 2035, taking into account urban-type accommodation tendency with higher OCR than resort-type accommodation.
- The target OCR in Thiès Region, as one of the major resort areas in Senegal, is set to reach 45%, taking into account the past achievement in Thiès and general tendencies in the world (reference: 40% is the minimum OCR level for profit-generating operation).
- The target length of stay (hereinafter LoS) in Dakar Region is set to reach 4.0 days due to increasing stays as a result of urban and rural tourism product developments in the region.
- The target LoS in Thiès Region is set to reach 7.0 days as a result of resort product development and surrounding option tour development.

Table 7.1.7 Target Indicators for Estimating Target Guest Nights

		2014*	2020	2025	2030	2035
Dakar	Occupancy rate (%)	24%	30%	40%	45%	50%
	Length of stay (days)	2.8	3.0	3.3	3.6	4.0
Thiès	Occupancy rate (%)	28%	32%	37%	40%	45%
	Length of stay (days)	5.8	6.0	6.4	6.7	7.0

Note: Figures* in 2014 are estimated based on the past data due to no data at present.
Source: JICA Study Team based on data of MTAT/DEP-DS

The target guest nights thus estimated are shown in Table 7.1.8.

Table 7.1.8 Target Guest Nights and Additional Requirements for Accommodation as of 2035 in Regions Relevant to the Study Area

Unit: thousand Guest Nights

Region	Category	2014*	2020	2025	2030	2035
Dakar	Demand	3,033	3,500	3,880	5,040	6,560
	Supply (stock)	3,800	3,800	3,800	3,880	5,040
	Balance	767	300	-80	-1,160	-1,520
Thiès	Demand	4,350	5,720	7,100	9,380	11,830
	Supply (stock)	4,620	4,620	5,720	7,100	9,380
	Balance	270	-1,100	-1,380	-2,280	-2,450

Note 1: This estimation is based on the below assumption of tourism indicators as targets. Figures in 2014 are also estimated based on the assumption of indicators (OCR, LoS) referring to past data due to no data at present.
Note 2: guest night (GN) assumption formula: GN = (number of target visitors x LoS)/OCR/1,000.
Source: JICA Study Team

It is envisaged that the balance in Dakar will turn negative, the demand surpassing the supply capacity, in 2025. The increase in the occupancy rate and the length of stay until then will need to be improved by the improved service level of the existing accommodation stock.

3) Tourism Sector Contribution

Contribution of the tourism sector to Senegal's economy can be measured by the proportion of tourism receipt to GDP. Tourism receipt is the total expenditure made by foreign tourists in the visiting country excluding the payments made in their original countries. It includes such expenditures as accommodation, restaurant, souvenirs and transportation. In 2013 the proportion of tourism receipt to GDP was estimated to be about 5.1%. Assuming this proportion remains constant until 2035, tourism receipt is estimated to be 542 billion FCFA in 2025 and 1,056 billion FCFA in 2035 at 1999 price level.

Table 7.1.9 Expected Tourism Receipt in Regions Relevant to the Study Area

Unit: billion FCFA

	2013	2025*	2035*	Annual Average Growth Rate (2013-2035)
GDP (1999 price)*	4,731	10,530	20,715	6.9%
Tourism receipt	243	542	1,056	6.9%
Share of GDP	5.1%	5.1%	5.1%	

Note 1: * The GDP figures estimated in the socioeconomic framework are presented in Section 6.3.1.
Source: JICA Study Team

(3) Development Plan

1) Accommodation Development

The accommodation facilities in Dakar will need to enhance their functions and roles to realize Senegal Gateway City, coupled with the provision of attractive urban tourism products and opportunities for more active communication and contact between visitors and locals. It is estimated that the existing stock of accommodation facilities in Dakar Region will cater for the short- to

medium-term target guests up to 2020. New accommodation facilities supply will be required after 2020.

Thiès will turn into deficit in accommodation supply in the more immediate future before 2020. The requirement for hotel development is estimated by converting the guest nights estimated in Table 7.1.8 to the requirement for the number of beds, the number of hotels and the land area. The number of beds required is estimated by applying the following equation:

NB = (target GN/365 days x OCR) x LoS, where

- NB: number of beds
- GN: guest nights (from Table 7.1.8)
- OCR: occupancy rate (from Table 7.1.7), and
- LoS: length of stay (from Table 7.1.7).

Guest nights here include only foreign tourists and do not include domestic tourists because data were not available. The number of beds required is thus estimated as shown in Table 7.1.10 below.

Table 7.1.10 Accommodation Target Requirement in Regions Relevant to the Study Area

Unit: No. of Beds

Region	Category	2014	2020	2025	2030	2035
Dakar	Cumulative stock	10,958	10,958	10,958	14,030	22,370
	Additional requirement	--	--	3,072	8,340	13,600
	sub-total	10,958	10,958	14,030	22,370	35,970
Thiès	Cumulative stock	13,314	13,314	15,040	23,740	37,040
	Additional requirement	--	1,726	8,700	13,300	21,300
	sub-total	13,314	15,040	23,740	37,040	58,340
Total		24,272	25,998	37,770	59,410	94,310

Source: JICA Study Team based on data of MTAT/DEP-DS

Note: The land requirements for the accommodation development shown in Table 7.1.10 are estimated based on the following assumptions:

Item	Dakar Region	Thiès Region
Number of beds per room	1.5	1.5
Gross area per room in m^2	45	90
Number of floors	4	2
Building coverage ratio	70%	70%

The land requirements thus estimated are shown below.

Table 7.1.11 Additional Land Requirements for Accommodation Development in Dakar and Thiès Regions

Unit: hectare

Area	2025		2035	
	Total*	Additional	Total*	Additional
Dakar Region	15.0	3.3	38.5	23.8
Thiès Region	237.4	105.4	583.4	349.8
Total	252.4	108.7	621.9	373.6

Note: The land area for the existing tourist accommodation facilities was first estimated based on the number of accommodation facilities and assumed land area per accommodation. The total values in the table are derived by adding the future requirements for land to this existing land area.

Source: JICA Study Team

The additional land requirement in Dakar Region in 2035 is estimated to be around 24 hectares, while that in Thiès Region is estimated to be around 350 hectares. Most of the land requirements in Thiès Region will be fulfilled outside the Study Area, except for some urban-type hotels around Diamniadio, Daga Kholpa, AIBD and resort-type hotels in Lac Rose. The total additional land requirement in the

Study Area will, therefore, be in a range slightly higher than that in Dakar. This level of land demand could be easily absorbed into the land use plan presented in Figure 4.5.2.

2) Tourism Gateway Formulation

Node and network development

Dakar has played a pivotal role in welcoming visitors and distributing tourists to key tourist destinations and is the most important gateway to Senegal, although there are inland border visitors coming from neighboring countries. Tourism development can be promoted in a strategic manner through nodes and network development, mainly to strengthen the gateway function of Dakar in association with urban development, as shown in Table 7.1.12.

Table 7.1.12 Tourism Gateway Development in the Study Area

Category	Element of Development and Improvement	Key Location
1. Node Development	1-1 Information Center	• Plateau, AIDB int'l airport, Terminals, etc.
	1-2 Visitor Centers at Tourist Destinations	• Plateau, Almadies, Lac Rose, Poponguine
	1-3 Tourism Plaza (events and promotion)	• Plateau, Key Urban Pole, Lac Rose
	1-4 e-Tourism Information	• e-information for mobile, smart phone, Internet
2. Network Development	2-1 Tourism Transport Service (shuttle)	• Dakar Plateau–Diamniadio–AIDB
	2-2 Tourist Route Formulation (signage, access road, resting places, etc.) connecting tourism products	• Heritage tour (Plateau-Gorée-others) • Culture, art, music & gastronomy tour (Plateau, etc.) • Handicraft tour (Guédiawaye, Pikine, etc.) • Sea cruise tour (Dakar–Rufisque–Mbour) • Agro-tourism in Lac Rose and Bambilor
	2-3 Pedestrian/Mall/Coastal Network by Walking and Cycling	• Plateau, Lac Rose, Poponguine
3. Others	3-1 Travel Service (agents, operators)	• Plateau, Daga Kholpa
	3-2 Accommodation Capacity and Quality	• Plateau, Almadies, Diamniadio, Lac Rose, Daga Kholpa, Poponguine
	3-3 Urban Tourism Product Development	• In conjunction with tourist tour described in 2-2 • Medical care in combination with optional tours • MICE activities in combination with optional tours • Micro-tourism promotion in handicraft villages
	3-4 Tour Guide Training Center	• Plateau, Lac Rose, other areas

Source: JICA Study Team

Tourism product development and destination management

In order to improve visitors' short stays in Dakar, tourism products will be a key element for prolonging visitors' stay over more days. Creating attractive tourist destinations by capitalizing on the potential tourism resources in the Study Area is important. Images and impressions of Dakar will be highly dependent on the "quality of hospitality in Dakar".

The development of attractive tourism products in association with a comfortable destination environment through appropriate infrastructure and visitor management will, therefore, play an important role in enhancing the attractiveness of tourist destinations. Table 7.1.13 proposes measures to improve and develop tourism products in urban and rural areas in the Study Area, as well as visitor management and facility development. In addition, those tourism product developments should be accompanied by marketing and promotion, agent operation, community participation and capacity development for hospitality services.

Table 7.1.13 Desirable Tourism Product Development and Destination Management in the Study Area

Category	Key Product Development	Destination Management	
		Visitor Management	Facilities Development
1. Urban Tourism Product Development	1-1 Culture, music & art events	• Access control, parking guide	• Open theater for events
	1-2 Handicraft shopping tour	• Zone designation, promotion	• Handicraft village center
	1-3 Cruise tour	• Route development	• Cruise ship and pier/jetty
	1-4 Medical & business tourism	• Option tour packaging	• High-grade medical facilities
2. Rural Tourism Product Development	2-1 Eco-tourism in Lac Rose	• Zone designation, nature protection measures, access control, etc.	• Eco-visitor center, walkway • Eco-tourism village zone with infrastructure
	2-2 Agri-product harvest tour	• Farmers' cooperation program	• Local product center
	2-3 Rural life stays and tours	• Villagers' involvement in stay program	• Village improvement for stays • Infrastructure improvement
	2-4 Religious heritage tours	• Supporting service and optional tour promotion for pilgrims to key religious places	• Souvenir shops, information facilities • Accommodation facilities
3. Resort Tourism Product Development	3-1 Culture, music & art events	• Access control, parking guide	• Open theater for events
	3-2 Business convention & options	• Optional tour packaging	• Convention center/facilities
	3-3 Marine/inland sports tourism	• Zone designation, promotion	• Marina, sports facilities
	3-4 Health & spa leisure	• Thalassotherapy program	• Health & spa facilities

Source: JICA Study Team

7.2 Urban Transport

7.2.1 Objectives and Development Strategies

(1) Objectives

PDUD 2025, which is the latest Urban Transport Master Plan, is structured around the five following themes which could be interpreted as objectives to cover all the components of the transport strategies:

- Improving the competitiveness of the economy,
- Securing an efficient and sound financing,
- Facilitating mobility for people,
- Sustainable transport plan, and
- Improving quality of life.

(2) General Strategies

PDUD 2025 set forth general strategies under each objective, as detailed below. This Study also follows the same strategies as a base, although the balance and focus among the proposed actions and plans under each strategy may be different. Among others, those with **bold keywords** indicate sustainable strategies that could be distinguished from conventional strategies and hence should be emphasized in this Study.

Urban transport plan that enhances national and regional economic competitiveness

- To increase road capacity through the development and improvement of road networks
- To make the most of the existing capacity through **traffic control and information systems**

Urban transport plan supported by efficient and sound financing

- To avoid excessive traffic concentration (i.e., economic loss of travel time) and to balance the travel demand and the transportation infrastructure supply or capacity through **traffic demand management and development control**
- To decrease excessive vehicular traffic demand through transportation demand management and **diverting private vehicle users to public transport**

Urban transport plan with easier and better mobility for people

- To improve the level of service of the existing public transport system
- To develop new mass transit systems
- To keep public transport fares affordable

Urban transport plan that contributes to the **sustainable development of the region**

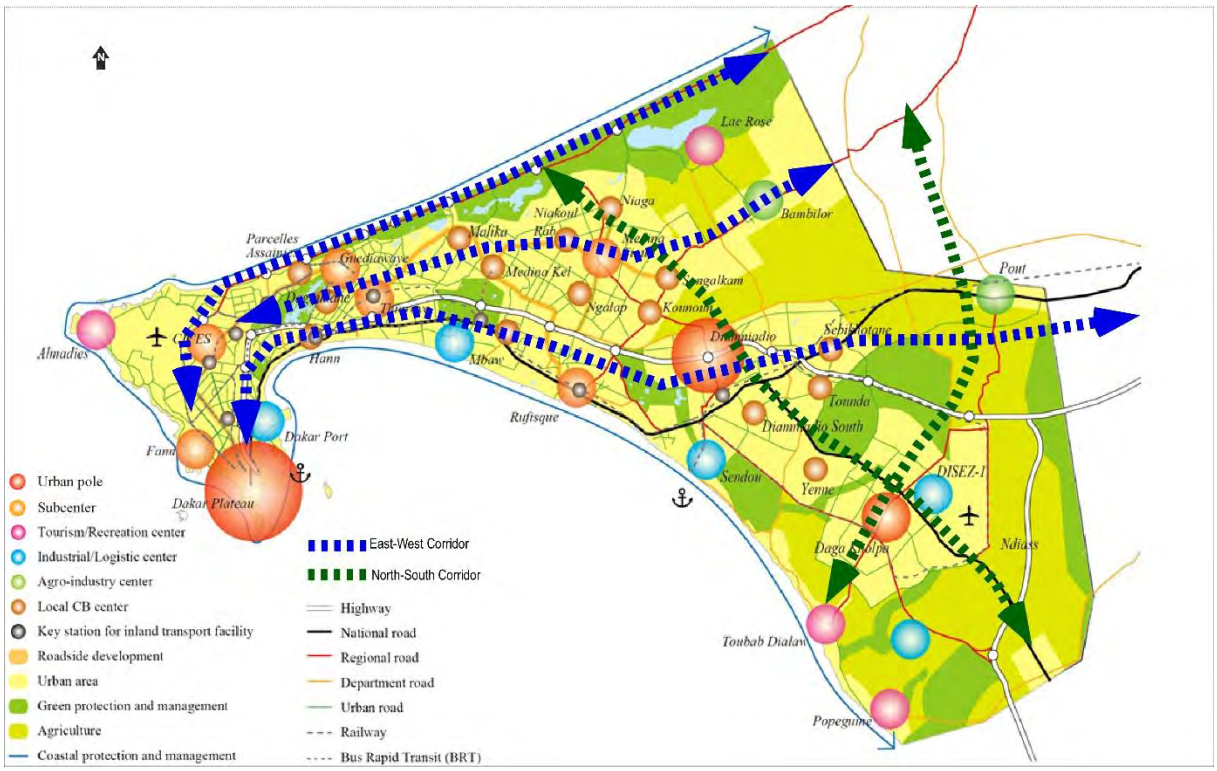
- To enhance **intermodality** through **development and improvement of transfer facilities**
- To apply **transit-oriented development (TOD)** for major public transport corridors including sub-centers

Urban transport plan for better quality of life

- To decrease air pollution and noise by enforcing the regulations
- To enhance traffic safety through law enforcement, public campaigns, training and education
- To provide user-friendly transportation facilities

(3) Road Development Corridors

Regional and metropolitan spatial structures are formed through major road corridors that usually form radials and rings. Ring and radial roads should be composed of primary arterial roads, or toll roads if they are economically and financially viable. In the case of the Study Area, due to its geographical features, north-south corridors have been identified instead of ring corridors. Since the pattern indicates concentric development, traffic concentrates in the center of Dakar. It is necessary, therefore, to disperse traffic demands in the city by connecting sub-centers. Based on the existing roads and road projects as well as the urban poles from the latest Urban Development Master Plan for 2025, a proposal for a long-term regional road development network is shown in Figure 7.2.1.



Source: JICA Study Team

Figure 7.2.1 Road Development Corridors in the Study Area

East-west corridors

Among the three radial corridors running east-west through the peninsula, the south corridor is the largest one, connecting Dakar, Rufisque and Diamniadio and stretching further to the east to Thiès. It is served not only by the national road (RN1 and RN2) but also by the toll motorway, part of which is already in service. Connecting to the port in the west, it also serves as a principal logistic corridor.

In the northernmost of the above three radial corridors, extension of VDN is still under development, but it will serve as an important corridor connecting Dakar and Guédiawaye along the north coast to the trunk roads in the region of Grand Niayes and further to Saint-Louis. Thus, it may also function as a logistic corridor.

In addition to the above two radial corridors running through the peninsula, the one in the middle is expected to support the existing and future urban developments along the corridor, such as Thiaroye, Yeumbeul, Keur Massar, Tivaouane Peulh and Bambilor, by serving as a trunk access road as well as an organic link between these developments. The most extensive road with relatively sufficient ROW for further development is Niayes Road (refer to Figure 7.2.1).

North-south corridors

There are two major corridors that run roughly north-south: an inner corridor, which connects all three east-west corridors through the planned development areas of Diamniadio and Daga Kholpa and further south to Mbour; and an outer periphery corridor, which connects Bayakh, Pout, AIBD and Daga Kholpa, running outside Dakar Region. They should serve as ring road corridors with a variety of functions, which are roughly classified into those for handling traffic flow and those for supporting urban structures.

7.2.2 Establishment of Development Target

Specific development targets are essential for guiding implementation of the programs proposed in the 2035 Master Plan and for monitoring the progress of the program implementation. Meeting the targets in road network and traffic (Table 7.2.1) and in urban transportation (Table 7.2.2) requires the implementation of projects and programs proposed in the 2035 Master Plan.

Table 7.2.1 Performance Targets in Road Network and Traffic

Performance Measures	Present Condition	Target in 2025	Target in 2035
Dakar Region			
- Paved road density (km/km^2)	1.01	1.5	2.0
- Ratio of paved roads (%)	35.5	50	70
- Number of fatalities per 100,000 persons in traffic accidents	3.65	1.5	1.0
- Average length of motorized trips (km)	(as of 2000) 5.6	8	10
CBD (Plateau zone)	(as of 2004)		
- Ratio of on-street parking to all paid parking (%)	90	60	40
- Ratio of irregular parking to all parking (%)	50	20	10
Private Car Traffic	(as of 2000)		
- Mode share of private car	10.2	20	20
- Average occupancy (persons/veh.)	2.5	2.5	2.5

Sources: JICA Study Team, based on data of AGEROUTE, Direction of Land Transport and CETUD

Table 7.2.2 Performance Targets in Urban Transportation

Performance Measures	Present Condition	Target in 2025	Target in 2035
Mode Shares (out of all modes)	(as of 2000)		
- Mode share of public transport (%)	65.9	70	75
- Mode share of informal public transport (%)	63.6	20	0
- Mode share of mass rapid transit including BRT and rail (%)	0.3	20	25
Convenience and Comfort			
- Average operational speed of conventional bus (km/h)	15	20	20
- Residents experiencing problems with public transport (%)	87	30	20
Cost	(as of 2000)		
- (Average household expenditure for public transport)/(Average total household expenditure) (%)	5.4	4.0	3.0

Sources: JICA Study Team, based on data of Social Survey and CETUD

The urban transport sector in the Study Area is characterized by increasing traffic congestion and environmental problems exacerbated by the monopolar urban structure centering on Dakar Department and the rapid increase in automobile traffic. The road density of Dakar is 1 km per km^2, which is far below the world standard, as explained in Chapter 3. Moreover, the majority of residents in Dakar experience problems with public transport, such as overcrowding, unsafe driving and difficult accessibility. Thus, both the road infrastructure and public transport are unable to accommodate the increasing transportation demand. The lack of available parking space in the CBD is worsening the situation and problems of "overflowing" parking vehicles causing traffic jams are observed everywhere in the CBD.

As for urban transportation, promotion of public transport is a principal measure to reduce dependence on private vehicles. The current mode share of public transport is 66%, which is relatively high, whereas that of private vehicles is about 10%, which is expected to increase due to ongoing

motorization. Mere improvement of public transport may not significantly attract people who have been accustomed to private vehicles. An increase in the security and comfort of public transport could also bring about an increase in passengers. Furthermore, integration of the transportation fare system should be enhanced for convenient use of public transport. A reduction in the transportation cost could also encourage the use of public transport.

7.2.3 Demand Forecast

For a demand forecast of vehicular as well as passenger traffic including average speed, congestion ratio and travel time, a series of comprehensive transport surveys are usually required. In a technical sense, the main purposes of the surveys are:

- To analyze current transport demand among the various existing transport modes and facilities; and
- To assist in the development and calibration of a computerized transport demand forecast model.

Among other tools, a household travel survey, which asks a series of questions relating to household characteristics, personal characteristics and journey characteristics, is a "backbone" of model development. The Survey on Mobility, EMTSU, which was conducted in Dakar Region in 2000 and utilized for the formulation of an Urban Transport Master Plan for 2025 (PDUD 2025), is the latest survey of Dakar. However, the structure of urban transport in Dakar has changed due to rapid motorization and the introduction of new modes of public transport, such as DDD and AFTU buses, and hence another household travel survey is currently being conducted by CETUD, targeting around 3,000 households in the Study Area. The results are expected to be published about one year after the survey and the Urban Transport Master Plan is to be revised accordingly.

Therefore, the urban transport development plans that are set forth in this chapter are not based on the scientific data and analysis but on qualitative analysis, including the current conditions and all the existing development projects and programs in the urban transport sector, in harmony with the Urbanization Master Plan that is proposed in this Study.

(1) Design Capacity and Speed by Road Class

The current road classification in Senegal seems to be a jurisdictional system with seven main road categories; however, all the roads are under the jurisdiction of AGEROUTE. Senegalese road standards are modeled on French standards, but UEMOA is planning to harmonize standards within its member states. ROW width is based on the standards. From the road-planning viewpoint, it is necessary to clarify the functional classifications and road hierarchy system for the Study Area. Traffic capacity (including the number of lanes) and speed on the planned roads should be determined in light of these standards and the future demand forecast.

(2) Intersection Types

Many roads are connected to principal roads, slowing down the flow of traffic due to vehicles entering the principal road. It is also dangerous for road users and is a possible cause of accidents. Only the roads classified as VU or higher should be allowed to have junctions with principal roads and local roads should not be allowed to cross principal roads directly. Intersections between national (N), regional (R), or departmental (D) roads and VU should be by roundabout or grade separation, depending on the traffic demand. Roundabouts can be considered with hourly traffic volume of up to 2,000 to 2,200 PCU per hour. The intersection type will be selected based on the results of the traffic

demand forecast.

Land acquisition will also be considered for grade separation type intersections, which require more space than a roundabout. For instance, the outer diameter of a four-lane road (two lanes for each direction) is approximately 40 to 60 m.

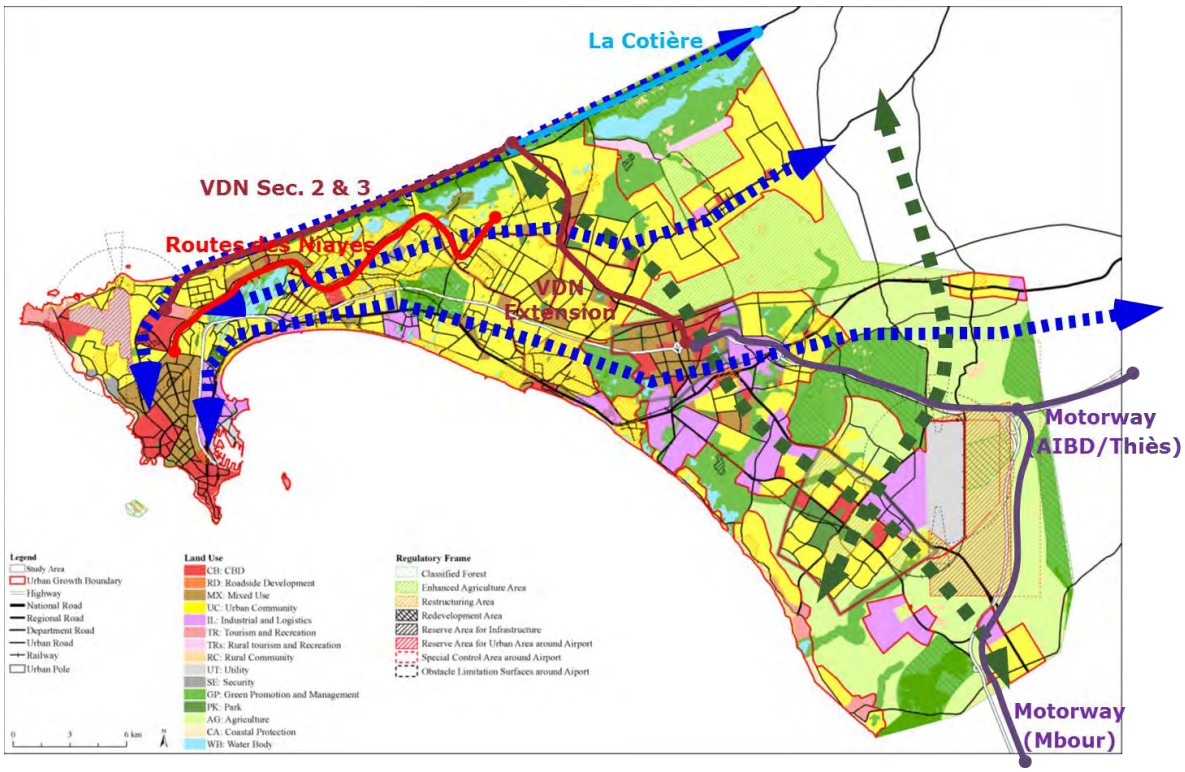
(3) Traffic Density by Transport Mode

After analyzing the travel demand and its forecast, the land use plans and the development directions in the Study Area, a new rail-based mass transit system should be a recommendation for the high-capacity public transport corridors. Whether to develop the new mass transit system as rail- or bus-based transportation, such as BRT, is dependent on the demand forecast and the service distances on the corresponding transportation corridors. In order to integrate public transport such as BRT within the road network, the first step is to secure sufficient space for both road users and public transport users along the targeted roads. The ROW width will be estimated based on the type of public transport facility planned, as well as its accessibility. However, it should be noted that future passenger demand also varies depending on the attractiveness and convenience of the new mass transit system, including its accessibility and linkage with other transportation modes.

7.2.4 Development Plan

(1) Road Network

Based on the draft land use plan of the Study Area as well as the growth poles from the latest Urban Master Plan for 2025, the abovementioned road development corridors and several major road projects are placed on the same map to confirm consistency, as shown in Figure 7.2.2. It can be seen that most of the proposed development corridors are served in full or in part by those major road projects.



Source: JICA Study Team

Figure 7.2.2 Proposed Land Use, Road Development Corridors and Major Road Projects

Among the three east-west corridors running through the peninsula, the south corridor, which is a principal logistic corridor and the largest corridor in terms of the scale of the cities that are connected, is served in full by the national road (RN1 and RN2) and the toll motorway, the section of which running east from Diamniadio is currently under construction. The north corridor is served in full by VDN Sections 2 and 3 and continuously by "La Cotière" (part of the PATMUR project by the World Bank) as a corridor for transit traffic as well as logistics traffic. The middle corridor is supported in part by the development of Niayes Road just up to Keur Massar, while it should be ensured that the remaining section eastward to Tivaouane Peulh and Bambilor will be served by road development project(s).

As for the two major corridors that run roughly north-south, the inner corridor connected with all the three east-west corridors is served in part by the extension of VDN just up to Diamniadio; hence, development of roads serving the remaining section from Diamniadio to Daga Kholpa and further south to Mbour is essential, especially for the development of Daga Kholpa, which will be the largest urban development envisaged in the Study Area. The other outer periphery corridor is not served by any major road development projects connecting Bayakh, Pout, AIBD and Daga Kholpa; therefore, new road development projects need to be proposed for this corridor as well.

Thus, as the first step for the road development in the Study, several road projects that will complement and support the abovementioned development corridors are to be proposed for the Study Area. Furthermore, a trunk urban transport system should be established in the context of regional development. The regional development plan demands support from the urban transport system in order to formulate a desirable regional structure and to support the direction of development in the region.

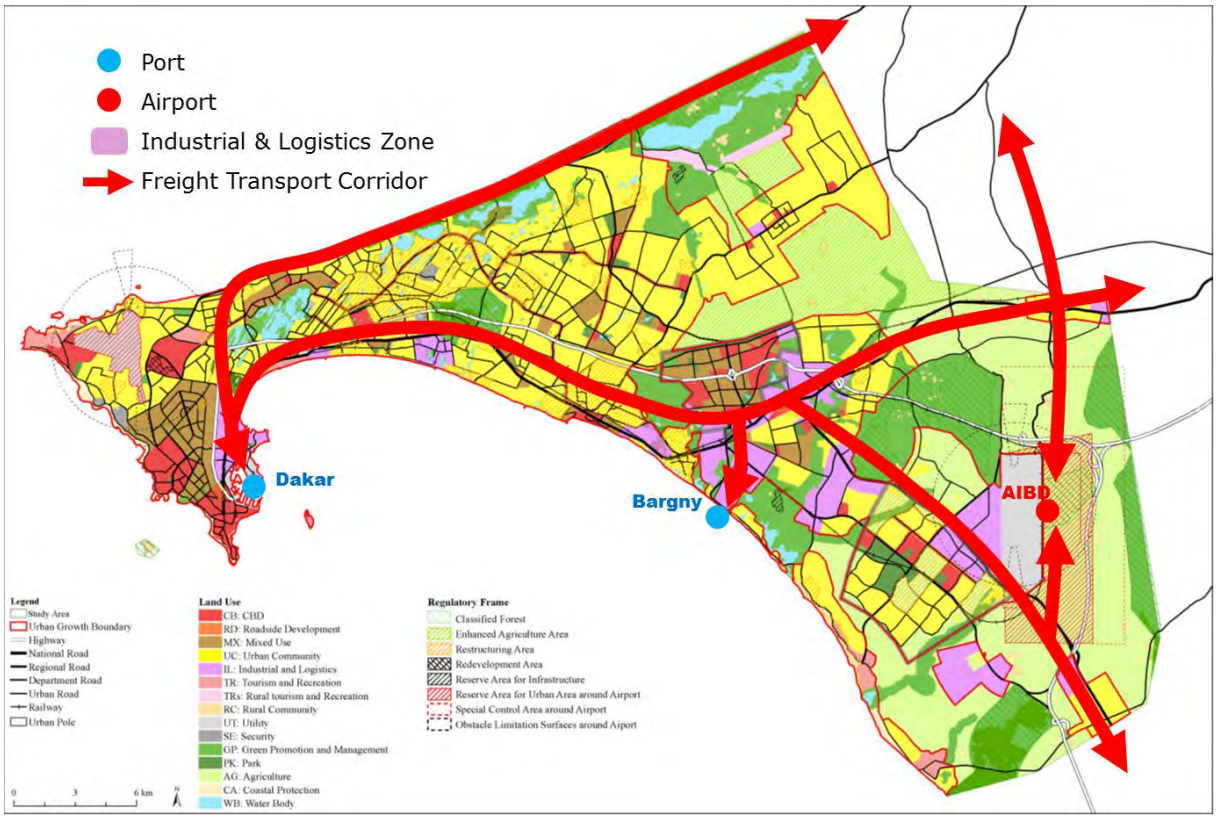
Below are specific strategies to note for road network development and improvement.

1) Development of Primary Transportation System to Support Inter-regional Freight and Passenger Transport Demand

Inter-regional freight transportation demand will increase as the regional economy grows and interactions with other regions in Senegal are amplified. The primary transportation network system, which serves inter-regional commodity movements, should be enhanced to meet increasing demand and to improve access to important transportation facilities such as the primary centers: the seaports, namely Dakar Port and Bargny Port; the airport, namely AIBD; and the industrial estates (Figure 7.2.3).

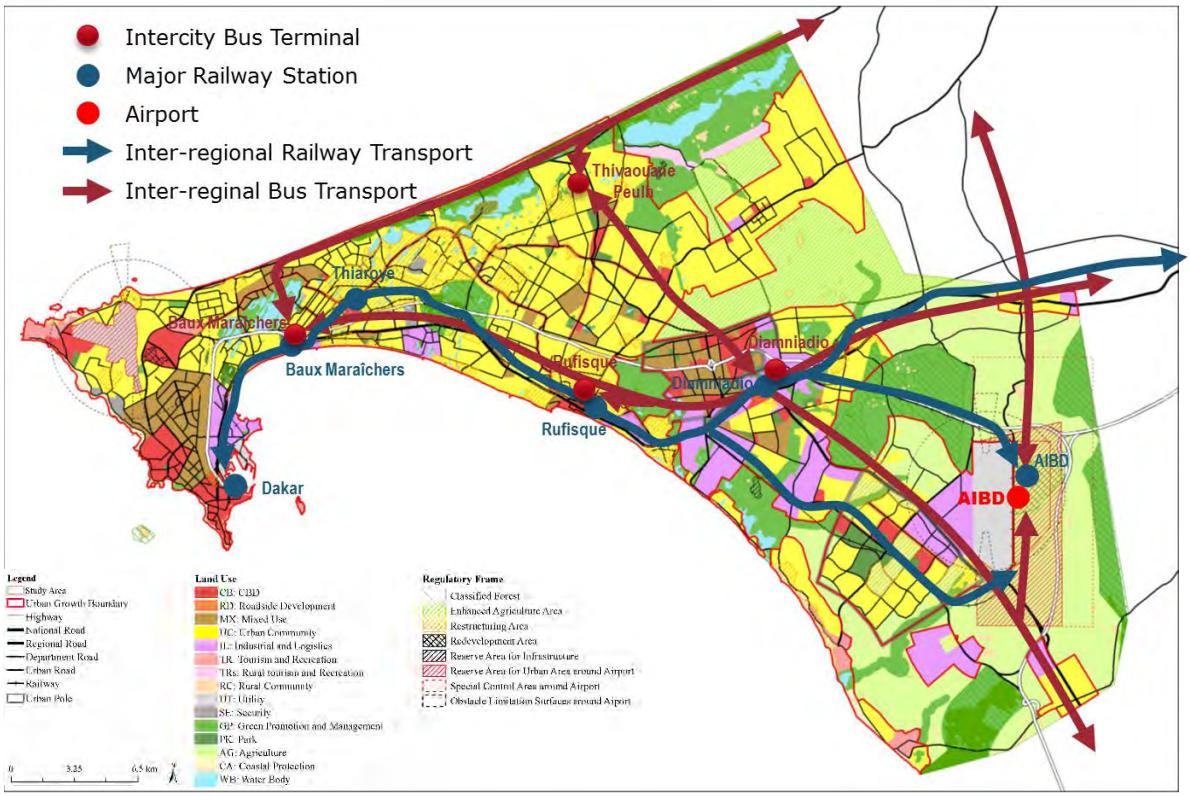
Meanwhile, the burden on the existing primary roads should be alleviated by providing alternative roads for both heavy vehicles and passenger vehicles. Separation of heavy vehicles from smaller general vehicles offers an efficient way to develop the road network, since axle load varies according to the vehicle size and the required thickness of pavement depends on traffic volume of heavy vehicles. Separation of heavy vehicles would also reduce the threat to the safety of the residents living along major heavy vehicle corridors.

For inter-regional passenger travel, access to the international airport, intercity bus terminals and the major railway stations should also be enhanced (Figure 7.2.4). Improvement of access to Dakar Port is an urgent task for regional economic development, whereas a robust access to AIBD should also be provided by improvement of the current national road as well as the construction of extensions of the toll motorway and the access roads.



Source: JICA Study Team

Figure 7.2.3 Inter-regional Freight Transport Corridor Development

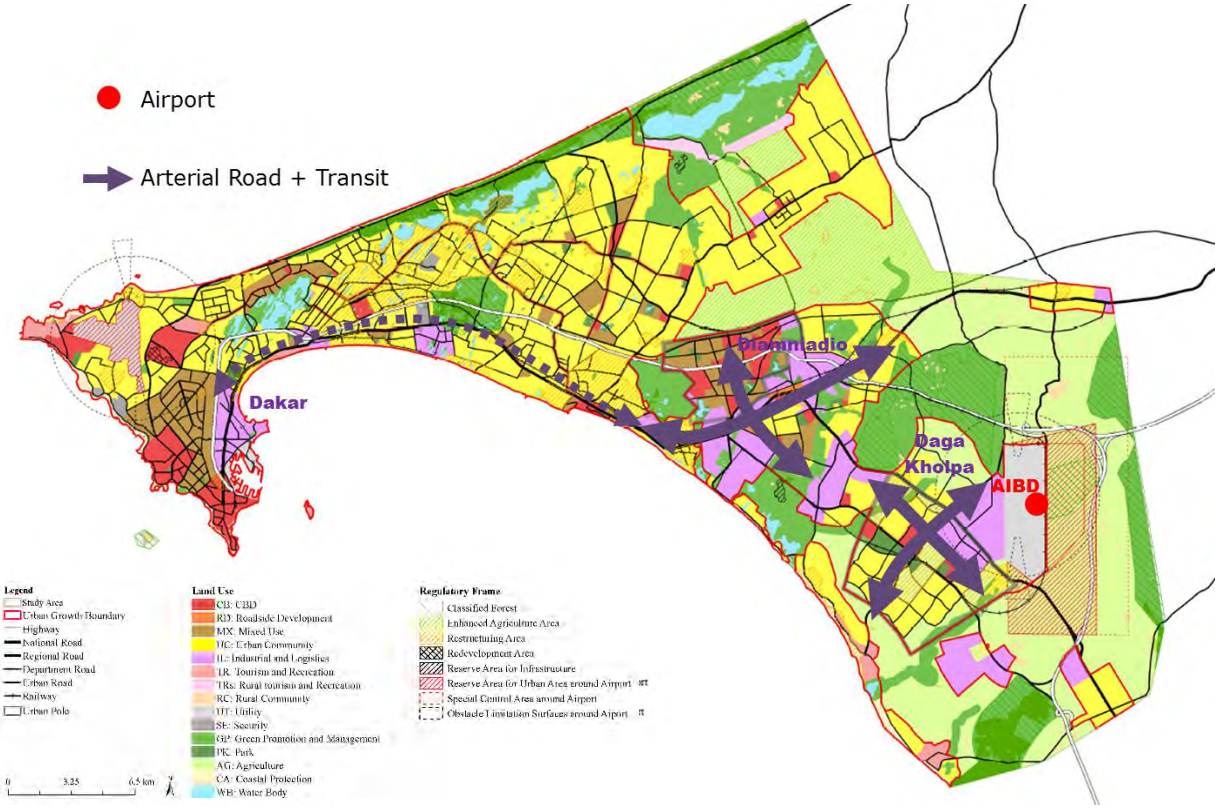


Source: JICA Study Team

Figure 7.2.4 Inter-regional Passenger Transport Corridor Development

2) Eastern Strategic Transport Corridor Development

To support the urban development policy in the eastern part of the Study Area, especially in Diamniadio and Daga Kholpa, urban transport system development should be utilized as a tool for guiding urban structure in the desired direction. Special attention should be paid to the east direction to induce urban development in the designated area, taking also the linkage with the center of Dakar into consideration, but within the urban growth boundary (Figure 7.2.5).

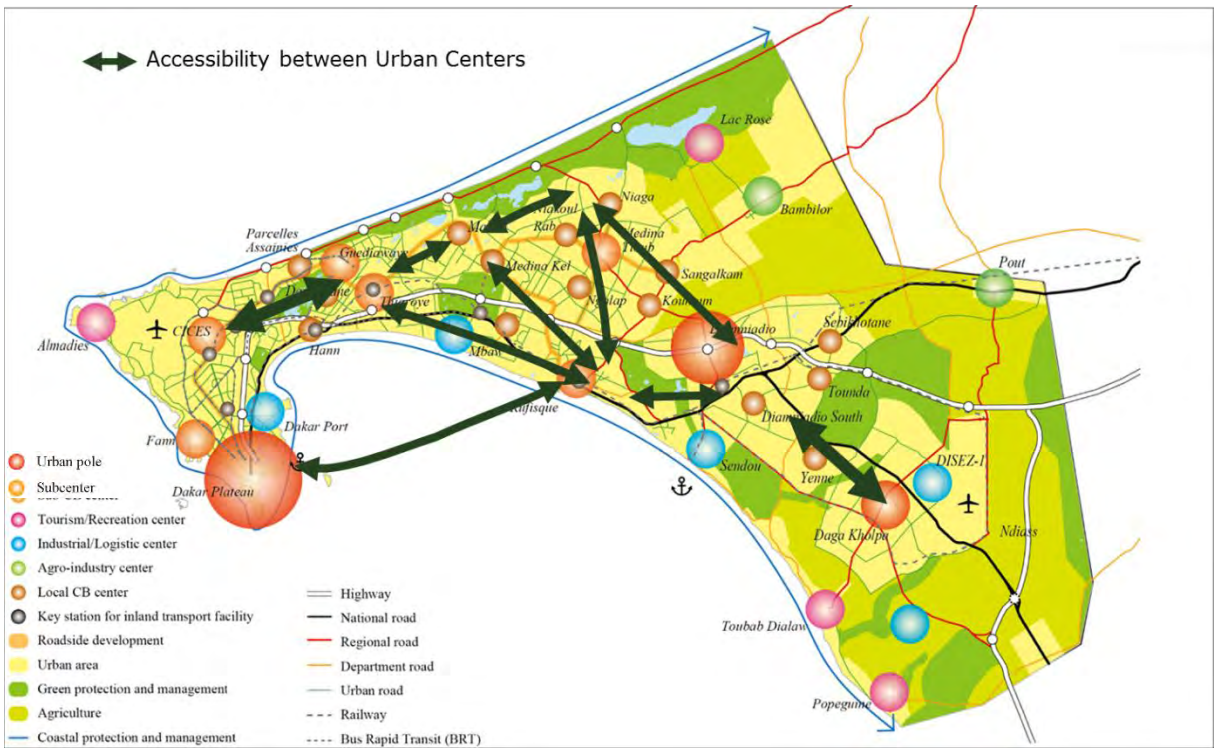


Source: JICA Study Team

Figure 7.2.5 Eastern Strategic Transport Corridor Development

3) Enhancement of Accessibility between Urban Centers in the Study Area

The development of urban growth poles outside the city of Dakar should be regarded as a long-term measure for decreasing the commuter flows to the city center. Accessibility between the urban centers in the Study Area should be enhanced to achieve sustainable development of the urban centers, by augmenting mutual interaction between the centers. Access to/from Dakar should also be reinforced to support the social and economic activities in the urban centers in the Study Area (Figure 7.2.6).

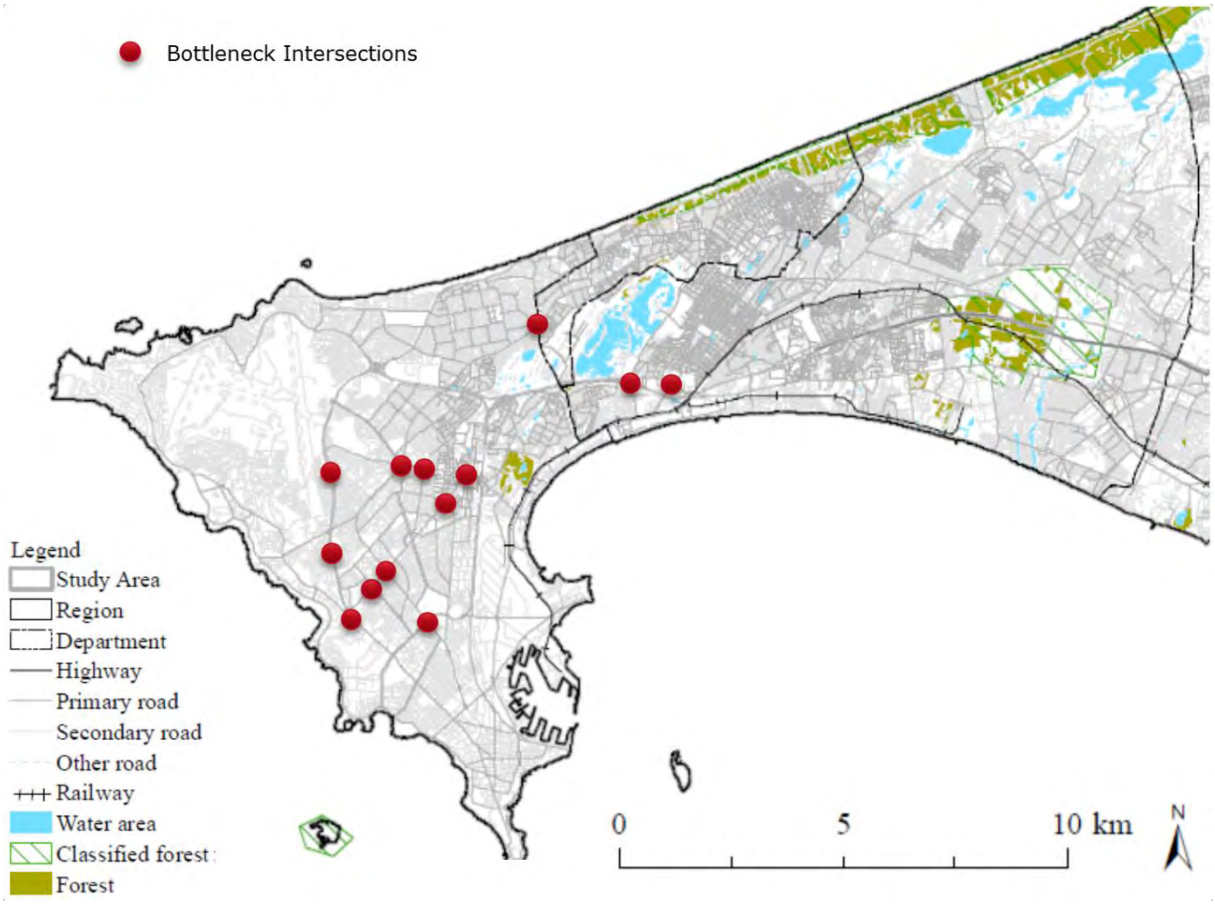


Source: JICA Study Team

Figure 7.2.6 Transportation Network Connecting Urban Centers in the Study Area

4) Improvement of Bottleneck Intersections

Construction of flyovers and underpasses would alleviate traffic congestion at bottleneck intersections by significantly increasing the road network capacity and would improve the road system performance. Dakar has been experiencing rapid expansion and, as a result, there are many bottleneck intersections on the arterial roads, where installing/changing the traffic lights or increasing the number of traffic approach lanes would not be sufficient to solve the problem (Figure 7.2.7). New infrastructures such as flyovers or underpasses need to be considered to solve these traffic congestions.



Source: JICA Study Team

Figure 7.2.7 Construction of Flyovers and Underpasses at Bottleneck Intersections

Flyovers or underpasses can be built on the main road corridors to the city center in order to alleviate congestion by minimizing the conflicts of traffic movements by providing grade separation. Such infrastructure is assumed to cause minimal impact on the surrounding area as it can sometimes be built inside the ROW of the road or require only limited widening. As those projects would have an immediate impact locally on the traffic flow, they can all be considered as priority projects.

5) Traffic Control and Management

In order to make the most of the existing capacity of the transport infrastructure, as well as to achieve a better transportation environment in the Study Area, the following TCMs are proposed:

- Development of Area Traffic Control system,
- Development of traffic information system,
- Parking system development, including development of parking facilities and parking information system, and
- Clearing of other illegal occupants on the road.

These TCMs should be prioritized as short-term projects as they are designed to optimize utilization of the existing transport infrastructure at a lower cost.

ATC system

As the number of automobiles is rapidly increasing in Dakar, traffic congestion is also becoming more and more serious. In light of this situation, it has become important to identify the bottlenecks responsible for traffic congestion using ITS and to disperse traffic through optimal traffic signal

control and the provision of traffic information. The ATC system will perform precise signal phase control for safety and smooth traffic both for pedestrians and vehicles at intersections on the arterial roads in a certain area. It will also perform real-time measurement of traffic demand, as well as appropriate signal control corresponding to traffic conditions. The existing systems adopt fixed timing plans, which must be upgraded to traffic-responsive control. For this purpose, vehicle detectors must be installed at intersection approaches, detector-data-processing functionality must be added to the central control system and traffic-responsive signal control software must be introduced. Some of the existing bottleneck intersections in Dakar could be improved through efficient signal control, along with enforcement of local traffic regulations.

Development of urban traffic information system

Although TCMs cannot entirely eliminate traffic congestion, they will certainly help to reduce it if properly implemented. The introduction of a comprehensive traffic information system is most highly recommended. Effective use of traffic information is becoming more important for heavily congested road networks. Most traffic data are collected through vehicle detectors installed by the government (traffic/road administrators). On the other hand, dissemination of traffic information has become easier with the proliferation of ITS. Furthermore, GPS-based technology has been established to acquire information from mobile objects, enabling the acquisition of rich traffic data in parallel with the traditional data collection methods. GPS-based mobile object traffic data can be precisely detailed and enable the identification of the movement of individual vehicles. Detailed data improve the accuracy of traffic simulation and therefore also enhance information provision and traffic operations/management. Without reliable and detailed traffic information, a traffic information system is not effective at preventing or minimizing traffic congestion. A plan for developing a traffic information collection system, which would use vehicle detectors and CCTV cameras as sensors, should be studied and formulated.

Parking system development

Given the situation of increasing numbers of automobiles and continuing reliance on private vehicles, it is essential to increase parking capacity in Dakar, especially in the CBD (i.e., Plateau). At present, off-street parking is scarce in Dakar. Out of a total of 1,341 pay parking places in the city of Dakar, over 90% (1,250 places) are on-street parking with parking meters. Problems of “overflowing” parking vehicles are observed everywhere in the CBD. Illegal on-street parking outside the designated parking areas is reducing the number of available driving lanes. This causes traffic disorder, consequently reducing road capacity and increasing travel time and eventually traffic pollution. On-street parking should be removed or tightly controlled, to be replaced by the space for the ROW of public transport, private vehicles and pedestrians. Consideration should also be given to the fact that business and commercial activities along the roads, especially in the CBD, will also be affected by any action or decision related to the parking regulations.

Meanwhile, construction of additional parking facilities is urgently necessary in the CBD to clear away the current on-street parking from the roads to utilize the road space for public transport and private vehicle traffic. Moreover, for the long term, local planning authorities should stipulate the requirement to supply parking spaces for development on private land. In addition, control guidelines for development, such as a building code, should be prepared. As proposed by the city of Dakar and CETUD, several parking buildings are planned in Plateau, such as in Petersen bus terminal (a four-story building with a total capacity for 1,030 vehicles), on Félix Eboué Road (inside the shopping mall) and at Gare Lat Dior (six-story building). Thus, development of more off-street parking facilities

should also be promoted in the CBD.

When those additional parking facilities have been developed, a parking information system will be necessary, guiding car users to the most appropriate public and private parking lots, as well as providing parking availability information through information devices such as parking information signboards. It will also help to reduce on-street parking vehicles and queues waiting to enter parking facilities in the central area.

Clearing of other illegal occupants from the road

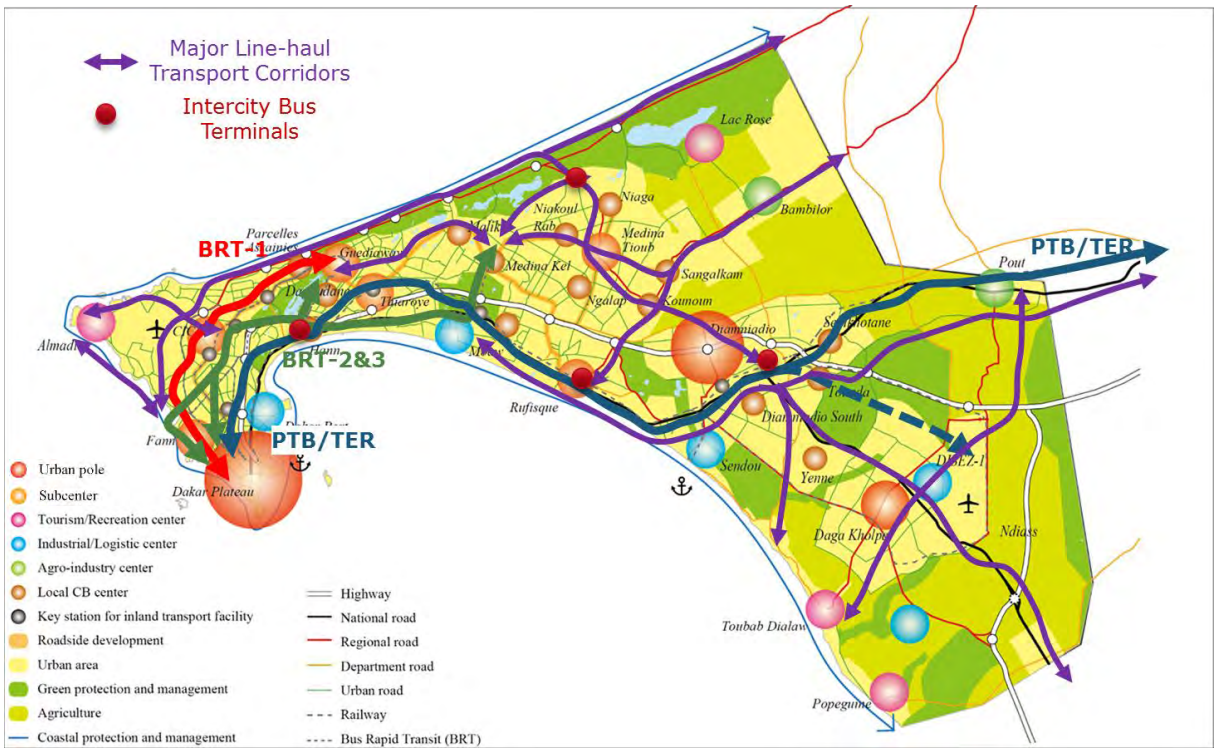
Informal minibuses stopping for passengers in the middle of the road should be strictly prohibited and streets should be cleared of vendors. This will be effective along with tighter enforcement of traffic regulations for alleviating traffic congestion.

(2) Public Transport

In order to support the goal of access to enhanced mobility for all in the Study Area, the policies must be guided to provide a comprehensive and integrated public transport network that is convenient, user-friendly and accessible to all income groups to serve all urban centers and sub-centers such as local community facilities, employment centers, leisure sites and tourism sites. To this end, the Study Team proposes to promote the following key initiatives in relation to public transport:

- Promotion of high-capacity public transport corridors,
- An enhanced and extensive public transport system, and
- Intermodality and integration of rail and bus transportation.

As for the public transport plans (Figure 7.2.8), they will also serve the road development corridors and the growth poles from the latest Urban Master Plan for 2025 that were also mentioned in relation to road development. There are three major public transport projects serving the high-capacity corridors. The first high-capacity corridor to be developed is BRT-1, as a pilot project for the development of BRT with a route from Guédiawaye to Dakar Main Station via Niayes Road and Rue 10, which has officially been designated by the Ministry of Transport for implementation by CETUD. The other lines of BRT, namely BRT-2 and BRT-3, connecting North Pikine and Keur Massar, are also planned by CETUD.



Source: JICA Study Team

Figure 7.2.8 Development of Major Public Transport Lines

In the future, there is a plan to increase the operation of public transport on the existing rail alignment. That is, the Senegalese government is currently promoting the TER, connecting the main stations of Dakar, Fass Mbao, Rufisque, Bargny, Diamniadio, Thiès and possibly AIBD. PTB's operation from Dakar to Thiès will be replaced by TER. Furthermore, in order to supplement these high-capacity corridors, other major line-haul transport corridors are proposed on the assumption that they are to be served by regular buses such as DDD.

However, as mentioned before, the type of public transport mode to be selected for each line-haul transport corridor will depend on the demand forecast and the service distances. It should be noted that future passenger demand also varies depending on the attractiveness and convenience of the new mass transit system, including its accessibility and linkage with other transportation modes. In cases where considerable volume of future passenger demand is expected, the current trend is to go for BRT or Bus with High Level of Service (BHLS), which, compared with rail-based modes of transport, is easier and less expensive to implement.

Below are specific strategies to note for public transport development.

<u>Development of rail-based transport and improvement of service</u>

Rail-based transport plays an important role as a trunk transportation system to serve massive passenger movements in metropolitan areas. There are several rail-based urban transit proposals with different system types, from an express type train to a medium-capacity tramway system. Improvement of the existing railway, namely PTB, and/or construction of a new railway line such as TER will significantly increase passenger capacity. The service level of railways should also be improved to attract people who currently use private modes of transport. At the same time, railway operators should improve management capability to reduce the operation cost and to increase the fare revenue from passengers.

Financial reform of high-capacity public transport operation

Following the same approach as the planned BRT, railway stations should be changed to a closed system to reduce free riders and to increase fare revenue from passengers. Closed system stations can be developed by elevation of platforms, provision of fencing and construction of stations over the platforms. In addition, rail or BRT operators should seek a way to absorb the development benefits accrued from the public transport service through coordination with a land developer, or alternatively the operators should expand the scope of business to include real estate business along the public transport line, although it requires modification of laws and regulations.

Provision of extensive public transport network

Bus route restructuring needs to be considered in light of existing and future travel demand. Generally, line-haul and circumferential routes should be served by BRT or DDD with a higher capacity, while central circular routes and suburban feeder routes could be served by smaller AFTU buses. This is a subject for further discussion once there is an estimation of the future demand in relation to the future land use planning.

In fact, a majority of public transport users residing in suburban areas would desire the improvement of feeder bus services in terms of accessibility, frequency and punctuality. This is the most vital point to strengthen the intermodal system of the overall public transport network. Ideally, all the residential areas should be served and covered by feeder public transport within about 250 m of the nearest bus stop. Consequently, the interval of parallel bus routes should be about 500 m maximum and intervals between bus stops should also be 500 m at a maximum. To achieve this, the informal sector could even take a role and develop into “formal” minibus services.

On the other hand, as urbanization progresses, people enjoy various urban lifestyles and have different values with regard to goods and services. In the context of the urban transport sector, the present public transport services may not fully satisfy the various types of demand in the city, since people demand various kinds of services according to their lifestyle and values. A public transport system at a higher level of service should be developed in the form of a network so that people can reach their destinations within the system. This means that a single route with a high level of service may not attract everyone to use public transport. A public transport network should consist of several trunk lines with feeder services and should cover as wide an area as possible. Such an extensive public transport network would provide a proper means of transportation for all people and can give them the choice to live in less populated areas, where they can have more spacious residences.

Giving priority to public transport

While densities of roads and public transport services are closely related to each other, better transportation without an increase in road capacity can be achieved by alternating usage of road space. This means allocating more road space to public transport and providing safe and comfortable pedestrian facilities. Moving more people in the same road space needs higher capacity vehicles. To make public transport more effective, buses should not be tied up in traffic congestion and should offer time-saving advantages over private vehicle use. Priority should therefore be given to bus services, and dedicated bus lanes, which are segregated from general traffic, should be provided, possibly continuously, on the urban arterial roads to form a smooth network for buses, thus acting like a Bus with High Level of Service (BHLS). It should be noted that the dedicated bus lane development is mainly for line-haul type bus lines, while feeder type bus lines serving the high-capacity public transport stations could also share and utilize dedicated bus lanes. By securing a relatively high operating speed, the time schedule can also be foreseen, consequently reducing the waiting time and

thereby attracting more passengers. Thus, the dedicated bus line network would be a prototype of BHLS or other mass transit by expanding the fleet size and frequency, along with designated platforms, when the demand grows in the longer term.

Enhancement of intermodality

Smooth transfer from one mode to another would significantly increase passengers' convenience when using public transport. Thus, intermodal facilities between rail/BRT and bus lines such as station squares and access roads should be developed and enhanced. Furthermore, introduction of new transit malls where BRT and many other bus routes meet, such as the terminal in front of Dakar main station, may be developed in conjunction with land use. It should also be noted that future passenger demand also varies depending on the attractiveness and convenience of the new mass transit system, including its accessibility and linkage with other transportation modes. Reorganization of the bus route structure will be required again to provide feeder bus services to offer convenience for prospective railway or BRT users. Generally, feeder bus services should be provided for rail passengers in order to cover an area within a 5 km radius of the station.

Furthermore, integration of the transportation fare system should be enhanced for convenient use of public transport. This system can be first introduced to the planned BRT lines and further extended to other public transport modes. Reduction of transportation cost would lead to another incentive for current private vehicle users to shift to public transport.

Transit-oriented development

It is also of great importance to make the urban structure convenient for public transportation users through appropriate land use plans. That is, since office buildings and shopping malls are large trip generators, they should not only be provided with enough parking spaces but also be located within walking distance from the high-capacity public transport stations. Setting high floor-area ratios in areas around existing and planned stations will also generate a large number of trips, which can easily be served by the high-capacity public transport system.

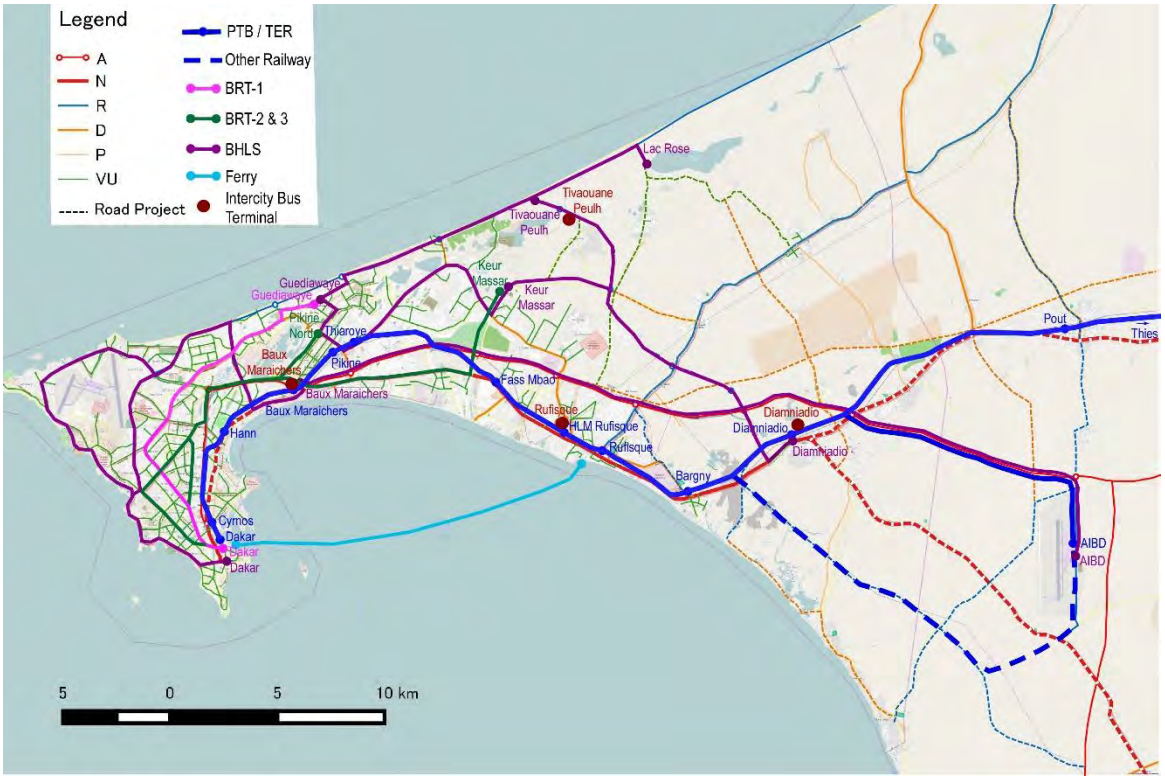
Both public transport and land use should be integrated under a concept of TOD and the promotion of high-density commercial land use around stations will benefit both the urban economy and the business of the public transport operator. Corridor areas that are served by the high-capacity public transport system will be endowed with great potential for dense urban development, such as business, industrial and commercial facilities, thereby having a significant impact on the urban structure. As for the suburbs, the high-capacity public transport system is expected to bring a wide variety of opportunities for dense suburban development, with new housing areas and shopping malls.

7.2.5 Urban Transport Projects

This section sets forth prospective projects and programs that will sustain the abovementioned development plans in the urban transport sector for the Study Area. A number of urban transport projects have been planned in the Study Area by the State, CETUD and AGEROUTE. These are also included in the listed projects (Table 7.2.3), while some of them have been modified. Locations of the projects are presented in Figure 7.2.9 for roads and in Figure 7.2.10 for public transport.

Note: A (motorway), N (national road), R (regional road), D (department road), P (listed track), VU (urban road)
Source: JICA Study Team, based on data of ANAT, PSE, AGEROUTE and CETUD

Figure 7.2.9 Location of Road Development Projects under Planning and Implementation by the Senegalese Government and Proposed by the JICA Study Team



Note: A (motorway), N (national road), R (regional road), D (department road), P (listed track), VU (urban road)
Source: JICA Study Team, based on data of ANAT, PSE, AGEROUTE and CETUD

Figure 7.2.10 Location of Public Transport Development Projects under Planning and Implementation by the Senegalese Government and Proposed by the JICA Study Team

Table 7.2.3 List of Urban Transport Projects

Project Code	Project/Program	Development Term			Cost (million FCFA)	Note/ Length
		Short (-2020)	Medium (-2025)	Long (-2035)		
T01	Intersection Improvement: VDN – Station SDE	Yes			8,000	
T02	Intersection Improvement: VDN – Cité Keur Gorgui	Yes			8,000	
T03	Intersection Improvement: VDN – Aimé Césaire	Yes			16,000	
T04	Intersection Improvement: Liberté 6 – Routes des Niayes	Yes			8,000	To be coordinated with BRT
T05	Intersection Improvement: Khar Yalla – Front de Terre	Yes			6,700	
T06	Intersection Improvement: Front de Terre – Bourguiba	Yes			5,700	
T07	Intersection Improvement: Bourguiba – Cheikh A Bamba	Yes			4,000	
T08	Intersection Improvement: Bourguiba – Dial Diop	Yes			4,000	
T09	Intersection Improvement: Bourguiba – Allées Sydou Nourou Tall	Yes			4,000	
T10	Intersection Improvement: Dial Diop – Rocade	Yes			4,000	
T11	Intersection Improvement: Croisement Case – Routes des Niayes	Yes			8,000	To be coordinated with BRT
T12	Intersection Improvement: Technopole Roundabout	Yes			7,500	
T13	Access Road Improvement around Baux Maraîchers Bus Terminal	Yes			7,400	
T14	Widening of Old Rufisque Road (Cyrnos – Seven up)	Yes			30,000	9 km
T15	Widening of Routes des Niayes (Dalal Jamm Hospital – Keur Massar)	Yes			56,000	13 km
T16	Widening of Malika Road between VDN and Routes des Niayes	Yes			1,700	1.5 km
T17	Widening of Rufisque - Niaga – Lac Rose Road between Keur Massar and Sangalkam		Yes		12,700	11 km
T18	Widening of Urban Roads in Rufisque	Yes			2,900	2.5 km
T19	Widening of Tivaouane Peulh Road	Yes			3,450	3km
T20	Extension of VDN Section 3 (Lot 2)	Yes			20,000	13 km
T21	Extension of Routes des Niayes		Yes		36,400	28 km
T22	Development and Widening of Rufisque - Niaga – Lac Rose Road between Rufisque and Lac Rose		Yes		8,500	7.4 km
T23	Widening of Bayakh – Lac Rose – Niaga Road			Yes	9,900	8.6 km
T24	Widening of Rufisque - Niaga –		Yes		3,200	2.8 km

	Lac Rose Road: Rufisque Section					
T25	Widening of Urban Roads in Bargny			Yes	9,100	4.9 km
T26	Development of Sangalkam – Deni mali Gueye Road			Yes	22,300	11.7 km
T27	Development of Connection Road between National Routes 1 and 2		Yes		3,800	2.9 km
T28	Widening of Sendou – Yene Road			Yes	6,900	6 km
T29	Development of Diamniadio – Daga Kholpa Road			Yes	27,300	21 km
T30	Widening of National Route 2 between Diamniadio – Thiès	Yes			22,100	17 km
T31	Widening of National Route 1 between Diamniadio – Mbour	Yes			27,300	21 km
T32	Development and Daga Kholpa – AIBD Road	Yes			19,500	15 km
T33	Development of AIBD – Mboul Road		Yes		11,700	9 km
T34	Widening of Urban Roads in Pout	Yes			1,200	1.0 km
T35	Development of AIBD – Pout Road	Yes			9,100	7 km
T41	Development of Regional Express Train (TER)	Yes	Yes		1,161,300	57 km
T42	Development of BRT Service: Pilot Phase (Dakar – Guédiawaye)	Yes			135,000	19 km
T43	Development of BRT Service: Lines 2 & 3 (Dakar – Pikine Nord / Keur Massar)	Yes	Yes		165,000	37 km
T44	Development of BHLS Service: Dakar – Baux Maraîchers	Yes			49,400	38 km (2 routes)
T45	Development of BHLS Service: Baux Maraîchers – AIBD	Yes			53,300	41 km
T46	Development of BHLS Service: Guédiawaye – Lac Rose		Yes		22,100	17 km
T47	Development of BHLS Service: Guédiawaye – Keur Massar		Yes		18,200	14 km
T48	Development of BHLS Service: Keur Massar / Tivaouane Peulh – Diamniadio		Yes		29,900	23 km
T49	Development of Railway Service: Diamniadio – Daga Kholpa – AIBD			Yes	489,000	24 km
T50	Development of High-Speed Ferry Service: Dakar – Rufisque	Yes			35,000	18 km

Source: JICA Study Team, based on data of ANAT, PSE, AGEROUTE and CETUD

7.2.6 Cost Estimate

The preliminary cost of the Master Plan for the urban transport sector has been estimated taking into account the abovementioned implementation schedule of the proposed projects.

Fund requirements for the Master Plan are summarized in Table 7.2.4, excluding operation and maintenance costs during the period from 2016 to 2035. An amount of 2,595 billion FCFA is required for the period between 2016 and 2035 in market prices of July 2015 including inflation. The public transport development, consisting of 15 projects including TER and BRT development, has a higher cost amounting to 2,158 billion FCFA, or 83% of the total cost. The road development consisting of 35

projects requires 436 billion FCFA.

From the viewpoint of the timing of cost distribution, 47%, 31% and 22% of the total cost need to be allocated in the short-term period until 2020, the medium-term period (2021-2025) and the long-term period (2026-2035), respectively, as shown in Table 7.2.4.

Table 7.2.4 Urban Transport Master Plan Cost (2016-2035)

Unit: million FCFA

Sub-Sector	Development Term			
	Short Term (2016-2020)	Medium Term (2021-2025)	Long Term (2026-2035)	Total (%)
Road Development	284,600	76,300	75,519	436,419
Public Transport Development	935,850	733,350	489,000	2,158,200
Total (%)	**1,220,450 (47%)**	**809,650 (31%)**	**564,519 (22%)**	**2,594,619 (100%)**

Note: The cost is estimated at 2015 market prices.
Source: JICA Study Team

7.3 Logistic Infrastructure

7.3.1 Objectives and Development Strategies

(1) Objectives

Logistics infrastructure consists of various transport infrastructures such as port, airport, railway and road and various logistic facilities such as logistics platforms, ICD, truck terminals and parking spaces. Among these various infrastructures or facilities, Dakar Port is the most important and key infrastructure of the logistic sector in Senegal and it is crucial to improve the conditions of Dakar Port above any other infrastructures, given the volume of cargo distributed to/from Dakar Port in the domestic market in Senegal. Not only Dakar Port itself but also the port's transport access must be improved in order to transport cargoes efficiently, so that social and economic activities not only in Dakar but also in Senegal as a whole can be facilitated. In addition, through the establishment of efficient logistics infrastructures, especially for Dakar Port, Dakar and Senegal as a whole will have more competitive advantages in terms of logistics aspects in the Western African region and, consequently, it can be expected that Senegal will become a logistical hub in the region in future.

Based on these conditions, the objectives of logistics infrastructure development can be identified as follows:

- To contribute to the sustainable development of economic activities in Senegal through the development of logistics infrastructure
- To make Senegal a logistical hub in the region (West Africa) by strengthening the competitiveness of the logistics infrastructure

(2) Strategies and Concept of Logistic Infrastructure Development

In order to realize the objectives of logistics infrastructure development mentioned above and also to make the physical distribution system efficient and effective, the following three main strategies should be considered for logistics infrastructure development:

- Port developments
  - ✓ Dakar Port development including expansion, rehabilitation and restructuring
  - ✓ Development of alternative or secondary port(s)
  - ✓ Reduction of degree of overconcentration in Dakar Port for risk aversion

- Improvement of accessibility and connectivity to/from Dakar Port
- Improvement of logistics facilities

Based on the abovementioned development strategies, the following development concept shall be considered for each logistics-related infrastructure:

- ***Port*:** to improve the conditions of Dakar Port in terms of port efficiency and to strengthen Dakar Port's competitiveness against ports in neighboring countries (e.g., Abidjan Port);
- ***Airport*:** to facilitate the supporting infrastructures for easy access to AIBD, to anticipate the future outcome and to examine the investment effects of AIBD, which is under construction;
- ***Access to/from Dakar Port*:** to improve access to the port by inland transport infrastructure (road and railway);
- ***Road*:** to overcome the various crucial problems in terms of physical infrastructure raised by concerned organizations and users;
- ***Railway*:** to strengthen the functioning and increase the capacity and efficiency of the Dakar-Bamako corridor;
- ***Logistic facilities*:** to develop a logistic platform/distribution center and trucking terminal to remove the existing problems and improve efficiency.

7.3.2 Establishment of Development Target

The WB has established an indicator in order to measure and evaluate the logistic competitiveness for each country, the so-called LPI. According to the WB report[1], Senegal's position in logistic competitiveness is not high, despite its geographical advantage. Senegal ranked 101st among 160 countries in the world, 10th among 40 Sub-Saharan countries and fifth among 12 ECOWAS countries for which data were available, after Nigeria (75th in the world and first in ECOWAS), Côte d'Ivoire (79th and second), Burkina Faso (98th and third) and Ghana (100th and fourth).

Moreover, the OECD has developed a different indicator, i.e., the trade facilitation indicator, in order to help governments improve their border procedures, reduce trade costs, boost trade flows and reap greater benefits from international trade. This indicator can identify areas for action and enable the potential impact of reforms to be assessed. This indicator consists of several aspects, such as information availability, involvement of trade community, advance rulings, appeal procedures, fees and charges, formalities of documents and internal and external border agency cooperation. OECD trade facilitation indicators in 2014[2] indicated that Senegal's trade facilitation performance is relatively good and that Senegal in fact performs better than average for Sub-Saharan Africa; however, continuous efforts to eliminate bottlenecks still have to be made.

With these indicators mentioned above, the accomplishment of the development of logistics infrastructure can be evaluated and measured considering any logistics infrastructure development in future. The Study Team proposes the following development targets for logistic infrastructure in 2025 and 2035:

- Development target in 2025
  - ✓ Senegal to rank first in ECOWAS according to the WB indicator
  - ✓ Senegal's performance to be above average for the Sub-Saharan African region and for lower-middle income countries according to all the OECD performance indicators.

[1] *Connecting to Compete 2014, Trade Logistics in the Global Economy, the Logistics Performance Index and its Indicators,* World Bank

[2] *http://www.oecd.org/tad/facilitation/senegal-oecd-trade-facilitation-indicators-april-2014.pdf*

- Development target in 2035
  - ✓ Senegal maintains its first position among the ECOWAS countries in the WB indicator
  - ✓ Senegal performance to be close to the best for the Sub-Saharan African region and for lower-middle income countries according to all the OECD performance indicators.

7.3.3 Demand Forecast and Needs for Development

(1) Demand Forecast

It is assumed that future cargo volumes for Senegal through Dakar Port are estimated by correlation with future GDP growth rate in Senegal, which was estimated by the Study Team as described in Chapter 6. As for Malian transit cargoes through Dakar Port, it is assumed that the future cargo volume is estimated by correlating with future GDP growth rate in Mali, which was estimated by the IMF. It is also assumed that other cargoes handled at Dakar Port are the same volume as in 2013. Based on these assumptions, the future cargo throughputs at Dakar Port can be estimated as shown in Table 7.3.1. This table shows that the expected cargo volume in 2035 will be about 2.8 times greater than that recorded in 2013.

Table 7.3.1 Cargo Volume Projection at Dakar Port

Unit: 1,000 ton

	Import & export	Transit cargo for Mali	Transit including transshipment excluding Mali	Total	Growth rate comparing cargo volume in 2013
2010	8,547	886	619	10,052	
2011	8,620	1,457	1,029	11,106	
2012	9,020	1,668	787	11,475	
2013	9,030	1,846	997	11,873	
2015	10,262	2,082	997	13,341	
2020	14,125	2,689	997	17,811	50.0%
2025	19,444	3,483	997	23,923	101.5%
2030	27,271	4,445	997	32,713	175.5%
2035	38,249	5,637	997	44,882	278.0%

Note: Annual growth rate for Senegalese cargo based on annual GDP growth rate (medium-term scenario) estimated by JICA Study Team.
Annual growth rate for Malian transit cargo based on annual GDP growth rate estimated by IMF. Cargo data in 2013 are the latest available data from PAD.
Source: Estimated by JICA Study Team based on the actual cargo data (2010-2013) from PAD

(2) Need for Development

It is obvious that development of the logistics-related infrastructures is needed in consideration of prospective future cargo volume handled in Dakar Port. However, detailed information such as cargo data, as well as cargo handling activities of each pier in Dakar Port and details of Dakar Port Master Plan, which were prepared and are being updated by PAD, were not provided from PAD due to confidentiality; therefore, it is not possible to justify quantitatively the capacity of existing facilities as well as the future capacity planned by PAD. Given these circumstances, the need for logistics-related infrastructures can only be examined qualitatively, as described below.

1) Need for Development of Dakar Port and its Auxiliary Infrastructures

Dakar Port is the most important key infrastructure among all related infrastructures for the logistic sector in Senegal. The port distributes cargo to/from Dakar for domestic purposes and for the landlocked country of Mali. Since DP World, one of the best-known and biggest container terminal

operators in the world, entered the container business in Dakar Port, productivity as well as the efficiency in handling container cargoes has improved considerably according to the port users. However, the serious congestion in the port as a whole and in the vicinity of the port are always problematic and this problem causes inefficiency in the total logistic supply chain.

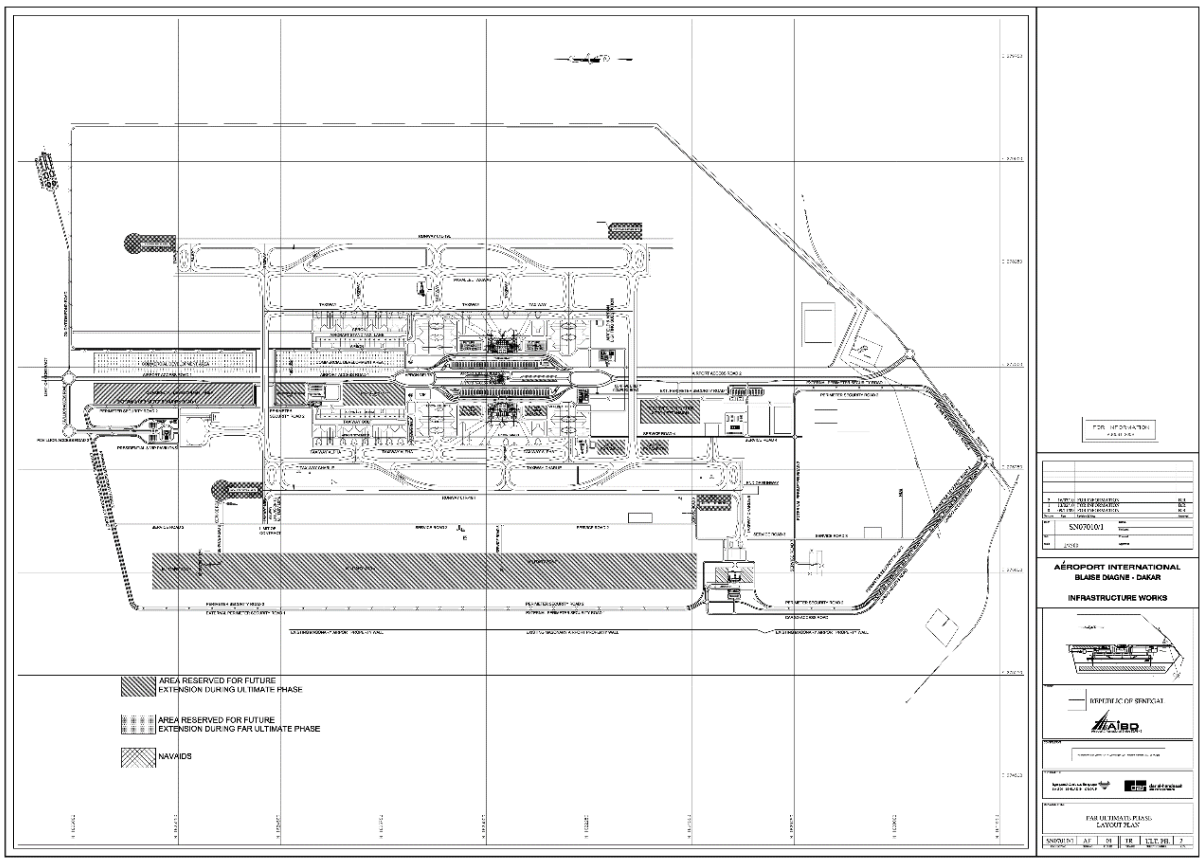
As port users always complain about the congestion of the port as well as the port's access road, the expansion of the port as well as the improvement of the inland transport infrastructure supporting the port is urgently needed, especially in order to accommodate the expected future cargo demand. In order to strengthen the competitiveness of Dakar Port, not only the port itself but also its hinterland should be improved, otherwise the competitiveness of Dakar Port will eventually decline.

2) Need for Development of Other Logistics Infrastructures

Apart from Dakar Port and its auxiliary infrastructure, the need for other logistics-related infrastructure development shall be examined. With regard to the airport sector, AIBD is now being constructed and operation is expected to commence in late 2016. AIBD has an expansion plan in hand in case the cargo handling volume as well as the number of passengers exceed expectations, as shown in Figure 7.3.1. Therefore, a future airport development plan for further expansion may not be needed and it will be examined and considered in years to come after the commencement of the new airport's operations. However, the supporting infrastructure to access the AIBD, such as railways and roads, shall be considered for development so that airport users can access the AIBD easily.

As for the railway sector, with consideration for efficient cargo transport in terms of travel time and security aspects and especially for the transportation of transit cargoes to/from Mali, railway rehabilitation for the Dakar-Bamako corridor is one of the highest priority projects. WB has offered support for this rehabilitation project to both the Senegalese and Malian governments; however, institutional reform is still being examined and the technical study has not yet commenced. It is obvious that, due to the inefficiency of railway cargo transport, this rehabilitation project should be urgently implemented.

Apart from the major transport infrastructures, the linkages between all major facilities must be established and/or improved in order to facilitate the smooth and easy movement of transport cargoes. In addition, logistic facilities such as cargo storage facilities and truck parking terminals need to be improved and provided so that cargoes and trucks are not stacked on the way to/from the port. This should enable the degree of congestion in and around the port to decrease.



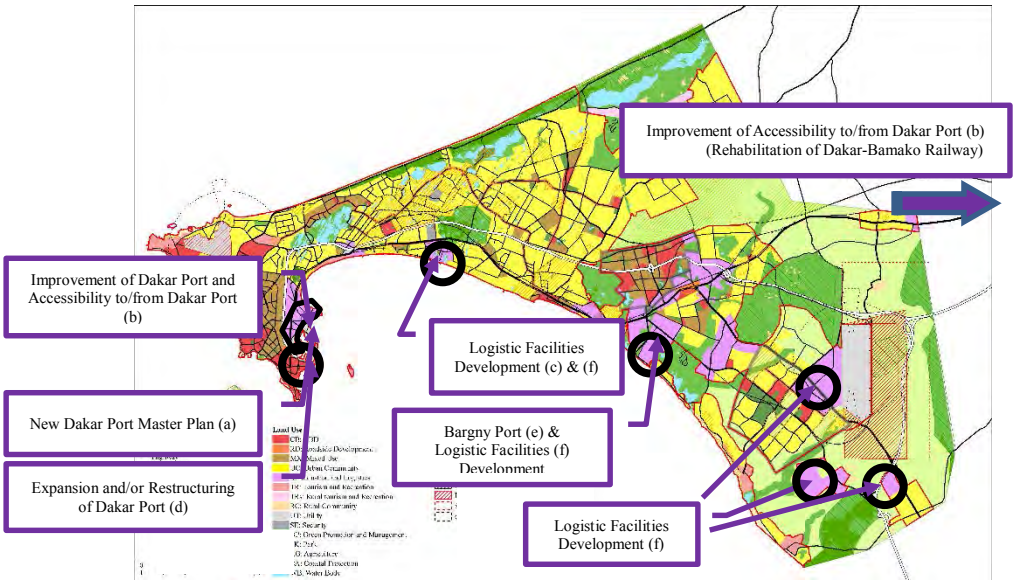
Source: AIBD

Figure 7.3.1 General Plan of AIBD

7.3.4 Development Plan

The following logistic infrastructure development plans were formulated for the 2035 Master Plan (Figure 7.3.2):

(a) Formulation of new Dakar Port Master Plan
(b) Improvement of Dakar Port and access to/from Dakar Port
(c) Improvement of logistics facilities
(d) Expansion and/or restructuring of Dakar Port
(e) Development of alternative or secondary port(s)
(f) Development of logistics facilities according to future land use plan



Source: JICA Study Team

Figure 7.3.2 Development Plans for Logistic Infrastructure in the Study Area

1) Formulation of New Dakar Port Master Plan

Since Dakar Port is located next to the city center, it is almost impossible to expand the port on the land side. It may only be possible to expand toward the sea side, although the investment cost will be very high. In order to improve efficiency of port activities, it is crucial to prepare an entire port development plan considering partial relocation of facilities and establishment of alternative or secondary port(s), instead of continuous investment for the expansion of Dakar Port itself. In addition, the auxiliary infrastructure such as the access road and railway must be improved at the same time. PAD prepared a port master plan and is now revising it; however, this master plan will unfortunately not be disclosed to the public. Since other ports except Dakar Port are managed and developed by the ANAM, a new Dakar Port Master Plan should be prepared by incorporating the other port development plans drawn up by ANAM, in order to improve Senegal's logistics infrastructure as a whole, and consequently make Dakar Port more competitive. Along these lines, construction of Foudiougne port is ongoing.

2) Improvement of Dakar Port and Access to/from Dakar Port

The north port area, which handles container cargoes, bulk cargoes and hydrocarbon cargoes, receives hundreds of trucks every day and the access road to the north port area is in poor condition, unpaved and narrow. There is not enough space for truck transportation around the north area. Consequently, the north area suffers from heavy congestion.

Although PAD have their own plans and have been developing the port, which might have solved these problems, some terminals have not been improved for many years. For instance, the Third Pier, which was constructed in the 1960s, has deteriorated significantly due to lack of maintenance and is suffering from inefficient cargo handling processes. The Third Pier of Dakar Port is mainly dedicated to the transit cargoes from/to Mali. JICA has just completed a preliminary study for the rehabilitation of the Third Pier in April 2015; another preparatory study was commenced in September 2015 and will be completed in May 2016. The Third Pier rehabilitation will improve the efficiency of Dakar Port.

The railway is the most suitable transportation mode for longer distances, reducing travel time and enhancing security and safety. Although WB is financing the preliminary examination for reform of the organizational structure, a technical feasibility study has not yet been done. As soon as the examination of the organizational reform is complete, it is highly recommended to commence a technical feasibility study for the Dakar-Bamako corridor, in order to increase the transit capacity to Mali.

3) Improvement of Logistics Facilities

PAD established a logistic platform in 2008, as shown in Figure 7.3.3, and plans to develop a new logistic platform in Mbao for those trucks carrying Malian transit cargoes. The new platform will provide more truck parking spaces and consequently raise urban mobility. This development should be implemented urgently considering the current degree of congestion.

Source: PAD

Figure 7.3.3 Logistic Platform established by PAD

4) Expansion and/or Restructuring of Dakar Port

In order to strengthen the competitiveness of Dakar Port, the port's efficiency must be improved and the port charge be reduced. In addition, Dakar Port needs to accommodate bigger vessels responding to the economy of scale. However, Dakar Port does not have enough depth to do so. Therefore, the depth in front of the berths and the access channel must be increased so that bigger vessels, which are accommodated at Lome Port and Lagos Port, can also be accommodated at Dakar Port.

5) Development of Alternative or Secondary Port(s)

ANAM, which is in charge of the development of ports other than Dakar Port, is preparing alternative port development plans as described below. These port development projects can be considered the components of Dakar Port Master Plan to enhance the competitiveness of Dakar Port.

Development of Bargny Port (Figure 7.3.4)

Bargny Port aims to establish a new deep seaport dedicated to mining and oil products. A new transit logistics platform in the port will alleviate the heavy cargos and bulk cargos from/to Dakar.

A feasibility study was completed in September 2014 by ANAM and ANAM is looking for finance. Bargny Port is expected to handle various dry bulk cargoes including coal, sulfur and plaster for import and iron ore, phosphate and clinker for export. Future cargo throughputs are projected as shown in Table 7.3.2. The major project components are shown in Table 7.3.3.

Table 7.3.2 Projection of Dry Bulk Cargo Throughput at Bargny Port

Unit: 10,000 ton

Name of Cargo	2020			2030		
	Import	Export	Total	Import	Export	Total
Dry bulk cargo	410	2,385	2,795	530	3,455	3,985

Source: ANAM

Table 7.3.3 Major Project Components of Bargny Port

Name of Facility	Dimension
Bulk cargo berth	Length 900 m/Width 24 m/39 m
Heavy cargo berth	Length 200 m/Width 20 m
Access bridge to bulk cargo terminal	Length 4,005 m/Width 24 m
Iron ore yard	49,000 m^2
Coal yard	29,400 m^2
Warehouse	47,280 m^2
Access road	21.0 km
Access railway	11.26 km
Parking space outside port	7,425 m^2

Source: ANAM

Source: ANAM

Figure 7.3.4 Bargny Port Development

Development of Kaolack Port (Figure 7.3.5)

The Kaolack Port development aims to strengthen the port system in Senegal and promote regional development outside Dakar. The port will encourage integration with landlocked countries such as Mali, Burkina Faso and Niger. Projections of future cargo throughputs are shown in Table 7.3.4.

Table 7.3.4 Projection of Future Cargo Throughput at Kaolack Port

Type of Cargo	Unit	2020			2030		
		Import	Export	Total	Import	Export	Total
Bulk cargo	10,000 ton	105	2	107	191	3	194
Container	10,000 TEU	3	2	5	6	4	10
Total	**10,000 ton**	**135**	**22**	**157**	**251**	**43**	**294**

Source: ANAM

This project has two phases:

Phase I:

- Dredging up to -7.0 m along Foudiougne channel;
- Renovation of existing wharves by:
  - ✓ Increasing the depth in the basin;

- ✓ Strengthening the existing wharves' structure;
- ✓ Resuming mooring systems and fenders;
- ✓ Expanding and renovating existing warehouses;
- ✓ Constructing new wharves along the existing anchoring line.

Phase II:

- Construction of a deep sea multipurpose wharf that can accommodate vessels with a draft of 16.0 m;
- Construction of a hydrocarbon terminal for the supply of Kaolack regions including the powerhouse at Kaone.

Source: ANAM

Figure 7.3.5 Kaolack Port Development

Dakar Port is a predominant port for Senegal and will continue to be so in future. However, if the cargo throughputs at Dakar Port continue to increase, Dakar Port will be saturated. Therefore, these alternative port developments are needed in order to reduce the degree of overconcentration in Dakar Port. Moreover, these alternative ports can be substituted for Dakar Port in case it is difficult for Dakar Port to operate sufficiently and effectively for any reason. Eventually, the competitiveness of Dakar Port will be strengthened and the objectives of the infrastructure development will be accomplished through the implementation of all the development plans.

6) Development of Logistics Infrastructure According to Future Land Use Plan

Aside from the development plans, in order to solve current problems and issues, the logistics infrastructures should be developed according to the proposed future land use plan for the Study Area. One of the reasons for the congestion in the vicinity of Dakar Port is that the industrial zone is located in the city center next to the port. In order to avoid congestion around the port, the existing industrial zone and/or logistic center may need to be relocated to the suburbs or new logistic facilities outside the city center. Based on this concept as well as the policy of new urban development, a future land use plan is prepared. The logistic infrastructure must be developed so that future economic activities in the Study Area will be facilitated smoothly. Not just logistic facilities such as logistic platforms, but also supporting infrastructures such as roads and railways must be established between the port, the new industrial zone and the new logistic infrastructure. In addition, in order to maintain the logistics infrastructure in good condition, maintenance must be secured. It is recommended to introduce asset management so that the conditions of the infrastructure can be monitored continuously and maintenance works can be done properly and efficiently, especially road paving.

7.3.5 Cost Estimate

(1) Implementation Schedule

An implementation schedule shall be decided with consideration for urgency and priority. Table 7.3.5 presents a tentative implementation schedule. Since there is no single organization that manages and implements the proposed development plans, all related organizations must be coordinated and

cooperate with each other so that the situation of the logistic sector as a whole can be improved.

Table 7.3.5 Implementation Schedule for Logistic Infrastructure Development (Tentative)

	Development Plan	2015	2020	2025	2030	2035
Short Term	a) Formulation of New Dakar Port Master Plan					
	b) Improvement of Dakar Port and Accessibility to/from Dakar Port					
	c) Improvement of Logistics Facilities					
Medium Term	d) Expansion and/or Restructuring of Dakar Port					
Medium-Long Term	e) Development of Alternative or Secondary Ports					
	f) Development of Logistics Infrastructure According to Future Land Use Plan					

Source: JICA Study Team

(2) Project Cost

It is very difficult to identify the scale of projects without conducting detailed surveys and preparing concrete and detailed development plans and consequently this makes it impossible to estimate project cost at this stage. However, a few studies were previously conducted and the project costs estimated in these studies are shown in Table 7.3.6.

Table 7.3.6 Project Cost

Development Plan	Type of Project	Scale of Project/ Project Cost
a) Formulation of new Dakar Port Master Plan	Study	Study period: 1 year No. of experts: 10 (50 MM)
b) Improvement of Dakar Port and accessibility to/from Dakar Port		
Rehabilitation of Third Pier of Dakar Port*1	Design and implementation	Implementation cost: 2.5 billion JPY Implementation period: 2 years
Improvement of Dakar Port access road	Design and implementation	N/A
Rehabilitation of Dakar-Bamako railway project	Design and implementation	N/A
c) Improvement of logistics facilities		
Improvement of truck terminal in Mbao	Design and implementation	N/A
d) Expansion and/or restructuring of Dakar Port		
Project(s) to be identified in new Dakar Port Master Plan	Design and implementation	N/A
e) Development of alternative or secondary ports		
Bargny Port project*2	Design and implementation	Implementation cost: 900 million USD Implementation period: 3 years
Kaolack Port project *2	Design and implementation	Approx. 250 billion FCFA
f) Development of logistics infrastructure according to future land use plan	Design and implementation	N/A

Note: *1: Information about the rehabilitation of the Third Pier of Dakar Port obtained from JICA.
*2: Information about both the Bargny Port project and Kaolack Port project obtained from ANAM
Source: JICA Study Team

7.4 Water Resources and Water Supply

7.4.1 Objectives and Development Strategies

(1) Objectives

The development objective for the water resources and water supply sectors is to ensure the access to safe and stable water supply for the entire population through the following:

- Development of alternative water sources
- Improvement of effectiveness and efficiency of water distribution system

- Reduction of water demand
- Sustainable and well-coordinated use of precious water resources

(2) Development Strategies

1) Basic Improvement Strategies

The strategies for basic improvement of the Dakar water supply system are as follows:

- ***Water resources development*:** Further development of surface water and groundwater is restricted by water availability and financial constraints. Therefore, to create diversity in water resources, new water resources, such as seawater by desalination, need to be developed with careful consideration for their feasibility and sustainability.
- ***Improvement of water distribution system*:** Due to the deterioration of aged facilities, problems such as leakages in pipelines and malfunctioning of pumps are observed, due to which water cannot be distributed effectively. Improvement in efficiency of the system can contribute to the reduction of NRW. Although some improvements are already planned and ongoing, the piped water supply system needs further subsequent rehabilitation works for sustainable management.
- ***Improvement of water quality*:** Low-quality groundwater in some areas is being treated and distributed, but boreholes taken out of service due to nonconformity to quality guidelines can be reactivated through construction and operation of water treatment stations. Even after treatment, if the water quality does not conform to drinking water standards, this water can be used for non-drinking purposes such as industrial and agricultural uses.

2) Enhanced Strategies for Sustainability

Strategies for the sustainability of water resources and water supply are proposed in Table 7.4.1.

Table 7.4.1 Strategies for Sustainable Water Resources and Water Supply

Strategy	Proposal
Water saving and recycling	Promotion of water saving and recycling is necessary to enhance the effective use of water in the Study Area where available water resources are very limited, necessitating reliance on water imported from outside the Study Area.
Implementation of integrated water resources management plan	An integrated water resources management plan for the Study Area needs to be formulated and its early implementation is essential to protect the environment with consideration for social and economic aspects. As a part of the plan formulation, enhanced understanding of the water cycle, including imported water from outside the Study Area, in terms of both water quantity and quality, is needed to recognize the actual scarcity of water resources.
Need for a multiple distribution system	Although the present water distribution system has a complicated pipeline network, the water flow is interconnected in a single system. Therefore, when an emergency occurs, the whole system practically fails. Dependence on such a system therefore involves high risks. Consequently, separate independent flows need to be planned to avoid incidents.

Source: JICA Study Team

7.4.2 Establishment of Development Targets

(1) Development Horizons

The target horizons for proposals of developmental improvements in water resources and water supply are set for the medium term up to 2025, when the initial stage of achievement will have been completed, and for the long term up to 2035 to confirm suitability for sustainable development. The parameters to indicate the realization of incremental development stages for water supply are water

accessibility rate, houses connection access rate, cost recovery, unit consumption rate and NRW rate. These parameters are presented hereafter.

The latest version of the Dakar water supply master plan accepted by SONES is included in *Réalisation des Etudes Détaillées pour la Construction d'une 3ième Usine de Traitement à KMS et ses Renforcements en aval, Phase 1: Etudes complémentaires préalables*, SONES, January 2015 (hereafter referred to as "KMS3 Study 2015"), in which the target year was extended from 2025 to 2035. Information from this report as well as from *Mission de collecte d'information pour l'approvisionnement en eau de la Région de Dakar* (JICA, 2014), were used as the basis for planning in the present study.

(2) Water Supply Development

Accessibility improvement of water supply

Although the rates of accessibility of a continuous supply of clean water in most areas of Dakar Region are already or almost 100%, the Study Area in Thiès is lagging behind. Therefore, a proposal for improvements in accessibility is necessary to support water supply in the departments as proposed below in Table 7.4.2.

Table 7.4.2 Proposal for Improvement in Water Supply Accessibility

Zone	Present Accessibility (%)		Medium-Term Target (%)		Long-Term Target (%)	
	2013*	2014**	2020	2025	2030	2035
Dakar Department	100	99.5	100	100	100	100
Guédiawaye Department	100	99.8	100	100	100	100
Pikine Department	100	97.7	99	100	100	100
Rufisque Department	99	96.9	99	100	100	100
Thiès in the Study Area	No data	54.6	65	75	86	100

Source: JICA Study Team based on information from SONES (*) and JICA Household Survey, 2014 (**)

Water distribution service improvement

The strategy for improved water distribution services will be to increase house connections (level three service) with consequent reduction in public tapstands (level two service) for eventual 100% access to house connections by 2035 as a measure to optimize services for enhanced cost recovery. However, for the Study Area in Thiès, although maintaining public tapstands in some rural areas is inevitable, SONES is promoting the replacement of public tapstands with social house connections (service connections through donor support) as a means to relieve the financial burden on the poor population. The proposal for improving water supply services through increasing house connections is proposed as follows in Table 7.4.3:

Table 7.4.3 Proposal to Improve Access Rates of House Connections

Zone	Distribution	Present Rate (%)		Medium-Term Target (%)		Long-Term Target (%)	
		2013*	2014**	2020	2025	2030	2035
Dakar Department	House connections	96	96.2	98	100	100	100
	Public tapstands	4	3.3	2	0	0	0
Guédiawaye Department	House connections	96	90.7	96	100	100	100
	Public tapstands	4	9.1	4	0	0	0
Pikine Department	House connections	96	91.3	96	100	100	100
	Public tapstands	4	6.4	3	0	0	0
Rufisque Department	House connections	88	85.8	89	92	96	99
	Public tapstands	11	11.1	10	8	4	1
Thiès Study Area	House connections	No data	45.3	56	67	80	96
	Public tapstands	No data	9.3	9	8	6	4

Source: JICA Study Team based on information from SONES (*) and JICA Household Survey, 2014 (**)

Improvement of cost recovery

Although the present cost recovery is very high at 98%, reaching 100% is expected to be difficult; however, efforts to achieve 100% are nonetheless needed to achieve sustainable management of the water supply system as proposed below in Table 7.4.4.

Table 7.4.4 Proposal for Steady Improvement in Cost Recovery

Parameter	Present Recovery Rate		Medium-Term Target		Long-Term Target	
	2013	2015	2020	2025	2030	2035
Cost Recovery (%)	98	98	98	99	99	100

Source: JICA Study Team based on information from SONES

Restraining water consumption

Normally, along with rise in income, per capita water consumption or unit consumption rate also grows, which is not a favorable trend in areas of scarce water resources. However, since gradual increase in water consumption is inevitable, the unit water consumption rate should be restrained to a level that will not hamper living standards.

For the forecasts made in the KMS3 Study 2015, unit consumption rates are kept constant at the 2013 value. For comparison purposes in this study, a growth in consumption rate in accordance with the economic growth pattern assumed as a probable trend is presented for comparison.

For Rufisque Department, the unit consumption rate for 2035 will consider the significant development of Diamniadio within the department. In this respect, the unit consumption rate for Diamniadio in 2035 is assumed to be the same as for Dakar Department at 75ℓ/cap/day, since economic and social conditions are predicted to become similar. On the other hand, the unit rate in other areas in Rufisque is assumed to be about 60ℓ/cap/day on average, including rural residents, of whom some will continue to receive water from public tapstands (at 35ℓ/cap/day). As a result, the average unit consumption rate in Rufisque is predicted to be about 63ℓ/cap/day, as calculated below.

- (Diamniadio unit rate × Diamniadio pop. + other area unit rate × other area pop.)/Rufisque total pop. = Rufisque average unit rate
- (75ℓ/cap/day × 542,400 persons + 60ℓ/cap/day × 1,873,306 persons)/2,415,706 persons = 63ℓ/cap/day
- The emerging development of Daga Kholpa in Thiès by 2035 is similarly reflected in the unit rate of 75ℓ/cap/day, while the average unit rate in other areas is set at 60ℓ/cap/day for an average rate of about 70ℓ/cap/day in the total area, as follows:
- (Daga Kholpa unit rate × Daga Kholpa pop. + other area unit rate × other area pop.)/Thiès Study Area total pop. = Thiès Study Area average unit rate
- (75ℓ/cap/day × 220,900 persons + 60ℓ/cap/day × 99,271 persons)/320,171 persons = 70ℓ/cap/day

Proposals for restraining unit consumption rates of domestic water use are shown below in Table 7.4.5.

Table 7.4.5 Proposal for Restraining Unit Domestic Water Consumption Rates

Zone	Option		Present Unit Rate (ℓ/cap/day)		Medium-Term Target (ℓ/cap/day)		Long-Term Target (ℓ/cap/day)	
			2013	2015	2020	2025	2030	2035
Dakar Region	SONES (Region average)		71	71	71	71	71	71
	Probable forecast		71	77	95	116	151	195
	Proposal for restraining	Dakar Depart.	68	69	70	72	73	75
		Guédiawaye, Pikine Departs.	51	52	56	61	65	70
		Rufisque Dep.	43	45	49	53	58	63
Thiès Study Area	SONES (Region average)		63	63	63	63	63	63
	Probable forecast		43	47	57	70	91	118
	Proposal for restraining		43	45	50	56	63	70

Source: JICA Study Team based on information from SONES, KMS3 Study 2015 and *Mission de collecte d'information pour l'approvisionnement en eau de la Région de Dakar*, JICA, 2014

Reduction of NRW

Another recommendation to counter the deficiencies in water resources to meet increasing water demand is to reduce NRW rates. Reduction in NRW rates can be realized through appropriate training on leakage detection and prevention as well as properly managed accounting practices. Although the performance indicator of SONES in the contract with SDE is 15%, the KMS3 Study 2015 maintains the 2013 rate up to 2035, as shown in Table 7.4.6. The JICA Study Team proposes to reduce the NRW to 10% in 2035 because the average NRW rate in Japan is about this amount (9.93% in 2009, Japan Water Research Center) and the AWWA uses 10% as its benchmark for NRW rate. Table 7.4.6 shows the proposal for gradual reduction to achieve the 10% goal.

Table 7.4.6 Proposal for Reduction of NRW Rates

Parameter	Option		Present Rate		Medium-Term Target		Long-Term Target	
			2013	2015	2020	2025	2030	2035
NRW Rate (%)	SONES	Dakar	23	23	23	23	23	23
		Thiès	19	19	19	19	19	19
	JICA Study Team	Dakar	23	21	17	14	12	10
		Thiès	19	18	15	13	11	10

Source: JICA Study Team based on information from SONES and KMS3 Study 2015

7.4.3 Demand Forecasts

Water demands are forecast up to the target year 2035 by SONES for all consumers of the Dakar water supply system, which includes not only Dakar Region, but the regions of Louga and Thiès as well (adopting forecasts of Scenario A from KMS3 Study 2015). Demands equivalent to those of the Study Area are assumed to be about 96% (as confirmed by SONES) of the demands for the total distribution area of the Dakar water supply system of SONES.

However, since covering the SONES demand forecasts would become difficult in later years, alternative demand forecasts are estimated in the Study under the following conditions, in an effort to meet the long-term demands:

- Population data as forecast in the 2035 Master Plan multiplied by the unit consumption rates to served populations are used as the domestic water demands. Unit consumption rates (or unit supply rates) for 2013 from *Mission de collecte d'information pour l'approvisionnement en eau de la Région de Dakar* (JICA, 2014) are used as base data since these are assumed to represent the present rates. The proposed restrained rates shown above in Section 7.4.2 are used for forecasts of unit consumption rates.
- The 2013 demand data for industrial, agricultural and other sectors (mainly administration) from *Mission de collecte d'information pour l'approvisionnement en eau de la Région de Dakar* (JICA, 2014), according to actual water distribution data of SONES, are used as base data for 2013 in all target areas except the Study Area in Thiès. For the industrial and other demands in the Study Area of Thiès, the ratios of GRDPs between Thiès and Rufisque were used to assume these demands and agricultural demand was assumed to be similar to that of Guédiawaye and Pikine.
- Since tapped water distribution capacities for agricultural demands are already saturated and further water distribution will be difficult, future agricultural demands are kept constant.
- The future demand for other sectors is predicted to grow naturally along with the population growth.
- As for industrial water demands, in the departments of Dakar, Guédiawaye and Pikine, since a significant structural change in industries cannot be envisaged, natural growth is assumed to be in line with the population growth. However, for Rufisque and the Study Area in Thiès, since industrial activities in these areas are projected to become increasingly intense according to the proposed 2035 Master Plan, the predicted GRDPs in comparison with those of Dakar, Guédiawaye and Pikine are used to calculate the future demands.
- Forecast NRW rates proposed previously in Section 7.4.2 are used for demand forecasts.

Demand forecasts of SONES as well as forecasts proposed in the 2035 Master Plan are shown in Table 7.4.7.

Table 7.4.7 Water Demand Forecasts

Parameter	Option			Present Demand		Medium-Term Forecast		Long-Term Forecast	
				2013	2015	2020	2025	2030	2035
Demand Forecast (m^3/day)	SONES	Total Area	Average	344,530	356,143	416,136	493,423	570,647	662,720
			Peak	386,224	398,180	464,893	551,017	637,193	739,888
		Study Area Equivalent	Average	331,000	342,000	399,000	474,000	548,000	636,000
			Peak	371,000	382,000	446,000	529,000	612,000	710,000
	JICA Study Team	Study Area	Average	287,817	309,097	363,003	441,832	503,561	594,159
			Peak	316,599	340,007	399,304	486,016	553,917	653,575

Source: KMS3 Study 2015 and JICA Study Team

7.4.4 Development Plan

(1) Population Distribution Plan

In Dakar Region, the departments of Dakar, Guédiawaye and Pikine are wholly urbanized, while Rufisque Department is mostly urbanized. On the other hand, in the adjoining Study Area in Thiès, rural areas where water is partially distributed through public tapstands are expected to continue to exist. As explained previously, the development strategy for improved water supply services and sustainable management aims to increase house connections and minimize public tapstands, but maintain service to rural residents. The plan for allocation of the population in urban and rural areas

(defined in this Study as areas outside urban growth boundaries) is shown below in Table 7.4.8.

Table 7.4.8 Population Distribution Plan

Zone	Population Allocation (%)	Present	Medium Term	Long Term
		2013	2025	2035
Dakar, Guédiawaye, Pikine Departments	Urban	100	100	100
	Rural	0	0	0
Rufisque Department	Urban	97	98	99
	Rural	3	2	1
Thiès Study Area	Urban	62	76	85
	Rural	38	24	15

Source: JICA Study Team

(2) Water Distribution Plan for New Development Poles

SONES is implementing plans for water distribution to new development poles through programs such as the *Programme de renforcment et d'extension de réseau de distribution autour des Pôles de développement urbain* (Program for Reinforcement and Extension of Distribution Networks to Urban Development Poles). The water demands for these new areas are accounted for in the water demand forecasts reflected in the population forecasts (as explained previously), since population densities in areas with 100% accessibility to house connections are already saturated and, inevitably, their further growth must be transferred to these new development areas.

(3) Water Supply Development Plan to Cover Demand

Measures to improve water distribution

The planned SONES programs and projects for increasing distribution to meet growing water demands while preserving precious water resources are explained in Table 7.4.9.

Table 7.4.9 Measures to Improve Water Distribution

Water Resource	Improvement	Measures
Surface Water	Increase Distribution	• The Ministry of Hydraulics proposed an expanded KMS3 purification plant of 300,000 m^3/day capacity. However, SONES commented on the difficulty of this: high prior investments will be required as anticipatory financing for future expansions to cater for this capacity. Nevertheless, SONES explained that expansion of the KMS3 purification plant up to 200,000 m^3/day is feasible. • Operation of the Ngnith purification plant up to its full capacity will be possible for a production increase of 10,000 m^3/day from 2020.
Groundwater	Increase Distribution	• The Urgent Program is being implemented and scheduled for completion by the end of 2015 to increase groundwater production by 61,160 m^3/day. • The Complementary Urgent Program to extract Paleocene aquifers at Tassette by 2018 can increase groundwater production by 20,000 m^3/day.
	Preserve Water Resources	• To protect the Maastrichtian aquifers from overexploitation, about half of the boreholes presently pumping groundwater from these layers are scheduled to be suspended by 2020 to decrease the yield by 42,395 m^3/day. • Boreholes in the Urgent Program that exploit Maastrichtian aquifers will be scheduled to be taken out of service in 2020 with a reduction of 34,980 m^3/day to conserve the Maastrichtian groundwater. • To prevent risks of saline water intruding into the Paleocene layers of the Complementary Urgent Program through continued pumping over five to 25 years of operation[3], these boreholes are scheduled for stoppage in 2030.
Seawater	Increase Distribution	• The feasibility study for implementation of a desalination plant at Mamelles is complete. The latest plan of SONES is to start operation of a 100,000 m^3/day capacity plant by 2027. • It was decided in early 2015 that the seawater desalination plant planned for construction at Sendou on the Petite Côte side was to be transferred to Grande Côte in view of the higher operation efficiency and improved cost performance due to Grande Côte having a deeper coastline. The Grande Côte desalination plant, with a capacity of 50,000 m^3/day, is scheduled to be completed in 2019 and distribution will give priority to Dakar.

Source: JICA Study Team based on information from SONES and JICA Mission (December 2015)

Water distribution program

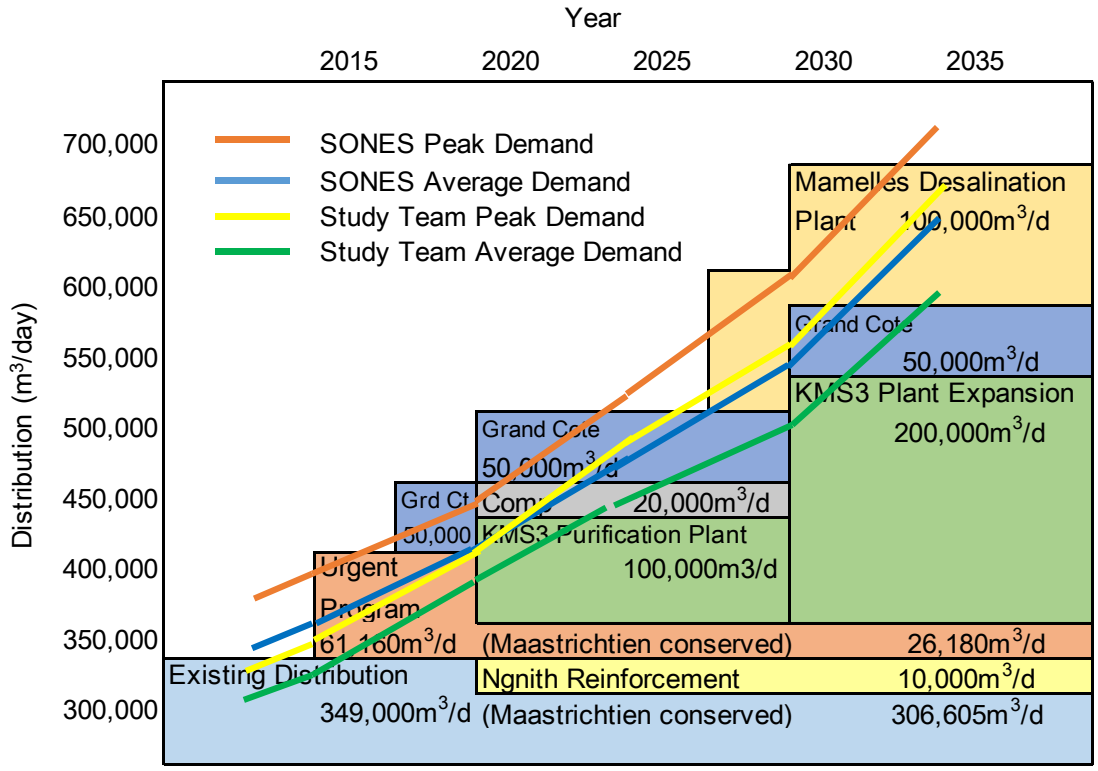
Program scheduling to incrementally increase water distribution to cover demand is shown in Table 7.4.10. The relationship between distribution and demand is visualized in Figure 7.4.1.

[3] In accordance with the hydrogeological study by ANTEA, 2015 and KMS3 Study 2015.

Table 7.4.10 Water Demand Forecasts and Distribution Scheduling

Component (m^3/day)				Present		Medium-Term Plan		Long-Term Plan	
				2013	2015	2020	2025	2030	2035
Demand Forecasts	SONES	Total Area	Average	344,530	356,143	416,136	493,423	570,647	662,720
			Peak	386,224	398,180	464,893	551,017	637,193	739,888
		Study Area Equivalent	*Average*	*331,000*	*342,000*	*399,000*	*474,000*	*548,000*	*636,000*
			Peak	*371,000*	*382,000*	*446,000*	*529,000*	*612,000*	*710,000*
	Study Team	*Study Area*	*Average*	***287,817***	***309,097***	***363,003***	***441,832***	***503,561***	***594,159***
			Peak	***316,599***	***340,007***	***399,304***	***486,016***	***553,917***	***653,575***
Existing Distribution				349,000	349,000	306,605	306,605	306,605	306,605
Urgent Program					61,160	26,180	26,180	26,180	26,180
Complementary Urgent Program						20,000	20,000	0	0
Mamelles Desalination Plant								100,000	100,000
Grande Côte Desalination Plant						50,000	50,000	50,000	50,000
Ngnith Plant Reinforcement						10,000	10,000	10,000	10,000
KMS3 Purification Plant						100,000	100,000	200,000	200,000
Total Distribution	Total Area			349,000	410,160	512,785	512,785	692,785	692,785
	Study Area Equivalent			**335,000**	**394,000**	**492,000**	**492,000**	**665,000**	**665,000**

Source: JICA Study Team based on information from KMS3 Study 2015, SONES and JICA Mission (December 2015)



Note: Comp: Complementary Urgent Program.
N.B.: Distribution rates are those for the total area (not for Study Area).
Source: JICA Study Team based on information from SONES and JICA Mission (December 2015)

Figure 7.4.1 Water Distribution Program

Reducing demand instead of increasing distribution

According to the above table and figure showing the water demand against the water distribution plan, the distribution rates can cover all demands up to 2030, but before 2035, only the SONES peak demand will be difficult to meet. As a measure to cover demands after 2035, the Study Team suggests that reducing the demand to meet the deficit is a more appropriate measure, since increasing the scarce water resources has restrictions.

7.4.5 Cost Estimates

Cost estimates for SONES programs and projects required to increase water production rates in order to cover water demand are listed in Table 7.4.11.

Table 7.4.11 Cost Estimates for Programs/Projects to Increase Water Production

Program/Project	Water Resource to be Developed	Amount Increased (m^3/day)	Implementation Period	Required Budget (million FCFA)
Urgent Program	Groundwater	61,160	2014-2015	6,800
Complementary Urgent Program (Tassette)	Groundwater	20,000	2015-2018	13,330
Mamelles Desalination Plant	Seawater	100,000	2014-2020	100,000
Grande Côte Desalination Plant	Seawater	50,000	2014-2019	40,000
KMS3 Construction and Transmission Reinforcement	Surface Water	200,000	2014-2025	203,050

Source: SONES

For SONES programs and projects which do not increase water production rates, but reinforce and improve Dakar's piped water supply system to provide more efficient water supply services, the cost requirements are shown in Table 7.4.12.

Table 7.4.12 Estimated Cost for Programs/Projects to Improve Water Supply Services

Program/Project	Implementation Period	Required Budget (million FCFA)
Program for Priority Investments (PIP) of PEPAM	2014-2015	8,600
Program for Prevention of Inundations – Disconnection of Thiaroye Boreholes	2014-2015	6,500
Study on Tariff Revision for Urban Water Supply and Sanitation Services	2014-2015	118
Program to Improve Water Quality – Construction of New Iron Removal Station at Point K	2014-2016	4,560
Program to Assure Proper Facilities and Operation for Dakar Water Supply	2014-2017	6,500
Program for 35,000 Social House Connections	2014-2016	3,800
Program for Reinforcement and Extension of Distribution Networks to Urban Development Poles	2015-2019	8,000

Source: SONES and PEPAM

Other than the above, costs required to implement the proposed program/projects by the JICA Study Team are needed. Most of them are non-structural measures, which would be implemented under the routine work of responsible agencies. However, the necessary budget and human resources should be secured for this implementation. The proposed technical assistance projects may require additional inputs such as international experts and supporting equipment.

7.5 Sewage and Sanitation

7.5.1 Objectives and Development Strategies

(1) Objectives

Development objectives for the sewerage and sanitation sector are summarized as follows:

- To upgrade the living environment with appropriate sanitation for all people
- To decrease the pollution load to mitigate environmental impact

(2) Development Strategies

Development strategies for sewerage and sanitation are as follows:

- ***To upgrade the sanitary environment with hygienic toilets:*** The sanitary environment should be improved by promoting the usage of hygienic toilets, to protect against contamination of groundwater and water bodies. This improvement contributes to the better living environment of local populations.
- ***Affordable and strategic expansion of the coverage of the sewerage system in the urban area:*** Growth of population and water consumption will be increased by urbanization in the Study Area toward 2035, which will result in an increase in wastewater discharge volume. The expansion of the sewerage system is required to cope with such an increase. On the other hand, a drastic increase in investment for the sector would not be realistic, although some increase would be possible. The target of expansion for 2035 should be set in an affordable manner by referring to the planned investment schedule given in *Etude d'Actualisation de Plan Directeur d'Assainissement Liquide de Dakar 2025* (PDA) toward 2025. In addition, strategic development of the sewerage system in the new development areas such as Diamniadio and Daga Kholpa would be taken into account.
- ***Appropriate management of septage with septage treatment facility:*** Since the development of a sewerage system usually takes a long time, proper management of on-site sanitation in unsewered areas is one of the key factors in reducing the pollution load. Regular maintenance of the toilet, such as withdrawing the generated septage (sludge from the septic tank), must take place. The necessary treatment facility for the septage should be installed to cover the unsewered area.
- ***Utilization of sewage resources:*** A sewerage system generates additional sewage resources. Sewage sludge has the potential to generate a large volume of biomass energy, which is one of the great additional benefits that may contribute to tackling global warming. Treated sewage can be reused as reclaimed water through appropriate treatment, which contributes to meeting increasing future water demand. The utilization of these sewage resources should be taken into account for the creation of a sustainable society.

7.5.2 Establishment of Development Target

(1) Access to Hygiene Toilet

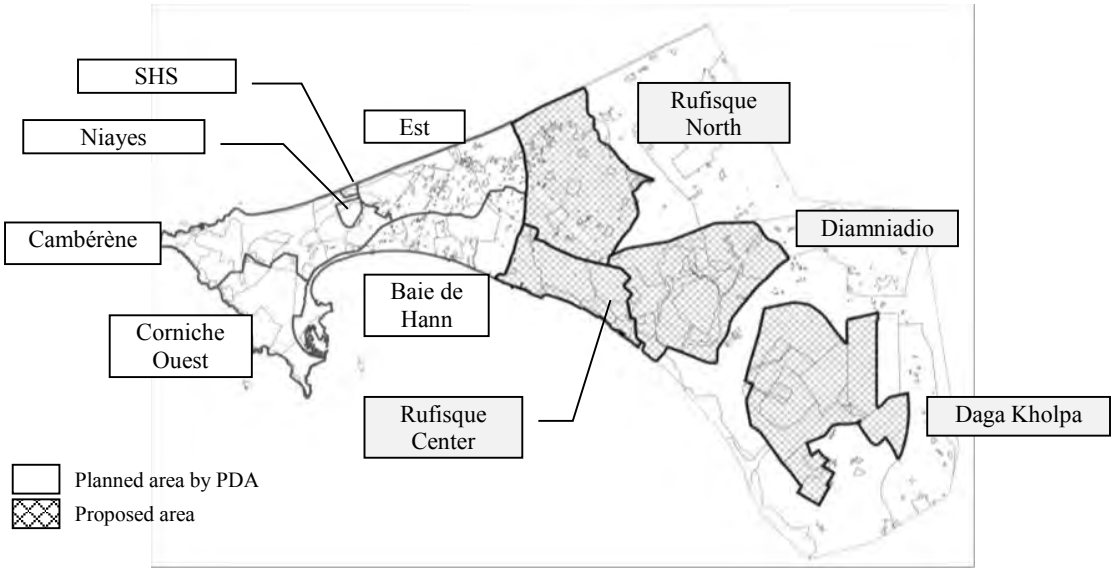
Sanitary facilities are classified into two categories: hygienic (VIP, TCM, septic tank) and unhygienic toilet. Unhygienic toilets contaminate the surrounding water bodies and can therefore cause waterborne diseases, which can still be seen, especially in rural areas. All people should have access to a hygienic toilet by 2035.

(2) Expansion of Sewerage System

1) Planned Sewered Area in a Long-Term Perspective

In a long-term perspective, the urban area should be almost completely covered by the sewerage system. In the present study, the "urban area" in the land use plan for 2035 is proposed to be almost wholly classified as a "*planned sewered area*". However, several urban agglomerations such as Sindia, Pout and Coast are not yet within the planned sewered area, considering their population and location. Figure 7.5.1 shows the existing planned sewered area of the PDA and the proposed planned sewered area determined by the JICA Study Team. The population in the planned sewered area is estimated at

3.1 million in 2013 and 5.8 million in 2035, as shown in Table 7.5.1. Table 7.5.2 shows the service population by probable sewage treatment plants.



Source: JICA Study Team

Figure 7.5.1 Planned Sewered Area

Table 7.5.1 Population in Planned Sewered Area and Other Areas by Department

Unit: 10^3 person

Department	2013		2025		2035	
	Planned Sewered	Other	Planned Sewered	Other	Planned Sewered	Other
Dakar	1,146	0	1,431	0	1,481	0
Pikine	1,171	0	1,443	0	1,521	0
Guédiawaye	330	0	344	0	346	0
Rufisque	413	78	1,209	117	2,233	183
Thiès	26	43	94	68	223	97
Total	**3,086**	**121**	**4,521**	**185**	**5,804**	**280**

Source: JICA Study Team

Table 7.5.2 Population Distribution in 2035 by Sewage Treatment Plants

Unit: 10^3 person

Area	Dakar	Pikine	Guédiawaye	Rufisque	Thiès	Total
Planned Sewered Area	1,481	1,521	346	2,233	223	5,804
Cambérène	672	187	73	0	0	932
Baie de Hann	51	694	0	0	0	745
Corniche Ouest	758	0	0	0	0	758
Est	0	640	237	0	0	877
Niayes	0	0	15	0	0	15
SHS	0	0	21	0	0	21
Rufisque Center	0	0	0	478	0	478
Rufisque North	0	0	0	1,109	0	1,109
Diamniadio	0	0	0	646	2	648
Daga Kholpa	0	0	0	0	221	221
Other Areas	0	0	0	183	97	280
Total	**1,481**	**1,521**	**346**	**2,416**	**320**	**6,084**

Source: JICA Study Team

2) Target for Coverage of Sewerage System in 2035

According to the investment program shown in PDA, the coverage ratio of the sewerage system in the PDA area in 2025 is expected to be 40% in total. Considering affordability in the sector, it is assumed that the same order of investment per annum per capita (4,300 FCFA/person/year from 2013 to 2025) will continue in the PDA area till 2035, which will make the coverage ratio about 66% in total. On the basis of prioritization among the planned sewered areas in the PDA, the coverage ratio in Dakar Department should reach almost 100%, whereas ratios in Pikine and Guédiawaye departments will stay at about 40% on average. It is proposed that these predicted coverage ratios are regarded as the target coverage ratios in the PDA area.

As for Rufisque Department, apart from Diamniadio, the target coverage ratio is set at 37% on average, assuming that the same order of investment per capita in the PDA area would be affordable.

For Diamniadio and Daga Kholpa, it is assumed that private sectors involved in land development should meet the construction costs for sewerage networks in their own development area, so that the necessary investment for the government agencies is limited to the cost for construction of STP and trunk sewerage. Under this assumption, the target coverage ratio is set at 100% in 2035.

The proposed coverage ratio in the planned sewered area is presented in Table 7.5.3.

Table 7.5.3 Proposed Coverage Ratio in Planned Sewered Area

Planned Sewered Area	2013			2025			2035		
	Total Population (10^3 person)	Coverage Ratio	Sewered Population (10^3 person)	Total Population (10^3 person)	Coverage Ratio	Sewered Population (10^3 person)	Total Population (10^3 person)	Coverage Ratio	Sewered Population (10^3 person)
Area covered by PDA	**2,646**	**29%**	**763**	**3,217**	**40%**	**1,282**	**3,348**	**66%**	**2,225**
Cambérène	761	50%	381	907	72%	653	932	100%	932
Baie de Hann	516	10%	52	705	27%	190	745	58%	432
Corniche Ouest	574	55%	316	730	58%	424	758	100%	758
Est	764	0%	0	839	0%	0	877	10%	88
Niayes	13	50%	7	15	47%	7	15	47%	7
SHS	18	45%	8	21	38%	8	21	38%	8
Rufisque	**363**	**5%**	**19**	**952**	**14%**	**137**	**1,587**	**37%**	**589**
Rufisque Center	255	8%	19	402	34%	137	478	100%	478
Rufisque North	108	0%	0	550	0%	0	1,109	10%	111
New Development	76	0%	0	351	40%	141	869	100%	869
Diamniadio	50	0%	0	258	40%	103	648	100%	648
Daga Kholpa	26	0%	0	93	40%	37	221	100%	221
Total	**3,085**	**25%**	**782**	**4,520**	**35%**	**1,560**	**5,804**	**63%**	**3,668**

Source: JICA Study Team

Table 7.5.4 shows the coverage ratio of the sewerage system against the whole population in the Study Area. In 2035 the coverage will reach 61% in total.

Table 7.5.4 Target on Sewered Population and Coverage Ratio

Department	2013			2025			2035		
	Total Population (10^3 person)	Coverage Ratio	Sewered Population (10^3 person)	Total Population (10^3 person)	Coverage Ratio	Sewered Population (10^3 person)	Total Population (10^3 person)	Coverage Ratio	Sewered Population (10^3 person)
Dakar	1,146	51%	588	1,431	63%	906	1,481	99%	1,460
Pikine	1,171	11%	128	1,445	21%	309	1,535	43%	653
Guédiawaye	330	14%	47	344	19%	67	346	32%	112
Rufisque	491	4%	19	1,329	18%	240	2,413	51%	1,235
Thiès Target Area	69	0%	0	157	24%	38	309	72%	223
Total	**3,207**	**24%**	**782**	**4,706**	**33%**	**1,560**	**6,084**	**61%**	**3,683**

Source: JICA Study Team

(3) Septage Management

In terms of the unsewered urban area, wastewater treatment measures shall be carried out by septic tank and septage treatment plant until 2035. The septic tank can reduce pollution load by up to 40% if it is maintained well. In general, septage withdrawal is done once every two to five years. The septage should be withdrawn properly by the maintenance operator and transported to a septage treatment plant. Until the sewerage system has wide coverage in the Study Area, the septage treatment plant will be required to properly treat the collected septage so that effective removal of pollution load is secured by the septic tank.

7.5.3 Demand Forecast

(1) Required STP Capacity

Projection of sewage volume is calculated considering the following factors:

- *Domestic and other water usage*: Domestic, commercial and industrial water usage is calculated by actual and projected water demand in each planned sewered area. Industrial wastewater is allocated to particular sewered areas according to the land use plan.
- *Sewage generation ratio*: Referring to PDA, the sewage generation ratio is set at 85% for Dakar Department and 95% for Pikine and Guédiawaye departments, respectively. Rufisque and Thiès are treated the same as Pikine and Guédiawaye, assuming similar land use and lifestyle.

The required capacity of STP is calculated based on the projected sewage volume, considering the following factors:

- *Groundwater infiltration*: Groundwater infiltration ratio is taken into account, depending on soil type, by referring to PDA. In case of sand, the groundwater infiltration ratio is set at 10% of sewage volume, whereas in the case of clay 0% is adopted.
- *Ratio of daily average, daily maximum*: Ratio of daily maximum against daily average is set at 1.1, referring to PDA. The daily maximum volume is adapted for required capacity of STP.
- *Sewage discharge volume in DISEZ*: The sewerage system in DISEZ is planned for construction by APIX, according to the master plan for DISEZ. It is assumed that the designed sewage discharge volume (1,781,820 m^3/year) from DISEZ does not flow into the Daga Kholpa sewerage system.

The estimated required STP capacity for 100% coverage of sewerage system in the planned sewered area in 2035 is estimated as shown in Table 7.5.5, together with the designed STP capacity estimated

by PDA.

Table 7.5.5 Required STP Capacities for 100% Coverage of Sewerage System in Planned Sewered Area

	Required STP Capacity (m^3/day)			Designed STP Capacity by PDA (m^3/day)
	2013	2025	2035	
Cambérène	56,700	73,700	81,400	56,000
Baie de Hann	53,900	78,100	90,600	38,000
Corniche Ouest	49,100	65,500	70,400	60,500
Est	47,100	60,900	74,300	37,500
Niayes	800	1,100	1,300	875
SHS	1,100	1,500	1,800	595
Rufisque Center	13,600	28,000	38,600	2,856
Rufisque North	5,600	37,300	73,200	-
Diamniadio	6,400	40,000	85,500	-
Daga Kholpa	2,300	8,100	26,600	-
Total	**236,600**	**394,200**	**543,700**	**196,326**

Source: JICA Study Team

The required STP capacity estimated by the JICA Study Team is larger than the designed STP capacity estimated by PDA. This could be because of differences in population and water demand projection. To achieve 100% coverage of the sewerage system, an additional increase in the designed capacity from estimate by PDA would also be required.

The capacities for sewerage treatment required to meet the proposed coverage ratio shown in Table 7.5.3 are shown in Table 7.5.6, together with the capacities implemented in PDA by 2025.

Table 7.5.6 Required Capacities for Sewerage Treatment considering Target on Coverage Ratio

	Required STP Capacity (m^3/day)			STP Capacity achieved by PDA by 2025 (m^3/day)
	2013	2025	2035	
Cambérène	28,350	53,060	81,400	47,360
Baie de Hann	5,390	21,090	52,550	12,930
Corniche Ouest	27,010	37,990	70,400	19,560
Est	0	0	7,430	0
Niayes	400	740	870	875
SHS	490	500	590	595
Rufisque Center	1,030	9,520	38,600	0
Rufisque North	0	0	7,320	0
Diamniadio	0	16,000	85,500	0
Daga Kholpa	0	3,240	26,600	0
Total	**62,670**	**141,960**	**371,260**	**81,320**

Source: JICA Study Team

(2) Required Septage Treatment Capacity

According to the PDA, septage generation per capita is set at 1 ℓ/capita/day. Based on this unit generation volume, septage volume is estimated for the 'unsewered population' who are not covered by the sewerage system in the Study Area in 2035.

On the basis of the previous examples given by ONAS, the required septage treatment capacity is set at 1.1 times the generated septage volume. Table 7.5.7 shows the required septage treatment capacity.

Table 7.5.7 Required Septage Treatment Capacity

Unit: m^3/day

Area	2013	2025	2035	Transport site
Planned Sewered Area	2,580	3,310	2,344	
Cambérène	420	280	0	Cambérène
Baie de Hann	520	570	350	Cambérène or Niayes
Corniche Ouest	290	340	0	Cambérène
Est	850	930	870	New construction
Niayes	10	10	9	Niayes
SHS	20	20	15	Niayes
Rufisque Center	260	300	0	Rufisque
Rufisque North	120	610	1,100	New construction
Diamniadio	60	180	0	New construction
Daga Kholpa	30	70	0	New construction
Other Areas	100	230	340	
Sébikhotane	20	30	40	New construction
Sindia	10	20	20	New construction
Pout	20	40	50	New construction
Coast	10	80	130	New construction
Bambilor	40	60	100	New construction
Total	**2,680**	**3,540**	**2,684**	

Source: JICA Study Team

7.5.4 Development Plan

(1) Promotion of Hygienic Toilet

In order to achieve 100% access to a hygienic toilet by 2035, awareness and promotion programs should be implemented. Among the hygienic toilets, the septic tank is effective for decreasing pollution load in an unsewered urban area if it is properly operated.

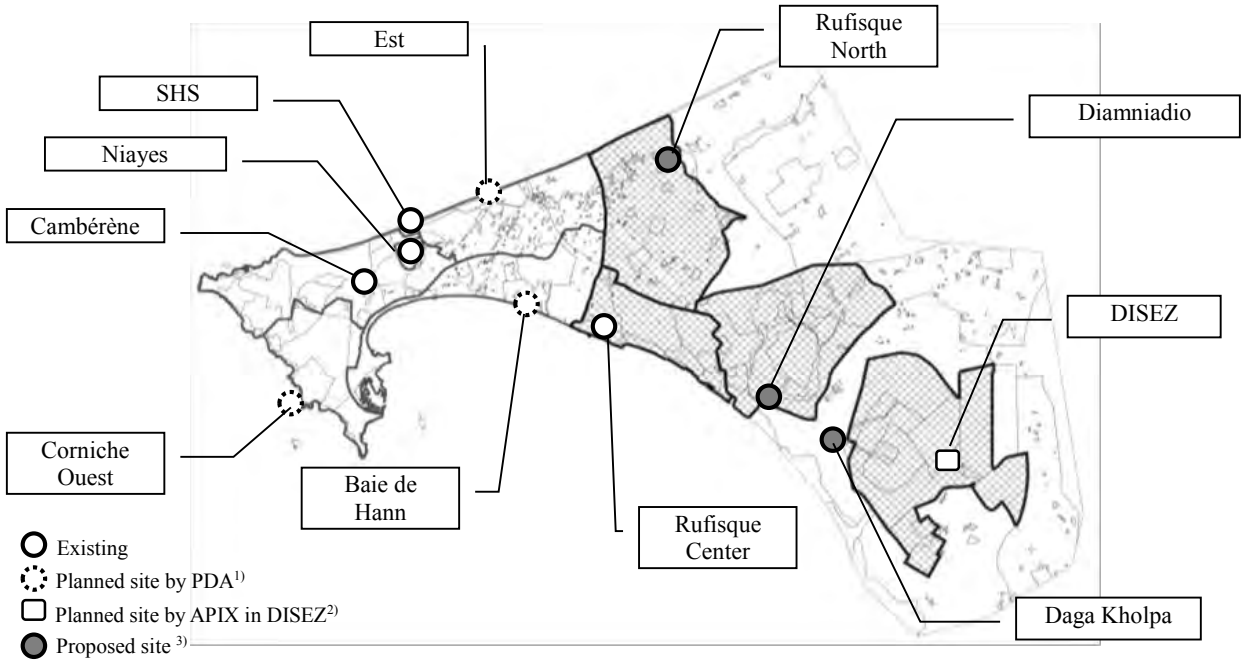
(2) Expansion of Sewerage System

1) Required STP Capacity

The required STP capacity is presented in Table 7.5.6 in Section 7.5.3.

2) Location of STP

Locations of STP for the planned sewered areas that PDA does not cover are proposed as shown in Figure 7.5.2. The location of STP is selected considering future land use, topographic conditions and required land area.



Source: 1) PDA, 2) APIX, and 3) JICA Study Team

Figure 7.5.2 Existing, Planned and Proposed Location of STP

3) Wastewater Treatment Process

An appropriate wastewater treatment process for the planned sewered areas not covered by PDA, such as Rufisque North, Diamniadio and Daga Kholpa, should be selected by taking into account required land area, construction cost, operation and maintenance cost and track record. So far in Senegal, three treatment processes have been adopted, as follows: (i) activated sludge process (four sites); (ii) lagoon (five sites); and (iii) aerated lagoon (one site). According to PDA, the activated sludge process is adopted for the new sewerage system of Baie de Hann and Est, because of the need to achieve basic water quality (COD_{Cr}, BOD_5 and SS) standards, aside from nutrition factors such as nitrogen and phosphorus.

The activated sludge process has the advantage of being able to treat a large volume of wastewater in a relatively small space. However, it requires large electric consumption. On the other hand, the lagoon process requires a large land area, but is able to treat waste with lower maintenance costs compared with the activated sludge process. These are considerable factors from the standpoint of sustainable sewerage management.

As shown in Table 7.5.8, an attempt is made to estimate the required land area for the activated sludge process and lagoon for Rufisque North, Diamniadio and Daga Kholpa. The activated sludge process is adopted in each sewerage system in the present study, since the lagoon process needs more than six times as much space as the activated sludge process.

Table 7.5.8 Required Land Areas in New Sewerage System

Item		Rufisque North	Diamniadio	Daga Kholpa
Required STP Capacity (1,000 m^3/day)		70	82	26
Required Land Area (ha)	ASP	10.5	12.3	3.9
	Lagoon	70	82	26

Source: JICA Study Team. ASP: Activated Sludge Process

(3) Septage Management

1) Required Septage Treatment Capacity

The required septage treatment capacity is presented in Table 7.5.7 in Section 7.5.3.

2) Location of Septage Treatment Facility

In terms of the cost, operation and maintenance of the septage treatment facility, shared use of the facility among neighboring cities needs to be considered depending on the distance, scale of facility and economic advantages. The proposed locations of the septage treatment facilities are shown in Table 7.5.7 in Section 7.5.3.

(4) Future Prospects for Reuse of Sewage and Sludge

Sludge can be utilized as a resource through appropriate treatment. It is recommended to promote the reuse of treated water and sewage, for example, the reuse of treated sewage for compost in agricultural activities. It is recommended to further expand the reuse of treated sewage.

Reuse of treated water

Water consumption will be increased, especially in new development areas. So far in Senegal, it is the case that the reuse of treated sewage has only been applied in agricultural activities. Reclaimed water can be used not only for agriculture but also for toilet, sprinkler and landscaping uses. Water use for these purposes does not require the same quality as drinking water. Reuse of treated sewage in such ways is an efficient measure against increased water demand in a new development area.

Reuse of sludge for construction work as cement ingredient

Inorganic matter in sewage sludge comprises silica, aluminum, calcium, iron, etc. and the clay which is used as a cement ingredient comprises the same elements. Thus, after generated sludge is dehydrated and incinerated, the incinerator ash can be used as a cement ingredient.

Sludge utilization for energy sources

In the process of the digestion of thickened sludge, methane gas is generated, which can be used as an energy source for electric power generation or warming of the digestion tank. Dried sludge or carbonized sludge can be used as a fuel and the exhaust heat from the incinerator or melting furnace can be effectively reused as an energy source for area-wide air conditioning or electric power generation.

(5) Development Scenario

The development scenario toward 2035 is summarized as shown in Table 7.5.9.

Table 7.5.9 Development Scenario toward 2035

Area	Short-Medium Term (2015-2025)	Medium-Long Term (2026-2035)
Planned Sewered Area		
Area covered by PDA	· Three sewerage systems (Cambérène, Baie de Hann, and Corniche Ouest) implemented as planned by PDA. · Septage treatment facility prepared at the initial development phase in Est sewerage system.	· 100% coverage of sewerage system in Cambérène and Corniche Ouest areas. · 58% coverage of sewerage system in Baie de Hann area. · 10% coverage of sewerage system in Est area. · Appropriate measures taken at other sewerage systems (Niayes and SHS).
Rufisque Area (except Diamniadio)	· Sewerage master plan formulated. · Septage treatment facility expanded in Rufisque Central sewerage system. · Septage treatment facility prepared at the initial development phase in Rufisque North sewerage system.	· 41% coverage of sewerage system in total.
Diamniadio and Daga Kholpa	· Sewerage master plan formulated. · A part of the sewerage system is constructed. · Septage treatment facility prepared at the initial development phase in Diamniadio and Daga Kholpa.	· 100% coverage of sewerage system.
Unsewered Area by 2035	· Awareness and promotion campaign for usage of septic tank carried out.	· 100% coverage of septic tank in unsewered urban area by 2035. · Septage treatment managed properly.
Entire Area	· Implementation plan for sewage resources (sewage and sludge) formulated.	· Sewage resources utilized actively.
Other Areas		
Sébikhotane, Sindia, Pout, Coast and Bambilor	· Awareness and promotion campaign for usage of septic tank carried out.	· 100% coverage of septic tank in unsewered urban area by 2035. · Septage treatment managed properly.
Entire Area	· Awareness and promotion campaign for usage of hygienic toilet carried out. · Hygienic toilet disseminated, especially in locations surrounding the urban area.	· 100% coverage of hygienic toilet.

Source: JICA Study Team

(6) Projects and Programs

In accordance with the development scenario shown in Table 7.5.9, ongoing projects as well as the planned projects and projects/programs proposed by the JICA Study Team are identified as listed in Table 7.5.10.

Table 7.5.10 Ongoing, Planned and Proposed Projects/Programs

Area	Project/Program	Status	Target			Remarks
			2020	2025	2035	
Planned Sewered Area						
Area covered by PDA						
Cambérène	Rehabilitation and expansion of STP and sewer network	Ongoing				Completion of priority components of PDA
		Planned				Completion of remaining components of PDA
		Proposed				Completion of additional works
Baie de Hann	New construction of STP and sewer network	Ongoing				Completion of priority components of PDA
		Planned				Completion of remaining components of PDA
		Proposed				Partial completion of additional works
Corniche Ouest	New construction of STP and rehabilitation and expansion of sewer network	Ongoing				Completion of priority components of PDA
		Planned				Completion of remaining components of PDA
		Proposed				Completion of additional works
Est	New construction of septage treatment plant	Proposed				
	New construction of STP and sewer network	Planned				Partial completion of all components of PDA
Niayes and SHS	Expansion of STP and sewer network	Proposed				Partial completion of additional works
Rufisque Area						
Rufisque Center	Formulation of sewerage master plan	Proposed				
	Expansion of septage treatment plant					
	Expansion of STP and sewer network					Near completion of proposed project
Rufisque North	Formulation of sewerage master plan	Proposed				
	New construction of septage treatment plant					
	New construction of STP and sewer network					Partial completion of proposed project
New Development Area						
Diamniadio	Formulation of master plan	Proposed				
	New construction of septage treatment plant					
	New construction of STP and sewer network					Completion of proposed project
Daga Kholpa	Formulation of master plan	Proposed				
	New construction of septage treatment plant					
	New construction of STP and sewer network					Completion of proposed project
Unsewered Urban Area by 2035						
Entire Area	Awareness program for promotion of septic tank	Proposed				
Other Areas						
Sébikhotane, Sindia, Pout, Coast and Bambilor	Awareness program for promotion of septic tank	Proposed				
	New construction of septage treatment plant					
Entire Area	Awareness program for promotion of hygienic toilet	Proposed				

Note: "Proposed" = proposed by JICA Study Team
Source: JICA Study Team

(7) Effect on Reduction of Pollution Load

The effect of the proposed projects and programs on the reduction of pollution load is compared for the cases with and without sewerage system.

The following five cases are evaluated for comparison:

Case-0 (2013): Existing condition of sewerage in 2013

Case-1 (2035): The population to be served by the sewerage system remains the same as in 2013 and other population will be served by septic tanks without proper maintenance or other toilets.

Case-2 (2035): The population to be served by the sewerage system remains the same as in 2013 and other population will be served by septic tanks with proper maintenance.

Case-3 (2035): Only PDA priority projects will be completed and other population will be served by septic tanks with proper maintenance.

Case-4 (2035): The proposed projects shown in section (6) are completed.

Typical BOD_5 generation per capita of 40-45 g/capita/day is applied in developing countries located in the tropical region, according to WHO. Based on this figure, 45 g/capita/day in Dakar and 40 g/capita/day in other areas are applied, respectively, considering urbanization in the Study Area.

A reduction rate of BOD_5 load is assumed, as shown in Table 7.5.11.

Table 7.5.11 Condition of Estimation of BOD_5 Generation and its Reduction Rate

Area			Dakar	Pikine, Guédiawaye Rufisque, Thies
BOD_5 generation per capita (g/capita/day)			45	40
Reduction Rate (%)	Sewerage system		90	
	Septic Tank	2013 without proper maintenance	10	
		2035 without proper maintenance	10	
		2035 with proper maintenance	40	
	Other toilets		10	

Source: JICA Study Team

The results of the BOD_5 load thus estimated are shown in Table 7.5.12.

The BOD_5 load at 2035 will be almost triple compared with that in 2013, if no project is implemented (Case-1). Although the population and generated pollution load in the Study Area will be significantly increased toward 2035, the total BOD_5 load in 2035 can be maintained at the current level, if all the proposed projects are completed (Case-4). In some areas, a drastic reduction in BOD_5 load will also be achieved.

Table 7.5.12 Estimated BOD_5 Load

Unit: t/day

Area	Case-0 (2013)	Case-1 (2035)	Case-2 (2035)	Case-3 (2035)	Case-4 (2035)
Planned Sewered Area	**72.59**	**193.47**	**128.03**	**115.28**	**66.06**
Cambérène	13.82	24.15	17.48	10.15	4.06
Baie de Hann	13.07	25.87	17.41	14.35	9.41
Corniche Ouest	11.90	17.88	13.34	10.94	3.41
Est	22.07	34.93	21.22	21.22	19.45
Niayes	0.34	0.23	0.18	0.23	0.23
SHS	0.60	0.32	0.26	0.34	0.34
Rufisque Center	6.73	20.13	13.48	13.39	2.64
Rufisque North	2.51	39.38	25.33	25.33	23.22
Diamniadio	1.31	22.20	14.69	14.69	2.45
Daga Kholpa	0.24	8.38	4.64	4.64	0.85
Other Areas	**2.61**	**6.71**	**6.71**	**6.71**	**8.42**
Sébikhotane	0.54	0.68	0.68	0.68	2.30
Sindia	0.07	0.34	0.34	0.34	0.33
Pout	0.57	1.07	1.07	1.07	1.00
Coast	0.31	2.66	2.66	2.66	2.82
Bambilor	1.13	1.97	1.97	1.97	1.97
Total	**75.20**	**200.18**	**134.74**	**121.99**	**74.48**
Rate of Increase (2013 Base)	**-**	**2.7**	**1.8**	**1.7**	**0.9**

Source: JICA Study Team

7.5.5 Cost Estimate

The order of magnitude of required investment is estimated at around 502 billion FCFA, as shown in Table 7.5.13.

Table 7.5.13 Order of Magnitude of Required Investment for 2035

Unit: billion FCFA

Area	Type	Sewer Network	STP	Septage Treatment plant	Total
Planned Sewered Area		249	239	12	500
PDA area	PDA priority[1)]	90	61	0	151
	PDA remaining[1)]	49	19	0	68
	Proposed additional[2)]	27	47	4	78
Rufisque except Diamniadio	Proposed[2)]	68	23	7	98
Diamniadio and Daga Kholpa	Proposed[2)]	15*	89	1	105
Other Areas	Proposed[2)]	-	-	2	2
Total		249	239	14	502

Note: * Only the cost for about 100 km of trunk sewer and interceptor is taken into account, without the branch sewer.
Source: 1) PDA, 2) JICA Study Team, on the basis of PDA

7.6 Solid Waste Management

7.6.1 Objectives and Development Strategies

(1) Objectives

The objectives of the solid waste management sector are as follows:

- To create an environmentally sound living condition for the people, free from unsanitary condition caused by littering, inadequate collection of garbage and open dumping at the landfill site
- To enhance the sustainability of solid waste management by promoting the 3Rs (Reduce, Reuse, Recycle) and introduce a proper waste intermediate treatment system

(2) Development Strategies

The solid waste management strategies proposed are as follows:

1) Waste Discharge: Promotion of Waste Reduction and Separation at Source

As the waste generation amount increases, the importance of waste reduction and separation at source should be given more priority, based on the concept of the 3Rs.

2) Waste Collection and Transportation: Increase in Collection Coverage

The collection coverage is expected to be improved, especially in the rural areas; the current collection rate (50-70%) should be increased to at least the level of 75%.

3) Intermediate Treatment: Introduction of Proper Waste Intermediate Treatment System

A waste intermediate treatment system should be introduced in order to promote waste reduction and stabilization. Composting of market organic waste and recycling of valuable metals and PET bottles

should be taken into consideration.

4) Waste Disposal: Safe Closure of Mbeubeuss Landfill and Opening of Sanitary Landfill

It is necessary to urgently close the Mbeubeuss landfill, which has caused environmental and social impacts on the surrounding areas. At the same time, a new sanitary landfill should be identified and opened to secure enough landfilling capacity. It is desirable that the Sindia landfill be reopened as soon as possible. For this, the conflict with surrounding residents, which caused its closure immediately after the opening, should be resolved through active and close consultations with them.

5) Emphasis on Public Involvement and Consultations

The public involvement and consultations should be paid more attention to, in terms of the whole process of waste management: promoting waste separation at source and reopening the Sindia landfill, etc.

6) Strengthening of Institutions and Legislations

The institutions to deal with waste management should be firmly established with a long-term strategic approach, including securing financial and human resources. In order to achieve sustainable waste management, the necessary legislation should also be reviewed, such as the regulations on environmental standards and illegal dumping.

7.6.2 Establishment of Development Target

(1) Target Waste

The target waste of the solid waste management plan is the waste from households, markets and street sweeping, which are described as “municipal waste”. “Domestic waste” means the waste discharged from households and individual business establishments (shops, hotels, offices, etc.). “Market waste” means the waste originating from groups of shops (markets). “Street sweeping waste” means the waste collected by road sweeping.

Industrial waste (from industries and construction sites) and hazardous waste (from industries and healthcare facilities) are dealt with separately to address the points to be taken into consideration in the future waste management.

(2) Target Areas and Responsible Agencies

The target areas for the Study are: 1) Dakar, Guédiawaye, Pikine and Rufisque departments; and 2) part of Thiès and Mbour Department. The former is covered by CADAK-CAR, while the latter is coordinated by the local municipalities and the Coordination Unit for Solid Waste Management of the PNGD, under the Ministry of Territory Planning and Local Government.

(3) Target Rates Related to Solid Waste Management

The development targets for solid waste management plans in the Study Area are described in Table 7.6.1. Target collection rate was determined in consideration of the current waste collection rate and the national targets set by PNGD.

Table 7.6.1 Target Collection Rate in the Study Area

Item (Unit)	2015	2025	2035
Collection rate (%)	67	76	88

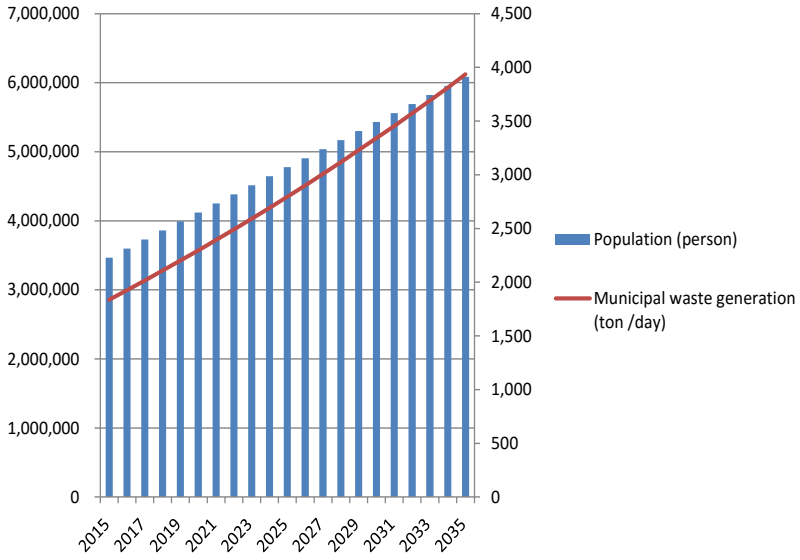
Source: *Incoming Waste at Mbeubeuss Landfill*, CADAK-CAR, 2014; JICA Study Team

7.6.3 Demand Forecast

(1) Amount of Waste Generation

The amount of domestic waste generation is estimated as shown in Figure 7.6.1 and Tables 7.6.2 and 7.6.3. The most direct impact on waste generation is the change in population. To estimate the future waste amount, the following are employed for calculation of the future waste generation amount:

- The current unit generation rate is 0.53 kg/day/person according to the survey conducted by PNGD in 2015. One percent is assumed as the annual increase growth rate of waste generation per capita for the solid waste management sector. Hence, the rate will increase to 0.59 kg/day/person in 2025 and 0.65 kg/day/person in 2035.
- As the population grows, more waste will be generated in the Study Area: the estimated amount in 2035 is 3,935 ton/day, which is more than double that in 2015.
- Currently, most of the municipal waste in the Study Area is generated in Dakar Department.
- As urban development proceeds, the population growth is relatively high in Daga Kholpa in Thiès Region, which accelerates the growth in total waste generation.
- In 2035, more domestic waste will be generated in Rufisque Department, where Diamniadio is planned for development with high population growth rate.



Source: JICA Study Team

Figure 7.6.1 Population Growth and Domestic Waste Generation in the Study Area

Table 7.6.2 Future Forecast of Waste Generation Amount in the Study Area

Item (Unit)	2015	2025	2035
Population (person)	3,467,634	4,775,824	6,084,000
Unit waste generation rate (kg/day/person)	0.53	0.59	0.65
Waste generation amount (ton/day)	1,837	2,796	3,935

Sources: *Incoming Waste at Mbeubeuss Landfill*, CADAK-CAR, 2014; JICA Study Team

Table 7.6.3 Future Forecast of Waste Generation Amount by Department

Item (Unit)	2015	2025	2035
1. Dakar			
Population (person)	1,152,536	1,184,936	1,217,339
Waste generation amount (ton/day)	611	694	787
2. Guédiawaye			
Population (person)	330,836	336,726	342,609
Waste generation amount (ton/day)	175	197	222
3. Pikine			
Population (person)	1,201,213	1,353,333	1,505,451
Waste generation amount (ton/day)	637	792	974
4. Rufisque			
Population (person)	670,207	1,567,777	2,465,352
Waste generation amount (ton/day)	355	918	1,594
5. Thiès			
Population (person)	85,610	289,160	492,706
Waste generation amount (ton/day)	45	169	319
6. Mbour			
Population (person)	27,232	43,892	60,543
Waste generation amount (ton/day)	14	26	39

Sources: *Incoming Waste at Mbeubeuss Landfill*, CADAK-CAR, 2014; JICA Study Team

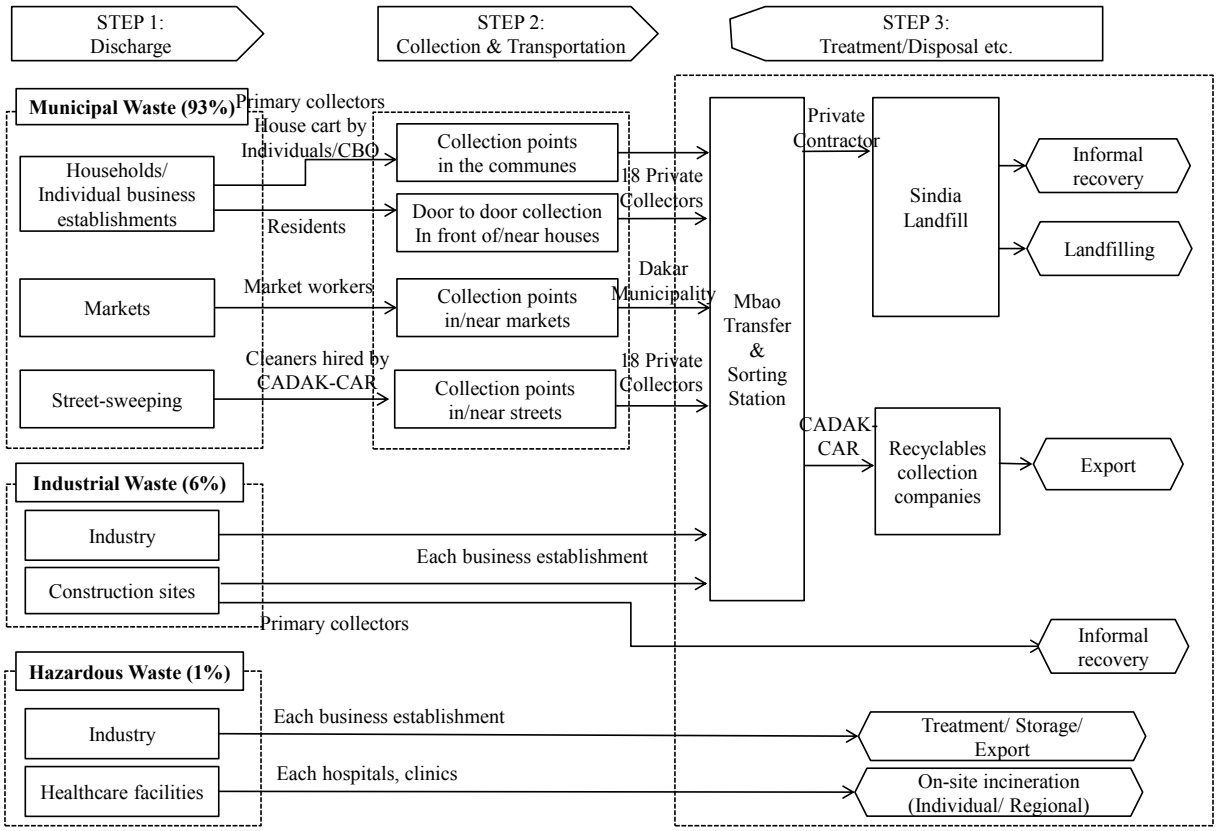
7.6.4 Development Plan

(1) Waste Flow

The waste flow in the Study Area in 2025 and 2035 is shown in Figure 7.6.2.

Municipal waste including waste from households, markets and street sweeping is collected and transported to Mbao transfer/sorting station, in which waste pickers hired by CADAK-CAR will work on waste segregation for intermediate treatment. The segregated waste will be transported to Sindia landfill by an outsourced private company.

As of 2015, Mbeubeuss landfill is the only existing dumping site in Dakar Region, while there are two open dumping sites in Thiès and Mbour departments. These sites are planned for closure, once new sanitary landfills are opened in Sindia *commune* and Tivaouane *commune*; the former will accept waste from Dakar Region and Mbour Department, while the latter receives waste from Thiès Department.



Source: JICA Study Team

Figure 7.6.2 Waste Flow in the Study Area in 2025 and 2035

(2) Development Plan of Future Solid Waste Management System

The development plan for solid waste management, aiming to achieve sustainable waste management, is described below.

1) Waste Discharge: Promotion of Waste Reduction and Separation at Source

Waste reduction and separation at source should be introduced in consideration of the following points:

(a) According to the survey conducted by JICA Study Team (2015), 23% of household waste is fine materials such as sand and soil. It is important to encourage the residents not to discharge the fine materials as waste.
(b) Source separation of recyclable waste such as metals and PET bottles will be essential, so that the recycling system can be more easily managed in the future.
(c) In order to introduce a market composting system, market waste should be separated into organic waste and other at each market, then only organic waste utilized for composting.

2) Waste Collection and Transportation: Increase in Collection Coverage

It is necessary to increase the collection rate to at least the level of 75%, by the following methods:

(a) The collection efficiency should be improved. As planned in the National Program on Waste Management, the introduction of collection points at district level is one of the options that helps to save waste collection time.

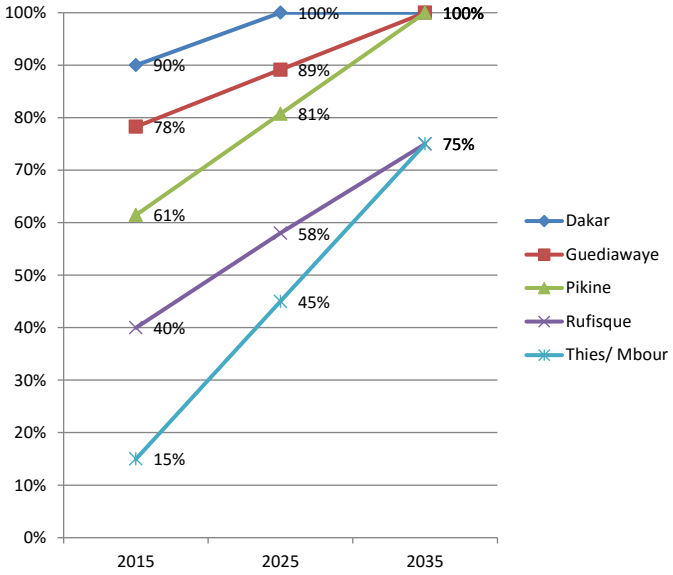
(b) The expansion of the collection service should be considered, especially in the rural areas such as Thiès and Mbour Department, where the collection rate is relatively low. The PNGD is expected to introduce an initiative to support the local municipalities.

The rates of waste collection in the Study Area are shown in Tables 7.6.4 and Figure 7.6.3.

Table 7.6.4 Future Forecast of Collection Rate by Department

Item (Unit)	2015		2025		2035	
	Rate (%)	Amount (ton/day)	Rate (%)	Amount (ton/day)	Rate (%)	Amount (ton/day)
1. Dakar	90	550	100	694	100	787
2. Guédiawaye	78	137	89	176	100	222
3. Pikine	62	391	81	639	100	974
4. Rufisque	40	142	58	528	75	1,196
5. Thiès	15	7	45	76	75	239
6. Mbour	15	2	45	12	75	29
Total (Average in the Study Area)	**67**	**1,229**	**76**	**2,124**	**88**	**3,447**

Sources: *Incoming Waste at Mbeubeuss Landfill*, CADAK-CAR, 2014; JICA Study Team



Source: JICA Study Team

Figure 7.6.3 Waste Collection Rate by Department

3) Intermediate Treatment: Introduction of Proper Waste Intermediate Treatment System

Currently there is no formal intermediate waste treatment system, even though some informal sectors, including waste pickers, collect recyclables on the streets and at the Mbeubeuss landfill. Once the operation of the Sindia landfill and the Mbao transfer/sorting center are launched, a proper waste treatment system should be introduced, as analyzed.

The following methods should be taken into account:

(a) Recycling of valuable metals and PET bottles should be formally organized. Waste brought to Mbao transfer/sorting center will be segregated by waste pickers hired by CADAK-CAR. Before formalizing the recycling system, a consultation with existing informal sectors should be effectively held by CADAK-CAR and related agencies. According to the survey conducted by JICA Study Team (2015), 3% and 2% of household waste are metals and PET bottles respectively, which can potentially be recycled.

(b) Composting of market waste should be promoted. The survey by JICA Study Team (2015) shows that 25% of market waste is organic waste. It is also important to establish a market channel through which farmers are able to acquire the produced composts and use them for farming.
(c) An incineration system should be examined as one of the options in the future. Electricity produced by the Waste to Energy system is beneficial to waste management operators, even though there are still some challenges to be solved, such as financial and technical issues.

4) Waste Disposal: Safe Closure of Mbeubeuss Landfill and Opening of Sanitary Landfill

In terms of waste disposal, the following points should be tackled:

(a) The open dumping site, Mbeubeuss landfill, should be urgently closed in a safe and sanitary manner. The land use and continuous monitoring of the post-Mbeubeuss landfills is a crucial issue to be considered.
(b) The open dumping methods should be transited into sanitary landfill methods. It is desirable that the existing sanitary landfill at Sindia be reopened as soon as possible. However, it is necessary to resolve the conflict with the local residents.
(c) A new sanitary landfill should be identified and opened, in case the Sindia landfill cannot be operated due to the opposition of residents.

5) Emphasis on Public Involvement and Consultations

Since lack of communication with local residents is one of the fundamental problems, social acceptability should be given more attention; a more careful consultation with the neighboring residents should be taken into consideration. The public involvement and consultations should be emphasized from the following viewpoints:

(a) Public awareness should be promoted for waste reduction and separation at households toward the residents and at markets toward market venders.
(b) Public consultations should be organized in order to reopen the Sindia landfill and to construct other waste-related facilities, which include provision of sufficient information about the sanitary landfill and securing transparency in operation.

6) Strengthening of Institutions and Legislations

(a) The responsible agencies of waste management should be firmly established with a long-term strategic approach, including securing financial and human resources.
(b) The necessary legislation should also be reviewed, such as the observance of environmental standards and the regulations on illegal dumping.

(3) Other Issues

Apart from domestic waste, the increase in other types of waste such as industrial waste and imported electronic waste is anticipated, due to the expansion of industrial areas, etc. For industrial waste, there are some important points to be considered:

(a) Preparation and enforcement of legislation to clarify dischargers' responsibilities in treating and disposing of waste properly;
(b) Demarcation of roles and responsibilities in controlling industrial waste among central and local governments; and

(c) Identification of proper industrial waste management options, including collection, tipping fee and discharge.

Special attention should be paid to the management of infectious waste originating from hospitals and clinics. There is an urgent need to establish a medical waste management system. Intensive segregation of hazardous waste from ordinary waste at source is essential. In addition, in-house treatment of medical waste should be encouraged, especially for large hospitals. Hazardous waste from medium and small hospitals, which are incapable of owning an on-site treatment system, is to be stored and collected appropriately in hospitals and should then be treated by establishing a regional treatment system.

In line with the plans mentioned above, ongoing, planned and proposed projects/programs of a solid waste management plan in the Study Area toward 2035 are identified as listed in Table 7.6.5.

Table 7.6.5 Ongoing, Planned and Proposed Projects/Programs of Solid Waste Management Plan

Level	Project/Program	Goal	Status*	Target Year
Discharge	Promotion of proper waste discharge and waste segregation at source	Public awareness activities strengthened so that the concept of 3Rs (Reduce, Reuse, Recycle) is disseminated.	Planned	2025
		Public awareness is fully raised; social acceptability of solid waste management activities is enhanced.	Proposed	2035
Collection & Transportation	Improvement of waste collection system	Waste collection rate in Table 7.6.4 is achieved.	Proposed	2025/ 2035
	Promotion of waste segregation at Mbao transfer/sorting station	Mbao transfer/sorting center is constructed and operated properly.	Planned	N/A
Intermediate treatment	Introduction of intermediate treatment system**	Intermediate treatment facilities are constructed and operated.	Proposed	2025
		Intermediate treatment facilities are operated sustainably.	Proposed	2035
Treatment & Disposal	Construction and operation of sanitary landfills (Sindia, Tivaouane)	Sanitary landfills are constructed and operated at Sindia/Tivaouane.	Planned	2020
Others	Preparation and enforcement of related legislation and plans (including the countermeasures of illegal dumping)	Related legislation and plans are reviewed, approved, enforced and monitored.	Proposed	2025

Note: * "Planned" = planned by Senegalese government, "Proposed" = proposed by JICA Study Team.
** The introduction of intermediate treatment system was analyzed in detail in Chapter 14.
Source: JICA Study Team

7.6.5 Cost Estimate

The draft cost estimation for the solid waste management plan in the Study Area is shown in Table 7.6.6.

Each municipality collects a waste collection tax (TCO) from residents and property owners, which is the main source of funding for waste management for local municipalities. In the Act relating to TCO, the maximum rate of tax is set at 3.6% for Dakar Region and 3% for other cities in Senegal on the basis of land tax. CADAK-CAR does not collect the fee directly from residents, but receives funding

from the central government, which amounted to approximately 10 billion FCFA in 2014.

Thus, the waste operation and maintenance costs shown in Table 7.6.7 should be mostly covered by the central government and only partially covered by the local municipalities.

Table 7.6.6 Draft Cost Estimation of Solid Waste Management Plan in the Study Area

Level		Description	Unit	2015	2025	2035
Collection & Transportation	Waste collection service	Operation & maintenance cost	1,000 FCFA/ year	9,954,900	17,204,400	27,920,700 (*1)
	Mbao sorting/ transfer station	Construction cost	1,000 FCFA	1,700,000	-	-
		Operation & maintenance cost	1,000 FCFA/ year	-	50,000	50,000
Treatment & Disposal	Incineration plants	Construction cost	1,000 FCFA	-	90,000,000 - 150,000,000	-
		Operation & maintenance cost	1,000 FCFA/ year	-	4,960,000- 6,760,000	4,960,000- 6,760,000
	Recycling facility	Construction cost	1,000 FCFA	-	1,500,000	-
		Operation & maintenance cost	1,000 FCFA/ year	-	50,000	50,000
	Composting plant	Construction cost	1,000 FCFA		1,500,000	-
		Operation & maintenance cost	1,000 FCFA/ year		50,000	50,000
	Sindia sanitary landfill	Construction cost	1,000 FCFA	7,300,000	-	-
		Operation & maintenance cost	1,000 FCFA/ year	-	1,440,000	1,440,000
	Tivaouane sanitary landfill	Construction cost	1,000 FCFA	-	6,000,000	
		Operation & maintenance cost	1,000 FCFA/ year	-	1,440,000	1,440,000

Note: (*1) This amount excludes the labor cost. See Table 7.6.7.
Source: JICA Study Team

Table 7.6.7 Operation and Maintenance Cost for Waste Collection in the Study Area

Year	Daily waste collection amount (ton/day)	Annual waste collection amount (ton/year)	Annual operation and maintenance cost (except labor cost) (FCFA/year)
2015	1,229	368,700	9,954,900,000
2025	2,124	637,200	17,204,400,000
2035	3,447	1,034,100	27,920,700,000

Note: 1) Based on the incoming vehicle records provided by CADAK-CAR, the operation and maintenance cost for waste collection is calculated as approximately 27,000 FCFA/ton, excluding labor cost.
2) The current rates of payment for collection concessionaires are:
1. Rate for compactors depends on the collection areas: Dakar, Rufisque: 9,240 FCFA/ton, Guédiawaye: 8,580 FCFA/ton, Pikine: 7,520 FCFA/ton.
2. Rate for open trucks is calculated based on the collected waste amount: more than 3.5 ton: 70,000 FCFA/truck; less than 3.5 ton: 12,000 FCFA/truck.
Source: JICA Study Team

7.7 Electricity and Renewable Energy

7.7.1 Objectives and Development Strategies

(1) Objectives

The objective of electricity and renewable energy supply is to ensure access to reliable and stable electricity supply for the entire population of the Study Area. Electricity supply sources include both those in the Study Area and those outside the Study Area, including neighboring countries.

(2) Development Strategies

In response to issues in the electricity and renewable energy sector, the development strategies of conventional and sustainable types are examined as shown in Table 7.7.1. The conventional strategies are effective in the short term as an emerging response. The sustainable strategies are intended to be long term and these will need considerable investment for implementation. Thus, the sustainable strategies should be examined in feasibility studies and carried out in tandem with the conventional approach for each agenda.

Table 7.7.1 Development Plans and Strategies for the Electricity and Renewable Energy Sector (Nationwide and Study Area)

Issues	Conventional strategies	Sustainable strategies
Enlargement of electricity supply capacity and improvement of supply reliability	• Expansion of small-scale diesel power facilities (possibly in local towns) • Enlargement of electricity import • Renewal of aged power facilities • Expansion of nationwide trunk transmission lines	• Promotion of construction of medium-scale coal-fired and/or gas-fired thermal power plants (reduction of the percentage of diesel generation) • Formulation of "Energy Mix" and its implementation
Reduction of high electricity prices	• Government-mandated setting of low electricity price • Manpower enlargement to improve the rate of electricity fare collection	• Shift to low-cost power resources (coal-fired plants, hydropower plants, etc.) • Reformulation of electricity pricing system to control electricity consumption • Modernization of electricity fare check and fare collection system (introducing smart techniques)
Enlargement of electricity distribution capacity in built-up areas in Dakar city	• Expansion of distribution lines • Renovation and upgrading of distribution lines, facilities and equipment • Preventative monitoring and control of illegal electricity use	• Redesign of power transmission/ distribution routes in downtown areas • Introduction of "public utility conduit" system conforming to the city's redevelopment plan
Infrastructure development in new development areas	• Dendritic expansion of transmission/distribution lines to new development areas • Sequential installation of new substations in new development areas	• Early introduction of loop distribution system for improving electricity supply reliability • Introducing modernized regional power dispatching system for the efficient operation of power plants and the rationalization of dispatching procedures • Introducing WAN system (by smart technologies) for monitoring/ controlling electricity demand/supply between SENELEC and large power consumers and public facilities
Improvement of the organization reform of SENELEC, which has had chronic deficits	• Privatization of the generation sector of SENELEC • Modernization (digitalization) of business processing system	• Leading participation to develop low-cost power plants • Promotion of electricity generation PPP projects
Enlargement of renewable energy use (suppression of greenhouse gas emission)	• Introduction of incentive policy to promote renewable energy use (FIT, etc.) • Nationwide promotion of PV generation • Pioneering introduction of PV to public facilities	• Promotion of development of domestic hydropower potential • Promotion of "waste-to-energy" in the form of biomass energy use

Source: JICA Study Team

7.7.2 Establishment of Development Targets

To implement the sustainable plans and strategies previously examined, major development targets in the electricity and renewable energy sectors are proposed in Table 7.7.2 for each targeted year.

Table 7.7.2 Sustainable Development Target (Plan) of Electricity and Renewable Energy Sector (Nationwide and Study Area) (*1)

Item \ Year	2013	2025	2035
(a) Electricity supply reserve ratio (%) (*1)	small	10	10
(b) Nationwide electrification ratio (%)	54	75	90
(c) Electrification ratio in the Study Area (%)	90	95	99
(d) National average electricity prices (FCFA/kWh) (*1)	(118.1)	84	75
(e) Ratio of diesel generation (%) (*1) (capacity (MW) base)	90	20	5
(f) Renewable energy-based electricity ratio-capacity base (%)	small	15	15(*2)

Note: (*1) These values are for electricity under the condition that all facilities are connected to the SENELEC grid systems.

(*2) The ratio of 15% as of 2035 was selected to be the same as that of year 2025, because the national target for 2035 has not been formulated at present.

Source: JICA Study Team

The target values of net electricity supply capacity (MW) are the same as the future forecast of annual maximum electricity demand (MW) (or consumption), which are examined in the next section. The electricity supply reserve ratio (%) is the guide for providing back-up supply capacity to prevent problems in case of accidents as a proportion of the generation and/or transmission/distribution systems. Usually, a reserve supply ratio of 10% is considered to be appropriate on an empirical basis. A larger reserve ratio will increase the amount of unused power facilities and would cause higher electricity prices as a result.

The national average electrification ratio was set at the level that has been used as the target for the long term in developing countries. With coverage of 90% at the national level, the urban electrification ratio is assumed to be nearly 100%.

The ratio of diesel generation, as of 2013, was as high as approximately 90%, although diesel generation entails high operation costs. New power plants in the future may not be costly diesel power plants, at least in the Study Area. The existing diesel power plants or facilities will be old and will be discontinued one by one. The targeted conditions assume that the existing diesel facilities will be reduced to 50% as of 2025 and 25% as of 2035. The assumption is that all existing diesel facilities in the Study Area will be discontinued completely as of 2035, but some diesel facilities in local cities will still be operated.

Future electricity supply will be conducted mainly by low-cost coal-fired and gas-fired thermal power plants. Thus, the future electricity price system will be examined based on the generation cost by each generation method. Section 3.6.7 in the Progress Report shows the survey results for generation costs by method, as follows:

- Cost of diesel generation: 200 FCFA/kWh
- Cost of coal-fired generation: 35 FCFA/kWh
- Cost of gas-fired generation: 74 FCFA/kWh

Based on the assumption that the coal-fired and gas-fired plants will play the main roles in electricity generation in Senegal in future, on a 50:50 split, the average generation cost is calculated to be 55 FCFA/kWh. However, the future ratio for each generation method will be controlled according to the "Energy Mix" policy to be formulated by the government. The rate of electricity supply capacity of diesel facilities will be reduced to 5% and the total average generation cost is calculated to be 62.3 FCFA/kWh. Considering the business profit of 20% at SENELEC for selling electricity, the electricity

price is estimated to be 74.8 FCFA/kWh (for the sake of simplicity, electricity costs of imported electricity and electricity generated by renewable energy resources are assumed to be of the same value, 62.3 FCFA/kWh).

It should be noted that the current national average electricity price of 118.1 FCFA/kWh as of 2013 was determined based on political considerations in order to supply cheaper electricity to the public, in spite of the fact that the estimated actual generation cost was 170-190 FCFA/kWh. Thus, greater attention should be paid to the difference between the current price and the targeted prices.

Concerning the promotion of renewable energy use, as the national policy that stated the targeted value of 15% in the total energy use as of 2025 has already been formulated, the targeted value for 2035 in the table was selected to be 15% as of 2025. However, considerable political effort might be needed to achieve that target. At present, although ANER gives top priority to PV promotion, hydropower and waste-to-energy are promising renewable energy sources and they should surely be strongly developed to attain the target. Moreover, the electricity from these resources is stable and cost-effective. The introduction of excessive renewable energy will have negative impacts such as electricity price rises. Thus, one should observe the trends and conditions carefully in the future. As a result, the targeted value of renewable energy use as of 2035 in the table was kept constant at 15%, as in 2025.

7.7.3 Demand Forecast

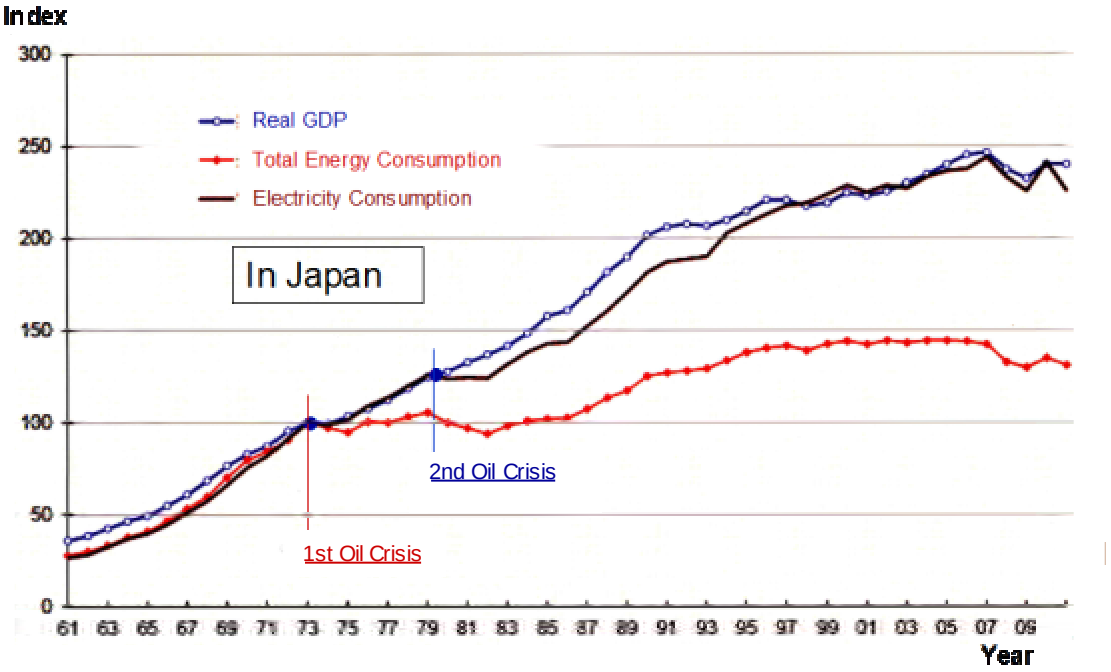
(1) Demand Forecast Method

1) Method for Demand Forecast

With regard to the electricity demand forecast as of the intermediate year of 2025 and the targeted year of 2035 for the national level of Senegal and for the Study Area, it is rather difficult to conduct by the method of accumulating future demand plans for individual electricity consumers. Thus, the electricity demand forecast is to be conducted by means of a macro perspective, using various economic indicators based on Senegalese national development policies and those targets.

For this purpose, the most important and useful information relating to Japan's past economic indicators, which was provided in the publication *Current Status and Future Prospects of the Japanese Electricity Industry* (in Japanese) by IR&A (Japan), was referred to. The trend of the indexes of total energy consumption and electricity consumption versus the real GDP trend index at the national level for Japan is shown in Figure 7.7.1.

In Japan, energy-saving policy was first strongly enforced just after the first oil crisis in 1973. After that, the total energy consumption in Japan, which had been increasing rapidly in tandem with the trend of real GDP until then, was dramatically suppressed. The reduction of energy consumption was mainly made in thermal energy at large factories such as iron mills, etc.



Source: Current Status and Future Prospects of the Japanese Electricity Industry (in Japanese), by IR&A (Japan)

Figure 7.7.1 Past Economic Growth Indexes in Japan

On the other hand, concerning electricity consumption, electricity-saving measures, such as thinning the coverage of indoor lighting and street lamps and limiting neon-light advertising, were conducted at that time. However, the measures scarcely reduced electricity consumption and the trend of the electricity consumption index is almost the same as that of real GDP.

Just after the second oil crisis in 1979, a reduction in thermal energy consumption was clearly achieved under the enhanced energy-saving policy. Moreover, the trend of the reduction in the electricity consumption index appeared under the condition of the rapid popularization of energy-saving home electrical appliances. However, from a long-term point of view, the trend in the electricity consumption index and the trend of the real GDP index have an almost one-to-one relationship. In other words, the real GDP elasticity of electricity consumption is one. This fact is very important for considering the electric power demand. It means that the trend of electricity consumption or demand has a directly proportional relationship with the trend of real GDP, if no dramatic technical innovations regarding electricity appear. In other words, real GDP will not increase much if electricity supply is constrained.

Using this clear macroeconomic correlativity, the electricity demand forecast for Senegal at national level and for the Study Area as of 2025 and 2035 was conducted as described below.

2) Real GDP/Real GRDP Forecast for 2025 and 2035

In Section 5.4.1 in the Progress Report, 'Socioeconomic Framework', the recorded value as of 2013 and the forecasts for real GDP/real GRDP as of 2025 and 2035 for Senegal at national level and for the Study Area were examined. The summary is shown in Table 7.7.3.

Table 7.7.3 Forecast Economic Growth Indexes in Senegal

Area	Economic Indicator			2013 (recorded)	**2025** (forecast)	**2035** (forecast)
Senegal (National)	GDP (Real)	Total	FCFA Billion	4,731	**10,530**	**20,715**
			Index (*1)	100	**222.6**	**437.9**
Study Area	GRDP (Real)	Total	FCFA Billion	3,295 (69.6% of Senegal)	**7,937** (75.3% of Senegal)	**17,136** (82.7% of Senegal)
			Index (*1)	100	**240.9**	**520.1**

Note: (*1) Numbers for the index were calculated in this section.
Source: JICA Study Team

3) Electricity Demand as of 2013

As electricity demand fluctuates by time zones and seasons, etc., the record of the maximum electric power supply in a year is examined. Considering the conditions at the outlet of each power plant system at the same time, the maximum electricity supply is theoretically equal to the maximum electricity demand plus transmission losses.

The total available capacity of power plants located in Senegal and connected to the Senegalese national grid system was 485 MW as of 2013, as referred to in Section 3.6.7 of the Progress Report. After adding the capacity of 15 MW of current power imported from Felou hydropower plant in Mali, the maximum recorded electricity supply capacity in Senegal was 500 MW. Thus, the forecast for the maximum electricity demand in the Study Area is calculated using the relationship of real GRDP/real GDP. The final maximum demand forecast comes to 348 MW (=500 MW×3,295/4,731).

4) Electricity Demand Forecast as of 2025 and 2035

Using the economic indicators noted above, the electricity demands (MW) as of 2025 and 2035 were forecast based on the trend of the index whose basic value was defined as 100 in 2013. For forecasting future demands, the assumption of constant transmission and distribution losses at the current actual value of 20% as of 2013 was adopted. The results are shown in Table 7.7.4.

Table 7.7.4 Electricity Demand Forecast for 2035

Area	Electricity Indicator	2013 (*3) (recorded)	**2025** (*4) (forecast)	**2035** (*4) (forecast)
Senegal (National)	Index (*1)	100	**222.6**	**437.9**
	Demand (MW), max.	500	**1,113**	**2,190**
Study Area	Index (*1)	100	**240.9**	**520.1**
	Demand (MW), max.	348 (*2)	**838.3**	**1,810**

Note: (*1) Numbers of the index were calculated in this section.
(*2) This value includes the transmission/distribution losses of approximately 20% as of 2013.
(*3) The demand value is considered to be the electricity supply value at the outlet of each power plant.
(*4) The demand values in 2035 were estimated by proportional calculation using index values. The values include the loss of 20%, the same as in 2013.
Source: JICA Study Team

(2) Demand Forecast in the Study Area

Concerning the typical development issues in the electrical sector in Senegal, the issues described below are examined and more specific development concepts and plans are suggested.

1) Enlargement of Nationwide Electricity Supply Capacity

Although determining the details of the "Energy Mix" policy, which is to be formulated by the Senegalese government, is ongoing at present, the ratio of nationwide electricity supply capacity as of 2035 by generation method would be forecast as shown in Table 7.7.5. Total electricity supply capacity as of 2035 would be forecast as 2,409 MW (2,190 MW plus the reserve ratio of 10%).

Table 7.7.5 Breakdown of Energy Source in 2035

	Energy Source		Proportion
1	Thermal power generation		70%
		Coal-fired	35%
		Gas-fired	35%
2	Diesel power generation		5%
3	Electricity import		10%
4	Generation by renewable energy resources		15%

Source: JICA Study Team

In the future, thermal power generation will play a major role in the electricity sector and a large amount of investment will be needed to construct the plants. The future investment is to be implemented essentially by IPPs according to Senegalese electricity policy. On the other hand, it should be assumed that the business participation of the Senegalese government, such as the capital injection and the participation of administrators and office staff, especially of SENELEC, in the generation sector will be needed, because timely commissioning of new power plants is needed to prevent future electricity shortages.

As thermal power plants on a medium scale or above need a large amount of seawater as cooling water for the condensing system, these plants are generally constructed at places near the coast. As locations in or near the urban areas of Dakar are inappropriate for such construction, the seacoast areas inside a 100 km range of Dakar would be appropriate. In addition, places near the SENELEC transmission lines are good for the plants. A pier or jetty and unloading facilities are required for a thermal power plant, because fuels such as coal and/or natural gas are to be imported.

Future electricity supply capacity in Senegal as of 2035 will be approximately 2,200 MW. This is rather low compared with industrialized countries around the world. As a large-scale plant of 1,000 MW class will have a major impact on the grid systems, a wide-ranging power failure would arise if an accident occurred at the plant. Thus, medium-class plants with the capacity of 200-300 MW per plant would be more appropriate, to be constructed and commissioned one by one in the future.

The generation capacity of each power facility using renewable energy sources is generally small compared with thermal power generation. There will also be various different business owners and operation/management methods. Thus, it would be difficult to suggest uniform and specific development methods.

2) Concepts for Power Supply Infrastructure Development in the Study Area

Concerning the power supply to the Study Area, it is necessary to examine and plan appropriate methods for each block, based on the rate of increase in electricity demand in each block in the Study Area. The prediction process for future power demand based on the index trend of real GRDP of each block is shown as follows. The prediction is based on the method described in item (3) of this section.

First, the index transition of real GRDP was examined from the forecast values of the real GRDP of each block, as shown in Section 6.3.1 ('Socioeconomic Framework'). The results are shown in Table 7.7.6.

Table 7.7.6 Real GRDP Forecast for Each Block in the Study Area

Year / Block	Socio-economic Item	2013	2025	2035
Dakar	Total GRDP (*1)	1,746.4	3,561.6	6,371,8
	Index (*2)	100	203.9	364.9
Suburban	Total GRDP	857.7	1,795.0	2,896.8
	Index	100	209.3	337.7
Rufisque	Total GRDP	365.3	1,271.9	3,404.2
	Index	100	348.2	931.9
Diamniadio	Total GRDP	109.5	585.4	2,013.3
	Index	100	534.6	1,838.6
Daga Kholpa	Total GRDP	42.1	275.7	1,190.0
	Index	100	654.9	2,826.6
Others (*3)	Total GRDP	174.0	447.3	1,259.9
	Index	100	257.1	724.1
Sum Total	Total GRDP	3,295	7,937	17,136
	Index	100	240.9	520.1

Note: (*1) Unit: FCFA billion at 1999 prices. The total GRDP includes the primary, secondary and tertiary sectors.
(*2) Calculated in this table.
(*3) Including blocks for Sébikhotane, Sindia, Pout, Coast and Rural.
Source: JICA Study Team

Once the future forecast of electricity demand in the whole Study Area was calculated as shown in Table 5.7.4, the electricity demand forecast was carried out for each block by allocating the demand in the ratio of GRDP for each year. The results are shown in Table 7.7.7.

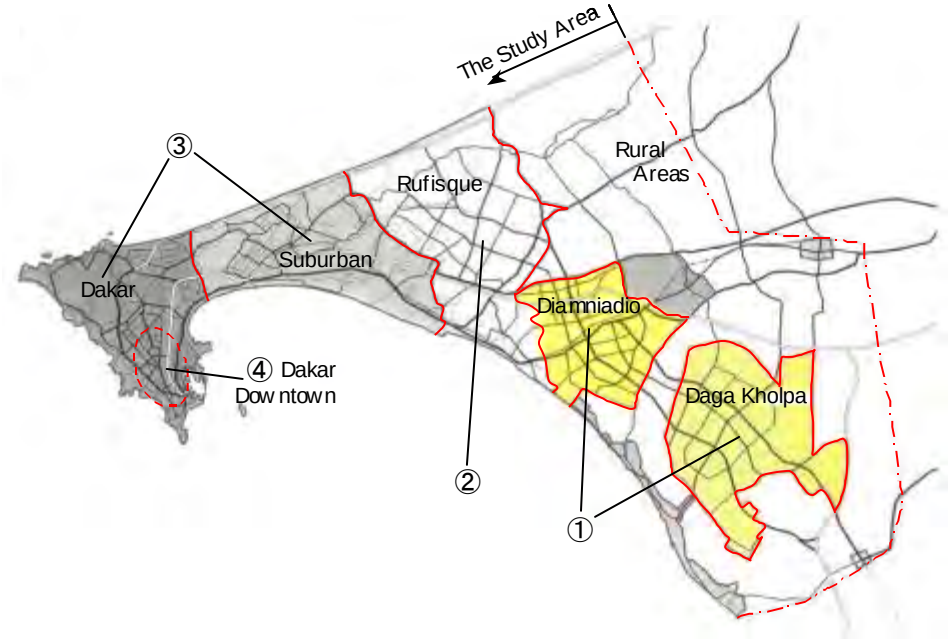
Table 7.7.7 Electricity Demand Forecast for Each Block in the Study Area

Year / Block	Socio-economic Indicator	2013 (actual)	2025 (intermediate target)	2035 (final target)
Total (*1)	Index	100	240.9	520.1
	Electricity Demand(*3)	**348**	**838.3**	**1,810**
Dakar	Index (*2)	100	203.9	364.9
	Electricity Demand(*3)	184.4	376.2	673.0
Suburban	Index	100	209.3	337.7
	Electricity Demand	90.6	189.6	306.0
Rufisque	Index	100	348.2	931.9
	Electricity Demand	38.6	134.3	359.6
Diamniadio	Index	100	534.6	1,838.6
	Electricity Demand	11.6	61,8	212.6
Daga Kholpa	Index	100	654.9	2,826.6
	Electricity Demand	4.4	29.1	125.7
Others	Index	100	257.1	724.1
	Electricity Demand	18.4	47.3	133.1

Note: (*1) For the Study Area from Table 7.7.4.
(*2) From Table 7.7.6.
(*3) Unit: MW, calculated in this table.
Source: JICA Study Team

As shown in Table 7.7.7, the existing urban blocks clearly have a large demand for electricity, but the ratios of demand increase are relatively small. In contrast, non-urbanized blocks, including new development areas, have large ratios of electricity increase. The fact that the existing urbanized blocks are highly populated and have far fewer vacant sites should be considered as one of the basic

conditions for planning sufficient electricity supply infrastructures.



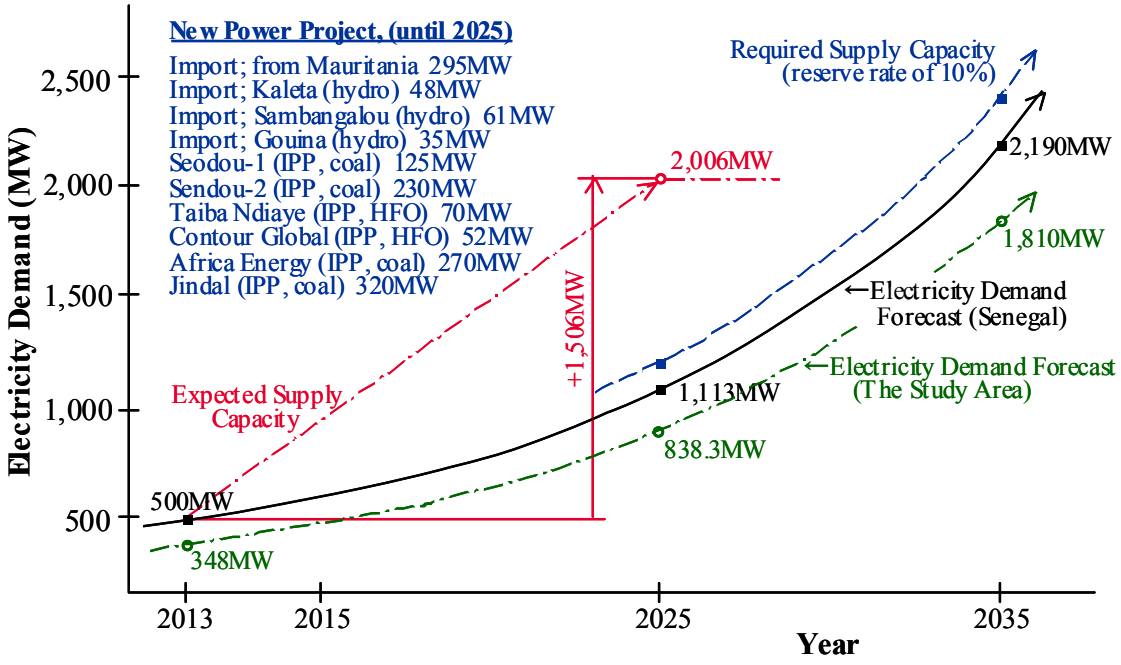
Source: JICA Study Team

Figure 7.7.2 Block Layout in the Study Area

7.7.4 Development Plan

(1) Electricity Supply-Demand Balance

An electricity supply and demand balance is reviewed for the Study Area and Senegal as shown in Figure 7.7.3. The supply capacity in 2025 is estimated by adding the capacities of all the power plants proposed to be commissioned by 2025 by the private sector under an IPP arrangement, on which data were made available by SENELEC. It should be kept in mind that there are uncertainties about the possibility of actual implementation of these projects, because investment decision by the project sector depends on market condition at each time. The review here, therefore, is for the government and SENELEC to have a broad perspective of electricity supply and demand balance condition in the coming years. The capacities of solar and wind power projects are not included.



Source: JICA Study Team

Figure 7.7.3 Relation between Electricity Demand and Supply Capacity

The electricity demand of both Senegal (1,113 MW) and the Study Area (838 MW) in 2025 will be fulfilled in the event that the proposed power plants such as Sendou-1, Sendou-2 and Jindal coal-fired power plant (350 MW) planned outside the Study Area, other planned power plants in Senegal and imports from neighboring countries are realized. Transmission of electricity from outside the Study Area will be required to fulfill the demands within the Study Area. The condition after 2025 cannot be foreseen yet because there are no projects planned after 2025. The government and SENELEC will need to ensure supply of sufficient amount of electricity to fulfill the predicted demands by closely monitoring the plans and progress of the power plant projects by the private sector.

The construction of new power plants in the areas with higher population density in the future is undesirable. It would be more desirable to select suitable sites for new power plants in the districts within 100 km of the Study Area. (A distance under 100 km is regarded as a short or medium distance in power transmission engineering terms.)

(2) Development Plan by Area

Examining the characteristic features of each block, the concepts of the electricity supply infrastructure formulation are classified into four patterns, as follows:

1) New Development Areas (Diamniadio and Daga Kholpa)

This concept is applied mainly for new development areas. As there is a great deal of unused land in these areas at present, there will be fewer restrictions for selecting suitable sites for the infrastructures.

Thus, prior constructions and/or land acquisition for various new substations and new transmission/distribution lines are possible, considering future electricity demand increase.

The electricity supply infrastructure concept specifically for Daga Kholpa block will be formulated in tandem with the urban planning of the block.

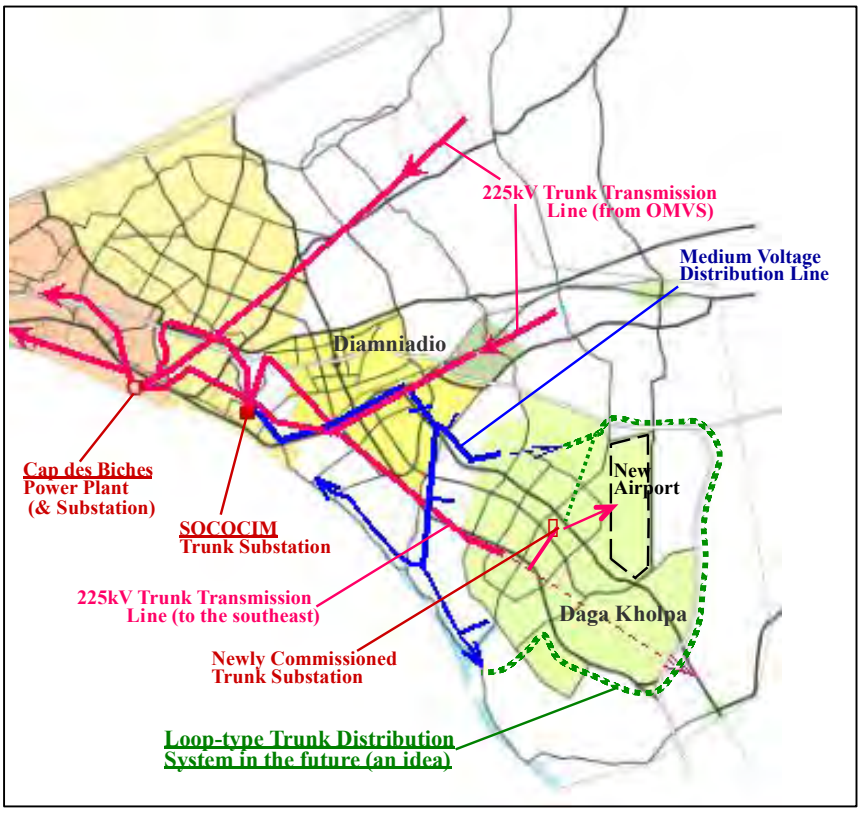
At a site near the coast in Diamniadio block, a new coal-fired power plant, Sendou-1 (125 MW), is

under construction at present and Sendou-2 coal-fired power plant (250 MW), which will be constructed in the vicinity of Sendou-1, is in the planning stage. However, even after the completion of these two power plants (375 MW in total), a power shortage is predicted based on the forecast demand for 838.3 MW of electricity in the Study Area as of 2025, if power supply sources are limited to the Study Area. Transmission of electricity from outside the Study Area, therefore, will be required.

Planning of new electricity supply infrastructure, new substations and distribution lines for these areas should be carried out carefully by SENELEC, after studying technical and cost matters. This process will take SENELEC a few years. DUA is expected to supply detailed urban development information to SENELEC and cooperate closely with them.

Figure 7.7.4 shows a possible concept of a future electricity supply system for the Daga Kholpa area, based on a preliminary examination by the Study Team. At present, there is one high-voltage transmission line shown in red lines and one medium-voltage distribution line shown in blue lines in Daga Kholpa. The current electricity supply capacity is largely insufficient to meet rising demands in the Daga Kholpa area and the adjacent area of Diamniadio.

Construction of new local distribution systems for Daga Kholpa and adjacent areas is, thus, needed. The concept of a loop-type trunk distribution system, shown in Figure 7.7.4, is a possible option for the system. The bold dotted lines in green show the new backbone or trunk distribution lines. The power for the system will be supplied from SOCOCIM substation and the new substation in Daga Kholpa in parallel. The loop-type system has the advantage of power supply reliability, while it requires a high level power flow control.



Source: JICA Study Team

Figure 7.7.4 A Preliminary Concept of Electricity Supply System in Daga Kholpa Area

2) Rufisque

In Rufisque block, land use for residential and commercial facilities, for example, has increased

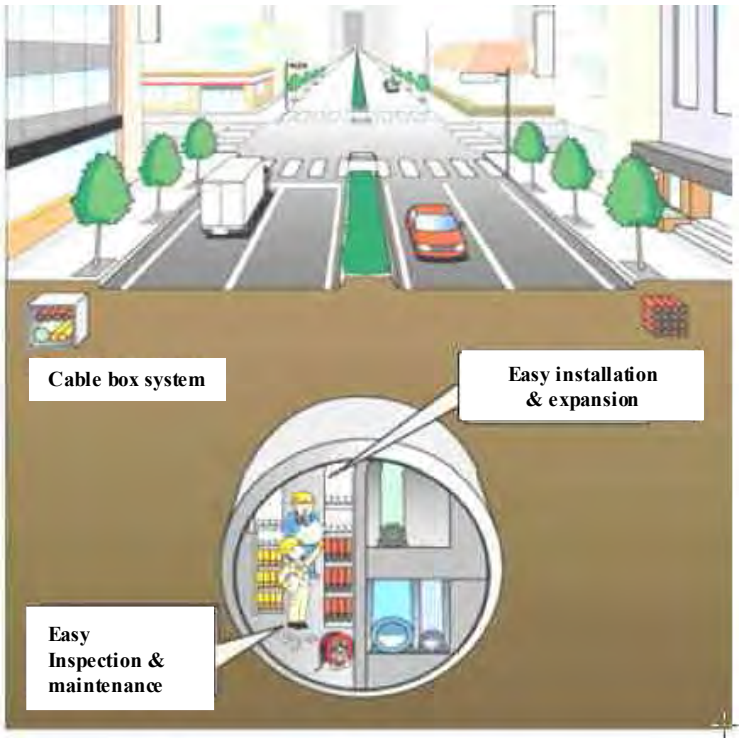
gradually and therefore the growth in electricity demand due to urban expansion is relatively high. Thus, the development and improvement of the power supply infrastructures should be carried out as a priority. However, because there is still a great deal of unused land in the block at present, the expansion of power equipment such as main transformers at existing substations and the construction of new transmission/distribution networks need to be conducted step by step, aiming toward the years 2025 and 2035.

3) Dakar City and Suburban Area (Pikine and Guédiawaye)

Since urbanization in the Dakar city area and the suburban block has developed considerably, the acquisition of suitable sites for new power supply infrastructures is generally considered to be very difficult. Therefore, to meet the increase in electricity demand, the replacement of existing power facilities, such as the replacement of distribution substations that are adequately installed in the block in order to enlarge their capacities, and the rehabilitation of aged facilities should be carried out step by step in order of priority.

4) Downtown Dakar

Essentially, plan 3) is to be applied to the downtown areas in Dakar city such as Plateau district, etc. A rapid electricity demand increase in specific districts caused by the construction of high-rise buildings associated with the city's redevelopment is predicted in the near future and countermeasures for the problem should be formulated. In the downtown district, the installation of underground power cables has been completed recently. To enhance the power supply capacity to cope with the rapid power demand increase, the replacement of the power distribution lines in the ground is needed by excavation at relevant places. Considering the situation, the introduction of a public utility conduit system into the redevelopment plan would be totally appropriate. One possible image of the public utility conduit is shown in Figure 7.7.5.



Source: Ministry of Land, Infrastructure and Tourism, Japan

Figure 7.7.5 Image of the Public Utility Conduit Concept

Figure 7.7.5 shows an example of the public utility construction and there are many possible configurations depending on the features of the corresponding district. Concerning power cables, trunk power cables are usually installed in trunk public utility conduits and subordinate power cables are installed not only in trunk conduits, but also in dedicated small conduits or trenches for power cables.

The lack of power capacity of the transmission and distribution infrastructures in existing urbanized districts has already become obvious. However, it is very difficult to examine and plan how to improve, repair and replace the infrastructure and in what places, in order to enhance the power supply capacity, because the arrangement of transmission/distribution lines has become complex. Therefore, conducting a "technical aid project for the detailed study of the transmission and distribution system in existing city areas of Dakar", one of the priority projects described in Section 8.1, is considered an effective approach to overcoming the problem.

(3) Promotion of Renewable Energy Use

The renewable energy resources are very varied and the difficulty of suggesting uniform and specified development methods was mentioned above. Senegalese national policy makes PV the top priority for development and one of its major purposes is rural electrification. PV is also expected to be promoted at a private level for general homes as a private electricity source.

As each PV system is quite small and cannot generate electricity at night and/or on cloudy days, PV cannot play a major role in electricity supply on a national level. Thus, the development of hydropower, which is a stable power source, could play a key role in stabilizing the frequency and voltage of the grid system and is expected to generate electricity on a fair scale, as suggested in this section.

There is large hydropower potential in the upstream areas of the Gambia River, near the border with Guinea. As the potential has barely been harnessed to date, the potential for power generation should be used positively in the future. In this area, large dam projects are very difficult to plan because of the topographical conditions, as this area has extensive woodlands and a national park. Thus, careful planning and development is needed for hydropower projects. The "low-head hydropower" method, the most environmentally friendly method, is highly appropriate for the area and is recommended for the projects. An image of a typical low-head hydropower plant in Japan is shown in Figure 7.7.6. This plant has the following specifications: head: 12.5 m, rated capacity: 15.7 MW. It is in a sightseeing area of a Japanese national park.

Source: JICA Study Team

Figure 7.7.6 Typical Low-Head Hydropower Plant (15.7 MW) in Japan

The upstream areas of the Gambia River just downstream of Sambangalou hydropower plant (128 MW), which is under construction at present, have great potential for low-head hydropower plants with the capacity of 5-10 MW. Additionally, along the tributaries, many low-head hydropower plants and/or conventional run-of-river type hydropower plants with a capacity of several MW or less could be constructed. Thus, sufficient pre-studies for such development are expected to be undertaken in the future. Concerning the power transmission from hydropower plants in this area to the Study Area, there is no transmission line at present, as of 2015. A trunk transmission line from Sambangalou hydropower plant to the metropolitan area is, however, in the process of construction and will be commissioned around 2020. As the transmission line under construction is planned to pass through the area noted above, the new hydropower plants completed after 2020 will be able to be connected to the transmission line and the electricity produced by those plants will be supplied to the Study Area.

As described in Chapter 3, SENELEC will be privatized in the future and the hydropower development will be undertaken by a different organization. Full-scale (for example, the capacity is over 1 MW) hydropower plants having a large value in a grid system can be implemented effectively by a specific public company to be newly established, such as a “hydropower development company”, because hydropower plants need large initial investment and it would be difficult for private companies to undertake such large-scale projects. Mini and/or micro hydropower facilities, having the capacity of less than several 100 kW, for rural electrification would be appropriate to be implemented, operated and maintained by small organizations such as a “rural electrification association” under the supervision of ASER.

7.7.5 Cost Estimate

The development costs are preliminarily examined as described below.

(1) Construction of Thermal Power Plants

The average capacity level of the new thermal power plants to be constructed in Senegal in the future is forecast to be around 300 MW per plant. The unit construction cost (per MW) of a thermal power plant with this capacity level is estimated to be approximately 2.5 million US$/MW, including all items such as land prices and unloading facilities for imported fuels. (Note: for the sake of simplicity, the construction cost of a gas-fired plant is regarded as the same as that of a coal-fired.)

Accordingly, the rough total construction cost of a 300 MW thermal power plant is estimated to be 750 million US$. As six thermal power plants will need to be constructed by 2035, the rough total amount of investment for the projects is estimated at 4.5 billion US$.

(2) Construction of Transmission/Distribution Systems

It is very difficult to forecast the length and voltage of each transmission/distribution line and the capacities and numbers of the various substations in the targeted areas in Senegal, even though this is basic information for estimating the future construction cost. Therefore, the future investment amount of the transmission/distribution systems in Senegal is forecast in this section in a macro perspective.

The unit investment amount (per MW) for a new transmission/distribution system including related substations is around 0.15-0.25 million US$/MW on an empirical basis. The additional electricity supply capability needed for Senegal in the future will be approximately 670 MW until 2025 and approximately 1,860 MW until 2035, including the reserve rate of 10% (see Table 7.7.8).

Table 7.7.8 Electricity Demand and Additional Install Capacity Needed

Year	Electricity Demand Forecast (MW) (*1)	Demand Increment (MW)	Additional Install Capacity Needed (MW) (*2)
2013 (record)	500	–	–
2025 (forecast)	1,113	+613	**+674**
2035 (forecast)	2,190	+1,690	**+1,859**

Note: (*1) See Table 7.7.4.
(*2) [Additional Install Capacity Needed] = [Demand Increment]×1.1 (the reserve rate of 10%).
Source: JICA Study Team

Therefore, the total investment amount of future transmission/distribution systems will be approximately 170 million US$ until 2025 and approximately 470 million US$ until 2035, assuming the unit cost to be 0.25 million US$/MW.

(3) Construction of Low-Head Hydropower Plants

The rough construction cost of a low-head hydropower plant with the capacity of 10 MW is estimated. Since the construction cost of a hydropower plant is largely affected by locational conditions such as the landscape and the accessibility, the unit construction costs (per MW) differ considerably for each project. However, the average unit cost is estimated to be approximately 3.0 million US$/MW.

Accordingly, a rough construction cost of a low-head hydropower plant with the capacity of 10 MW is estimated to be 30 million US$. The rough total project investment is forecast to be 150 million US$, if five plants of the same capacity are constructed by 2035.

7.8 Urban Disaster Risk Reduction

7.8.1 Objective and Strategies

(1) Objective and Overall Target

The objective of the urban disaster risk reduction for the 2035 Master Plan is "minimizing disaster risk to support creation of a comfortable environment and sustainability of urban development".

The strategic objectives on disaster risk reduction set out in the National Strategy for Economic and Social Development (NSESD 2013-2017) are as follows: 1) prevent and reduce major disaster risk, and 2) improve the management of natural disasters. This indicates that the sector's objectives place emphasis on "major" and "natural" disasters. In the Study Area, flood and coastal disasters have been recognized as major natural disasters. Therefore, flood and coastal disasters are mainly targeted in the present study. In addition, the overall disaster risk reduction is also taken into account.

The overall targets along with the objective are set as follows:

- Improved management of disaster risk
- Reduced flood damage
- Well-conserved coastal protection area.

(2) Strategies

Considering the issues identified in Section 2.2.10, strategies for achieving the objective and overall target are proposed, as shown in Table 7.8.1.

Table 7.8.1 Strategies for Urban Disaster Risk Reduction

Theme	Strategy
Overall Disaster Risk Reduction	Strategy A-1: Capacity enhancement against disaster risk by promoting a culture of disaster risk reduction, preparation and implementation of contingency plans and development of an information sharing system for disasters. Strategy A-2: Identification of potential hazard area and its reflection in the land use plan for the urban expansion area, in order to minimize future investment for hazard mitigation.
Flood Hazard	Strategy B-1: Designation of flood management areas* where flood hazard is expected to be severe and regulation of new development there to prevent further increase in disaster risk. Strategy B-2: Coping with flood disaster risk by non-structural measures such as hazard mapping and early warning. Strategy B-3: Flood hazard mitigation in urbanization area, except the flood management area, up to a certain safety level by structural measures, utilizing the effect of natural/artificial detention as much as possible.
Coastal Hazard	Strategy C-1: Strengthening coordination among urban development sectors and coastal management bodies, in order to promote regulation of development along the shoreline and optimum countermeasures against coastal hazards considering environmental conservation.

Note: * Definition of Flood Management Area is described in Section 7.8.3 (2) in detail.
Source: JICA Study Team

7.8.2 Development Target

The development target for urban disaster risk reduction is conceptually set as shown in Table 7.8.2.

Table 7.8.2 Development Target on Urban Disaster Risk Reduction

Theme	Target
Overall disaster risk reduction	Enhanced capacity for dealing with emergency situations at all levels of government
	Raised population awareness and activated community-based disaster risk management
	Shared disaster information among relevant organizations and populations
Flood hazard	Established and well-managed Flood Management Area where flood hazard is expected to be severe
	Enhanced non-structural measures such as establishment of early-warning system and preparation/dissemination of flood hazard map
	Installed and well-maintained main drainage facilities in almost all urban areas by land use category, with safety level of extreme storm events with 10-year return period
Coastal hazard	Established framework of coastal protection and management
	Protected coastal zone by implementation of countermeasures for priority coastal area

Note: * Definition of Flood Management Area is described in Section 7.8.3 (2) in detail.
Source: JICA Study Team

7.8.3 Development Plan

(1) Overall Disaster Risk Reduction

1) Capacity Enhancement against Disaster Risk

Three strategic targets with related actions are proposed in accordance with strategy A-1, as shown in Table 7.8.3.

Table 7.8.3 Strategic Targets and Related Actions for Capacity Enhancement against Disaster Risk

Strategic Target	Action
Enhanced capacity for dealing with emergency situations at all levels of government	1) Preparation of contingency plans against disaster at all levels of government (central, regional, departmental and *commune*) 2) Enhancement of human resources in DPC* and BNSP** 3) Training of personnel relating to disaster risk reduction at all levels of government
Raising popular awareness and activating community-based disaster risk management	1) Information and Education Campaign (IEC) on disaster risk reduction for populace as a whole 2) Promotion of community-based disaster risk management
Sharing disaster information among relevant organizations and populace	1) Establishment of a disaster risk management center in order to integrate and share the disaster information as well as unify the command structure 2) Introduction of integrated information system for disaster risk reduction, which includes a database of past disasters, meteo-hydrological information, warnings and alerts 3) Establishment of early warning mechanism to disseminate information related to disasters to all relevant organizations and populace

Source: JICA Study Team

2) Land Use Plan Considering Potential Hazards

In order to avoid an increase in the future disaster risk due to new development and the attendant possibility of having to invest in hazard mitigation to protect the new development area, it is necessary to consider the potential hazard area in order to prepare the land use plan in the new expansion area. According to strategy A-2, the land use plan for PDU in the present study strategically reflected the

potential hazard area shown in Section 3.7.4 as far as possible.

(2) Flood Hazard

1) Proposed Framework for Flood Management under the 2035 Master Plan

Following strategy B-1, the concept of a "Flood Management Area" is proposed as below.

Proposed categorization of stream and flooding from the point of view of flood management

In the Study Area, almost all streams are ephemeral. Water flow appears only after heavy precipitation. However, the flooded area could sometimes become significant. The Study proposes categorizing streams and flooding from the point of view of flood management as shown in Table 7.8.4 and Figure 7.8.1.

Proposed flood management area

The area flooded by the main river and the urbanized inland inundation area for extreme storm events with a 10-year return period[4], *assuming future land use and completion of existing flood control and drainage plans*, are proposed for designation as the Flood Management Area. In addition, the inundation area of the dam reservoir with a designed high water level is also to be designated as a Flood Management Area (see Figure 7.8.2)[5].

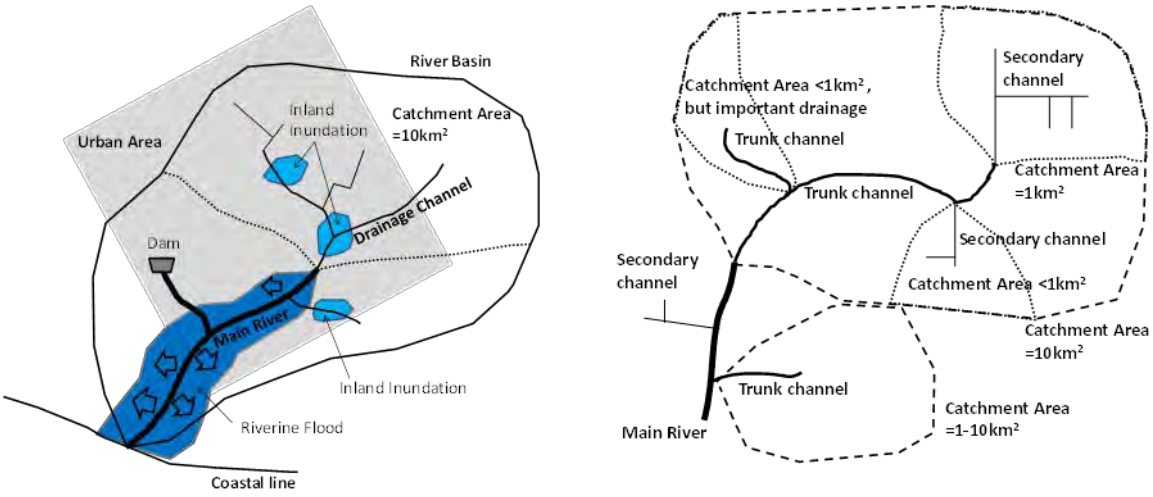
Table 7.8.4 Proposed Categorization of Stream and Flooding

Stream	It is proposed that the stream is categorized by size of catchment area, as follows: Main river: The stream with a catchment area of more than 10 km^2 in principle or in downstream reach of dams Drainage channel: The natural stream or artificial channel with a catchment area of less than 10 km^2 in principle The drainage channel is proposed to be further categorized as follows: Trunk channel: The major drainage channel whose catchment area is usually 1-10 km^2, or other important channels for the drainage scheme Secondary channel: The drainage channels other than the trunk channel Although some catchment areas in PDD/PROGEP* and PDA** areas in Dakar, Pikine and Guédiawaye are more than 10 km^2, all channels in those areas are regarded as the drainage channel, because they are already planned as part of the urban drainage scheme in the existing plans
Flooding	There are two types of flooding, as follows: Riverine flood: Flooding by overflow from the main river, which is usually relatively large-scale compared with inland inundation because of its volume of flooding Inland inundation: Inundation before flow enters the main river, mainly due to lack of drainage capacity

Source: JICA Study Team

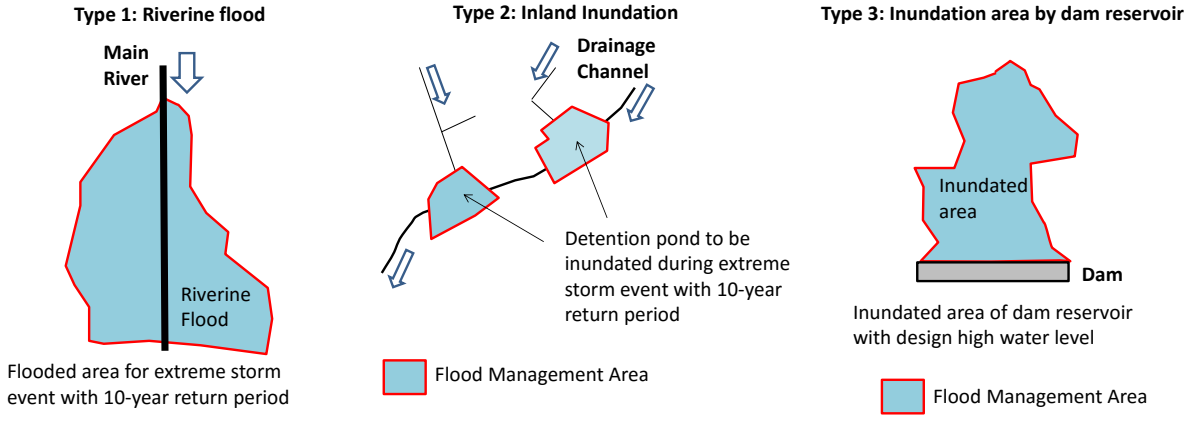
[4] It is proposed to adopt the extreme storm event with a 10-year return period, considering the target safety level of urban drainage facilities in Dakar, Pikine and Guédiawaye in the existing plans, as well as the balance between flood risk and necessary land area for new urban development. In the case that the more severe extreme events, such as that with a 100-year return period, are adopted, a wider food management area can be reserved and one could easily adopt a higher safety level than the 10-year return period in future by limiting the development in the possible flood area during the extreme storm event with a greater than 10-year return period. However, the developable area would be reduced and many developed areas would be restricted for further development instead.

[5] If significant flooding by raised groundwater level is identified, which could occur in special geological conditions such as limestone, it could also be designated a Flood Management Area.



Source: JICA Study Team

Figure 7.8.1 Proposed Categorization of Stream and Flooding

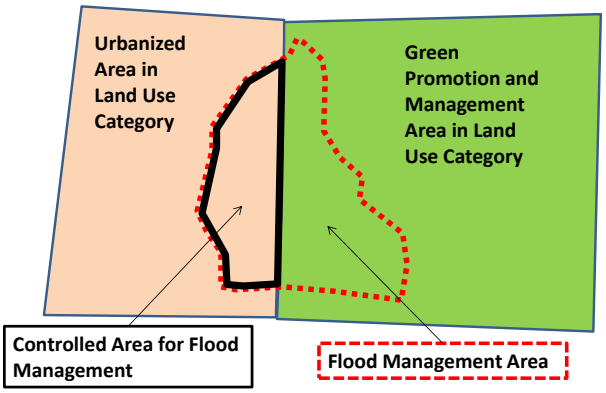


Remarks: If significant flooding caused by raised groundwater level is identified, which could occur in special geological conditions such as limestone, it could also be designated a Flood Management Area.
Source: JICA Study Team

Figure 7.8.2 Flood Management Area

A Flood Management Area is not a category of land use. It is rather a designated area for special management purposes, like a Forest Management Area for the conservation of forestry, although it has no legislative background at this moment. In a Flood Management Area, new development should be regulated in order to prevent further a increase of flood risk in the future. To do so, it is essentially allocated as a Green Promotion and Management Area in the land use plan, that is, a controlled area for new development, under the 2035 Master Plan. However, if there is already heavy occupation in a Flood Management Area, such an area cannot be easily allocated as a Green Promotion and Management Area in the land use plan. If so, the area is to be designated as a "Controlled Area for Flood Management" instead (see Figure 7.8.3).

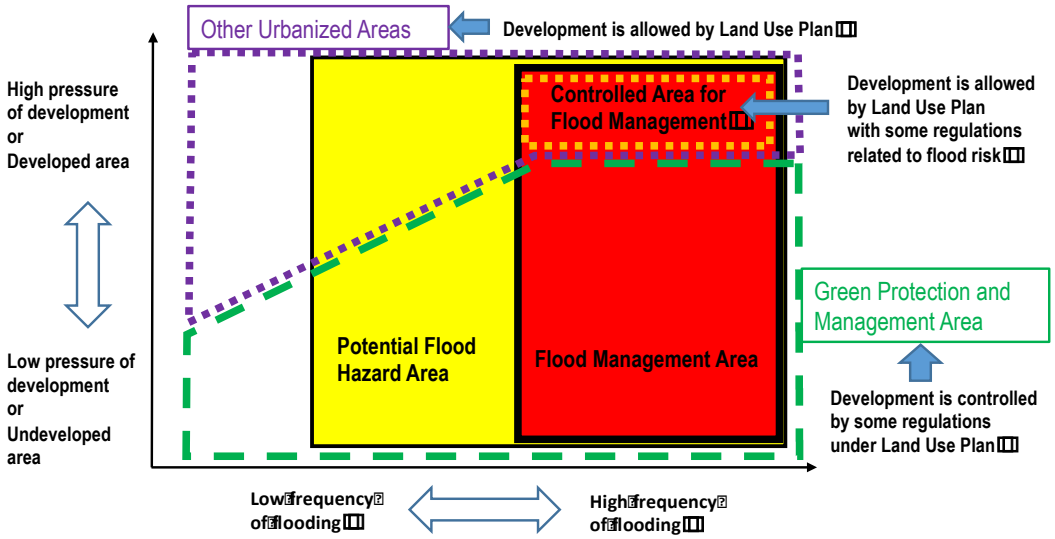
A Controlled Area for Flood Management is again not a category of land use. It is the area that has immediate flood disaster risk within a Flood Management Area in the urbanized land use category under the 2035 Master Plan. In a Controlled Area for Flood Management, the residents should be informed of the flood hazard, including its magnitude, and how to reduce the risk depending on the magnitude of the hazard should be discussed among the stakeholders. A regulation that new construction could be permitted only if it complies with flood-proof structure, as well as promotion of voluntary resettlement, could be possible measures to reduce the risk.



Source: JICA Study Team

Figure 7.8.3 Controlled Area for Flood Management

The relationship among land use plan, potential hazard area, Flood Management Area and Controlled Area for Flood Management is further demonstrated in Figure 7.8.4.



Potential Flood Hazard Area	Flood Management Area
Expected flood area by the extreme rainfall event with the past maximum occurred in Dakar-Yoff in 2012 (equivalent to order of 100-year return period) under the condition with existing land use	Expected flood area by the extreme rainfall event with 10-year return period under the condition with future land use and completion of existing flood control plans
In the area with low pressure of development or undeveloped area, it is designated as Green Protection and Management Area, and thus *the development is controlled by Land Use Plan as much as possible.*	*Some sort of regulations on land use are introduced* in order to reduce flood risk, regardless the pressure of development and situation of development.

Source: JICA Study Team

Figure 7.8.4 Relationship among Land Use Plan, Potential Hazard Area, Flood Management Area and Controlled Area for Flood Management

When a new road is planned in a Flood Management Area, it is necessary to carefully assess its impact on the flooding conditions. The adverse impact on flooding patterns caused by installation of the new road should be minimized. Existing discharge capacity of the main river should be secured where the new road crosses the main river.

Draft flood management area and draft controlled area for flood management

In the land use plan for PDU in the present study, a draft Flood Management Area and a draft Controlled Area for Flood Management are set as a guide for more detailed land use plans such as PUD, using the available information and data (as of November, 2015) as well as considering the scale of mapping for PDU (see Figure 7.8.5).

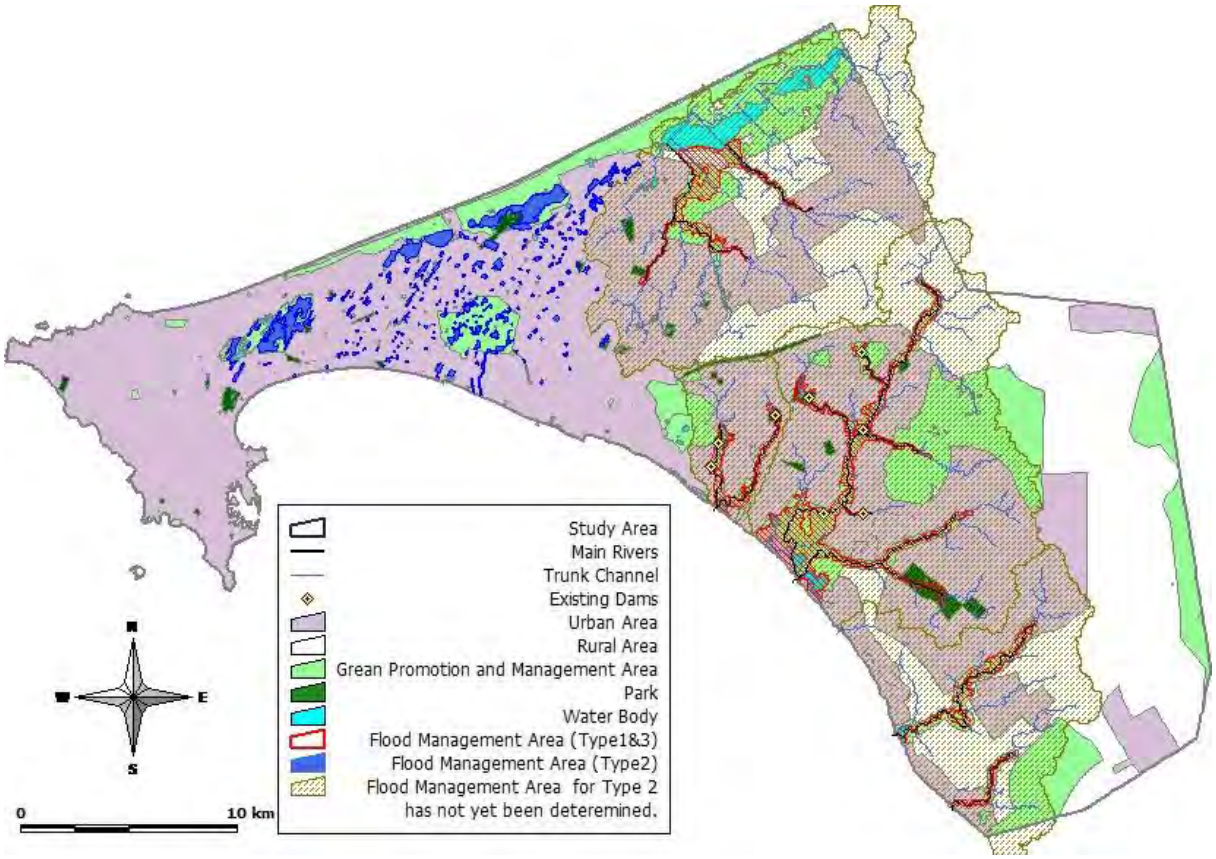
It should be noted that the Flood Management Area for the inland inundation area within the urbanization area (Type-2) can be designated only after the urban drainage plan is formulated. Therefore, in an area where there is no drainage plan, such as the new urban expansion area in Rufisque and Thiès, a Flood Management Area for the inland inundation area within the urbanization area (Type-2) is not yet established even at draft level in the present study. It should be urgently established with the formulation of the drainage plan in future.

Update of flood management area and controlled area for flood management

As soon as new flood control and drainage plans are formulated, they should reflect the Flood Management Area and the Controlled Area for Flood Management.

Capacity enhancement for dealing with flood management area

Since there is no legislative background at this moment, the Flood Management Area and Controlled Area for Flood Management could be effective only under the framework of the 2035 Master Plan. It is necessary for relevant agencies to enhance their capacity for dealing with Flood Management Areas: how to designate such an area scientifically, how to regulate the development activities in it, how to review applications for permission for construction, etc.



Source: JICA Study Team

Figure 7.8.5 Draft Flood Management Area

2) Non-Structural Measures besides Land Use Management

According to strategy B-2, the following non-structural measures besides land use management are proposed:

Flood hazard map

A flood hazard map shows the expected area flooded by the main river and the inland inundation area within the urbanization area during an extreme storm event with a 10-year return period or even more severe, *assuming the current condition of the land use as well as the existing flood control/drainage facilities*. It should be prepared and disseminated to all relevant organizations and populations, to enhance awareness of the existing danger of flooding.

For the area where the structural measures have not yet been completed although there are existing plans for structural measures, as well as the Controlled Area for Flood Management, the flood hazard map should be prepared as a priority action.

For the area where the structural measures have been completed up to design safety level, the residual risk for more extreme storm events should be shown in the flood hazard map.

Early warning

According to the ANACIM, most heavy rainfall events in the rainy season are caused by the cumulonimbus system moving from east to west. The movement of storms could be monitored by enhanced meteorological observation. Such information could be used for early warning for flooding in the Study Area.

The meteo-hydrological monitoring system in the Study Area should be enhanced. The installation of a number of automatic rain gauges with data transmission capability to cover the Study Area is recommended in order to precisely monitor a storm event. Hydrological monitoring for flooding conditions is also recommended at important points along the main rivers and the trunk channels.

The early warning system, which includes the transmission of information as well as the monitoring of storm events, should be enhanced, in line with the enhancement of the integrated information system for disaster risk reduction, which is described in the section on overall disaster risk reduction.

3) Structural Measures

The structural measures according to strategy B-3 are proposed as below:

Flood control along main rivers

Since the expected flooding area for the extreme storm event with a 10-year return period is proposed for designation as a Flood Management Area, major flood control by structural measures along the main rivers is not taken into account. However, it might be necessary to install minimum flood control facilities in some cases, which can be identified by more detailed study.

The Green Promotion and Management Area allocated to cover the Flood Management Area along the main rivers should have a clear physical boundary with other land use categories. In some cases, there will be a vehicle road along the boundary. Otherwise, installation of a pedestrian road along the boundary is recommended (see Figure 7.8.6).

Main drainage facilities in urbanization area

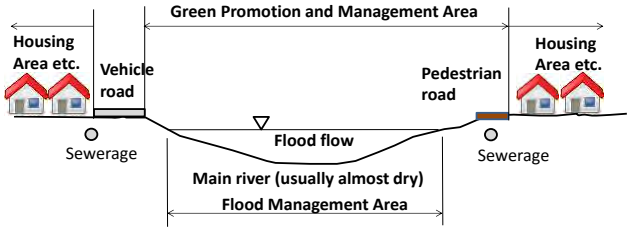
It is proposed that all urbanization areas except the Controlled Area for Flood Management be covered by the main drainage facilities such as the trunk channel and detention pond, with the design scale for an extreme storm event with a 10-year return period.

For the new urban expansion area in Rufisque and Thiès, it is proposed that the urban drainage scheme be planned according to the guiding principles shown in Table 7.8.5.

Table 7.8.5 Proposed Guiding Principles for Urban Drainage Scheme for New Urban Expansion Area in Rufisque and Thiès (Draft)

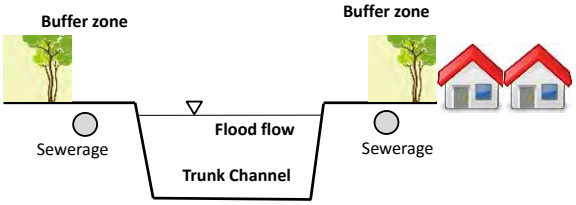
- Natural drainage course with catchment area of 1-10 km^2 should be utilized as the trunk channel, which should essentially be an open channel.
- In the case where the trunk channel is located in a Green Promotion and Management Area, the channelization should be minimal so as to utilize the natural detention effect around it. The expected flooding area around the trunk channel in the Green Promotion and Management Area should be designated a Flood Management Area.
- Natural depressions should be utilized as detention ponds as much as possible in order to minimize the channel size as well as to reduce peak discharge in downstream reaches, a basic concept in PDD/PROGEP.
- The secondary channel could be a closed conduit and follow road networks, but storm water should generally be drained by gravity considering topographic conditions.
- The main drainage facilities should have a buffer zone around them for easy maintenance and reserve some space for installation of other public facilities in future (see Figure 7.8.7).
- Where the drainage channels cross a road, enough discharge capacity should be secured.

Source: JICA Study Team



Source: JICA Study Team

Figure 7.8.6 Green Promotion and Management Area Allocated to Cover Flood Management Area along Main Rivers



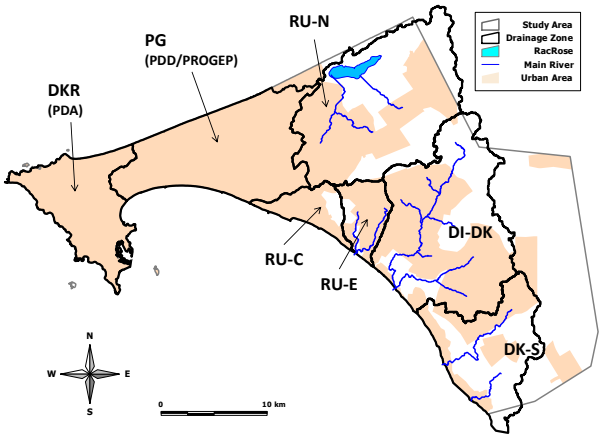
Source: JICA Study Team

Figure 7.8.7 Trunk Channel and Buffer Zone

The urbanization area to be covered by the main drainage facilities is presented in Figure 7.8.8, together with drainage zones that are based on the catchment boundary. A total of 457 km^2 should be covered by the main drainage facilities. Of that, about 100 km^2 in Dakar and the urban area of Rufisque have already been covered. In this area, some rehabilitation/expansion works are required. The remaining area of about 357 km^2 has almost no drainage facilities except the portion covered by Phase 1 of PROGEP, which essentially requires new construction.

Maintenance of drainage facilities in urbanization area

The installed drainage facilities should be maintained in good condition. The ONAS should be responsible for the maintenance of the drainage facilities in the urbanization area, especially for the main drainage facilities, considering its accumulated previous experience of the maintenance of drainage facilities in Dakar Department. The necessary budget for maintenance by ONAS should be secured as a responsibility of central government. The local communities and local government should also be jointly responsible for the maintenance of the secondary channels in their territory.



Drainage Zone Code	Total Area (km^2)	Urban Area (km^2)	Current situation of drainage plan and its implementation
DKR	75	75	1) Drainage facilities exist 2) PDA prepared for rehabilitation/expansion, but no implementation
PG	127	127	1) Almost no drainage facilities 2) PDD prepared and partially implemented by PROGEP
RU-C	24	20	1) Drainage facilities exist 2) Old plan exists
RU-N	175	89	1) Almost no drainage facilities 2) No urban drainage master plan
RU-E	27	23	
DI-DK	171	108	
DK-S	88	39	
Others	N/A	27	
Total	687	608	

Source: JICA Study Team

Figure 7.8.8 Urbanization Area to be Covered by Main Drainage Facilities for Respective Drainage Zones

(3) Coastal Hazard

According to strategy C-1, the following are proposed:

Establishment of framework of coastal management under 2035 Master Plan

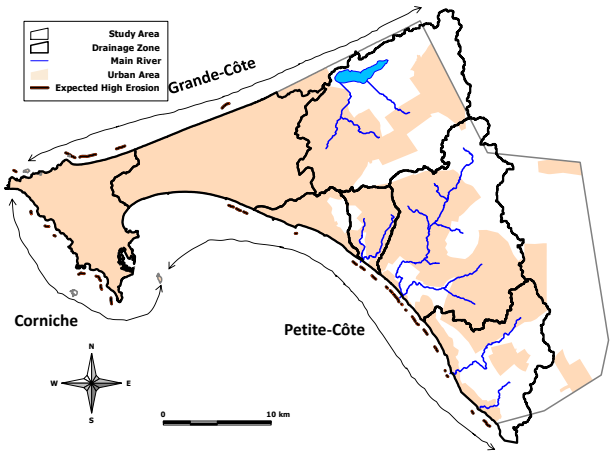
In the PDU land use plan, the coastal protection area is designated as one of the land use categories. The coastal protection area should be well conserved under the 2035 Master Plan. The regulatory and management authority for urban development should coordinate with the coastal management bodies such as the DEEC to establish the framework for coastal management in the Study Area. The preparation of the comprehensive coastal management plan for 1) Corniche, 2) Grande Côte and 3) Petite Côte is proposed, to set the framework for joint efforts between the regulatory and management authorities for urban development and the coastal management body. It should include the following elements: a basic study of coastal erosion and existing socio-economic activities along the coastal area, guidelines on regulation of coastal protection areas, institutional arrangements for management, the identification of the area to be regulated and necessary countermeasures against coastal erosion and their priority.

Structural measures

At the priority sites for countermeasures against coastal erosion that are to be identified in the comprehensive coastal management plan, the optimum structural measures with consideration for environmental conservation should be implemented to conserve the coastal area.

The priority sites for countermeasures against coastal erosion are preliminarily explored by utilizing the latest evaluation (World Bank, 2013) of the expected magnitude of hazards caused by coastal erosion.

There are three ranks (high, middle and low) for the expected magnitude, considering future climate change. For 2030, a total of about 15 km along the shoreline is ranked as high. This could be a candidate shoreline for priority sites at which to apply the countermeasures (see Figure 7.8.9).



Area	Shoreline length in the Study Area (km)	Length of shoreline with expected high erosion in 2030 (km)
Grande Côte	44	5
Corniche	24	3
Petite Côte	48	7
Total	96	15

Source: JICA Study Team based on World Bank, *Etude économique et spatiale de la vulnérabilité et de l'adaptation des zones côtières aux changements climatiques au Sénégal, Phase 2*, 2013.

Figure 7.8.9 Candidate Shoreline for Priority Sites to Apply Countermeasures

(4) Development Scenario toward 2035

The development scenario toward 2035 is proposed as shown in Table 7.8.6.

Table 7.8.6 Development Scenario for Urban Disaster Risk Reduction toward 2035

Theme	Target	No	Current (2015)	Short term (2020)	Medium term (2025)	Long term (2035)
Overall disaster risk reduction	Enhanced capacity for dealing with emergency situations at all levels of government	1-1	No contingency plans	Contingency plans prepared by DPC and at regional and departmental gov. levels	Contingency plans prepared at *commune* level	Contingency plans continuously updated
		1-2	Limited number of personnel in DPC and BNSP	Number of personnel in DPC and BNSP is double compared with the 2015 level		
		1-3	Limited training opportunities	Training of personnel related to disaster risk reduction continually implemented		
	Raised popular awareness and activation of community-based disaster risk management	1-4	Low awareness of disaster risk reduction	Priority communities identified and pilot activities conducted	Information and Education Campaign (IEC) continually implemented	
		1-5	Few community activities in disaster risk reduction	Priority communities identified and pilot activities conducted	Promotion of community-based disaster risk management continually implemented	
	Sharing of disaster information among relevant organizations and populations	1-6	No disaster risk management center	Disaster risk management center established	Disaster risk management center operates in good condition	
		1-7	No information system for disaster risk reduction	Integrated information system for disaster risk reduction began operating	Integrated information system for disaster risk reduction enhanced	Integrated information system for disaster risk reduction operating in good condition
		1-8	Early warning up to region level	Early warning mechanism established in pilot area	Early warning mechanism established in priority area	Early warning mechanism established in the whole Study Area
Flood hazard	Established and well-managed Flood Management Area where flood hazard is expected to be severe	2-1	Concept of Flood Management Area proposed	Flood Management Area is reflected in all PUD	Flood Management Area well managed	
		2-2		Capacity for dealing with Flood Management Area enhanced		
	Enhanced non-structural measures such as establishment of early-warning system and preparation/dissemination of flood hazard map	2-3	No flood hazard map	Flood hazard map prepared and disseminated in priority area	Flood hazard map prepared and disseminated in the entire Study Area	Flood hazard map continually updated
		2-4	Weak meteo-hydrological monitoring system	Meteo-hydrological monitoring system enhanced in priority area	Meteo-hydrological monitoring system enhanced in the entire Study Area	Meteo-hydrological monitoring system maintained in good condition
	Installed and well-maintained main drainage facilities in almost all urban areas by land use category, with safety level of extreme storm events with 10-year return period	2-5	PDA plan only in Dakar Department	PDA fully implemented in Dakar Department Drainage facilities well maintained		Drainage facilities well maintained
		2-6	PDD partially implemented in Pikine, Guédiawaye departments	PROGEP completed	PDD fully implemented in Pikine, Guédiawaye departments Drainage facilities well maintained	
		2-7	Old master plan for Rufisque urban area	Old master plan updated	Updated master plan implemented in Rufisque urban area Drainage facilities well maintained	
		2-8	No flood control/ drainage master plan in new urban expansion area	Urban drainage master plan prepared for new urban expansion area	Master plan implemented in new urban expansion area Drainage facilities well maintained	
Coastal hazard	Established framework of coastal protection and management	3-1	Almost no coordination among urban development sector and coastal management body	Comprehensive coastal management plan prepared and framework for management established	Coastal protection and management area well conserved	
	Protected coastal zone by implementation of countermeasures for priority coastal area	3-2	Limited countermeasures for coastal erosion	Priority area identified	Countermeasures for coastal erosion on priority area implemented	

Source: JICA Study Team

(5) Programs and Projects

In relation to the development scenario shown in Table 7.8.6, the programs and projects proposed by the JICA Study Team, as well as the ongoing projects aiming to achieve the target, are listed in Table 7.8.7.

Table 7.8.7 Ongoing and Proposed Programs and Projects (Draft)

Theme	Program/Project	Status	Assumed Responsible Agency	Support	Related Theme /Target	Short (2020)	Medium (2025)	Long (2035)
Overall disaster risk reduction	Disaster Risk Management and Climate Change Adaptation Project (DRM Plan) (Phase 2)	Ongoing	DPC	WB	1-1, 1-2, 1-3, 1-4, 1-5, 1-6, 1-7, 1-8	I		
	Program for Preparation of Contingency Plans at Local Government Level	Proposed	DPC		1-1	I	I	
	Program for Training Personnel related to Disaster Risk Reduction	Proposed	DPC/BNSP		1-2	I	I	I
	Technical Assistance Project for Capacity Development on Disaster Risk Reduction	Proposed	DPC		1-4, 1-5, 1-7, 1-8	I		
	Program for Enhancement of Awareness against Disaster Risk and Community-based Disaster Risk Management	Proposed	DPC		1-4, 1-5	I	I	I
	Project for Enhancement of Integrated Information System for Disaster Risk Reduction	Proposed	DPC		1-7		I	
	Program for Expansion of Early Warning Mechanism	Proposed	DPC		1-8	I	I	I
Flood hazard	Preparation of PUD in Pikine, Guédiawaye Departments under Storm Water Management and Climate Change Adaptation Project (PROGEP)	Ongoing	ADM/DUA	WB	2-1, 2-6	I		
	Technical Assistance Project for Capacity Development on Land Use Management with Emphasizing Concept of Flood Management Area	Proposed	DUA/others		2-1, 2-2, 2-3	I		
	Program for Preparation and Dissemination of Flood Hazard Map	Proposed	MHA/DGPRE / ADM/ONAS		2-3	I	I	I
	Project for Enhancement of Meteo-hydrological Monitoring	Proposed	ANACIM/ DGPRE		2-4	I	I	
	Implementation of PDA (Drainage component) in Dakar Department	Master Plan completed	ONAS		2-5	I	I	
	Implementation of PDD in Pikine, Guédiawaye Departments under Storm Water Management and Climate Change Adaptation Project (PROGEP) Phase-2	Ongoing	ADM	WB	2-6	I		
	Implementation of remaining portion of PDD in Pikine, Guédiawaye Departments	Master Plan completed	ADM/ONAS		2-6		I	I
	Rehabilitation/Expansion of Drainage System for Urban Area of Rufisque	Proposed	ONAS		2-7	S	I	
	Formulation of Urban Drainage Master Plan and its Implementation for Northern Catchment Area of Rufisque	Proposed	ADM/ONAS/ MHA		2-8	S	I	I
	Formulation of Urban Drainage Master Plan and its Implementation for Eastern Catchment Area of Rufisque	Proposed	ADM/ONAS/ MHA		2-8	S	I	I
	Formulation of Urban Drainage Master Plan and its Implementation for Catchment Area with Emergent Urbanization of Diamniadio and Daga Kholpa	Proposed	ADM/ONAS/ MHA		2-8	S	I	I
	Formulation of Urban Drainage Master Plan and its Implementation	Proposed	ADM/ONAS/ MHA		2-8	S	I	I

	for Southern Catchment Area of Daga Kholpa							
	Formulation of Urban Drainage Master Plan and its Implementation for Other Areas in the Territory of Master Plan 2035	Proposed	ADM/ONAS/ MHA		2-8		S	I
Coastal hazard	Economic Regional Program (PER)/Program of Inshore Erosion in Senegal	Ongoing	DEEC	UEMOA	3-2	I		
	Formulation of Comprehensive Coastal Management Plan and its Implementation in Corniche	Proposed	DUA/DEEC		3-1, 3-2	S	I	I
	Formulation of Comprehensive Coastal Management Plan and its Implementation in Grande Côte	Proposed	DUA/DEEC		3-1, 3-2	S	I	I
	Formulation of Comprehensive Coastal Management Plan and its Implementation in Petite Côte	Proposed	DUA/DEEC		3-1, 3-2	S	I	I

Note: Proposed=Proposed by JICA Study Team at conceptual level, I=Implementation, S=Study,
Source: JICA Study Team

7.8.4 Cost Estimate

The implementation of the ongoing and proposed programs and projects requires a considerable amount of investment, especially for the structural measures. Although it is very difficult to estimate the cost for the proposed projects at this moment, the order of magnitude of the required investment is very roughly estimated as shown in Table 7.8.8.

Table 7.8.8 Order of Magnitude of Required Investment

	Project	Project Cost (billion FCFA)
Flood hazard	Implementation of PDA (drainage component) in Dakar Department[*1]	22
	Implementation of remaining portion of PDD in Pikine and Guédiawaye departments, including PROGEP Phase-2[*2]	88
	Rehabilitation/expansion of drainage system for urban area of Rufisque[*3]	6
	Formulation of urban drainage master plan and its implementation for new urban expansion areas (northern catchment area of Rufisque, eastern catchment area of Rufisque, catchment area with emergent urbanization of Diamniadio and Daga Kholpa, southern catchment area of Daga Kholpa, other areas in the territory of 2035 Master Plan)[*4]	199
Coastal hazard	Formulation of comprehensive coastal management plans and their implementation[*5]	75
Total		390

Source: *1: ONAS, *ETUDE D'ACTUALISATION DU PLAN DIRECTEUR D'ASSAINISSEMENT LIQUIDE DE DAKAR 2025*, 2013.
*2: ADM, *ETUDE DU PLAN DIRECTEUR DE DRAINAGE (PDD) DES EAUX PLUVIALES DE LA REGION PERIURBAINE DE DAKAR, RAPPORT N° 3, LE PLAN DIRECTEUR DE DRAINAGE PLUVIAL, RAPPORT FINAL*, 2012.
*3: JICA Study Team: The unit cost for rehabilitation/expansion per drainage area (km^2) in PDA area is referred to, assuming a similar drainage system.
*4: JICA Study Team: The unit cost for new construction per drainage area (km^2) in PDD/PROGEP area is referred to, assuming a similar drainage system.
*5: JICA Study Team: The unit cost for dike construction in Rufisque (Thiawlène) per shoreline length (km) given in the Project for Funds for Adaptation to Climatic Changes is referred to.

About 390 billion FCFA could be required from 2015 to 2035 for the structural measures; the annual investment is about 20 billion FCFA/year on average.

Most of the proposed programs relating to non-structural measures would be implemented under the routine work of responsible agencies. However, the necessary budget and human resources should be secured for this implementation. The proposed technical assistance projects would provide support to

allow the programs to go online, which may require additional inputs such as international experts and supporting equipment.

7.9 Investment Requirement

The investment requirement is obtained from the estimates of broad investment requirements in each sector presented in Section 7.1 to 7.8. The total investments were classified into those to be borne by the private sector and those to be borne by the government budget as shown in Table 7.9.1. The proportions to be borne by the private sector were assumed in consideration of the policies of the Senegalese government in promoting PPP and the nature of the projects.

Table 7.9.1 Investment Requirements for Master Plan 2035

Sector	a. Total Investment requirements required for 2035 Master Plan (million FCFA)	b. Amount that could be financed by private sector (million FCFA)		c. Investment requirement for the government (million FCFA) *a-b*
1. Urban transport	2,594,619	2,008,200		586,419
Road	*436,419*	*0*		*436,419*
Public transport	*2,158,200*	*2,008,200*	*(1)*	*150,000*
2. Logistics	552,059	270,000		282,059
Dakar Port 3rd pier	*12,059*	*0*		*12,059*
Bargny Port	*540,000*	*270,000*	*(2)*	*270,000*
3. Water resources and water supply	401,140	101,525		299,615
Water resources	*363,180*	*101,525*	*(3)*	*261,655*
Water supply	*37,960*	*0*		*37,960*
4. Sewerage and sanitation	14,486	50		14,436
Sewage treatment plant	*238*	*43*	*(4)*	*196*
Sewer network	*248*	*8*	*(4)*	*241*
Septage treatment plant	*14,000*	*0*		*14,000*
5. Solid waste management	129,000	115,500		13,500
Incineration plant	*120,000*	*108,000*	*(5)*	*12,000*
Recycling facility	*1,500*	*750*	*(6)*	*750*
Composting plant	*1,500*	*750*	*(6)*	*750*
Sanitary landfill	*6,000*	*6,000*		*0*
6. Electricity and renewable energy	3,174,000	2,204,553	*(7)*	969,447
Power generation	*2,790,000*	*2,204,553*		*585,447*
Transmission and distribution	*384,000*	*0*		*384,000*
7. Urban disaster risk reduction	390,000	0		390,000
Flood hazard prevention	*315,000*	*0*		*315,000*
Coastal hazard prevention	*75,000*	*0*		*75,000*
Total	**7,255,304** ***100%***	**4,699,828** ***65%***		**2,555,476** ***35%***

Note: (1) Including 100% of TER (regional express train), 50% each of three BRT phases for vehicles, 100% of five routes of BHLS (bus with high level of service), 100% of railway Diamniadio-Daga Kholpa-AIBD and 100% of high-speed ferry service Dakar-Rufisque.
(2) 50% assumed.
(3) 100% of Kayak Desalination Plant by PPP assumed.
(4) 50% assumed to be borne by private sector for Diamniadio and Daga Kholpa.
(5) 90% assumed to be borne by private sector.
(6) 50% assumed to be borne by private sector.
(7) 80% assumed to be borne by independent power producers (IPPs) for thermal power plants according to SENELEC's policy and 50% assumed to be borne by private sector for low-head hydropower generation on the basis of PPP assumed.

Source: JICA Study Team

CHAPTER 8 STRATEGIC ENVIRONMENTAL ASSESSMENT

8.1 SEA Procedure

The following sections transcribe in a condensed way the essential results of the SEA: firstly, the prospective work of comparison of (8.2) the different spatial development scenarios and of the (8.3) PUD candidate sites and, secondly, the (8.4) evaluation of the impacts of development strategies and spatial organization adopted by the PDU, for which (8.5) enhancement measures for positive impacts and suppression, reduction and mitigation measures for negative impacts will be proposed.

8.2 Evaluation and Comparison of Spatial Development Scenarios

Within the framework of the upgrading of the PDU for Dakar, three scenarios of development are envisaged. In spite of the differences in ambition, they all plan to build a multipolar urban structure. The urban poles are defined as zones sheltering urban activities, in particular business and commercial activities, and public services at the national, regional and urban level.

This common aim was certainly already displayed in the PDU 2025, but the old document acknowledged the encroachment of urbanization on the Niayes area and did not clearly define the functions, the limits and the land needs of every urban pole.

The new aspect of this stated ambition is that every urban area will have a compact built-up area and be surrounded by a green belt to curb urban sprawl.

Scenario A-1: The dual pole of Plateau-Diamniadio

Scenario A-1 is based on an urban structure with the two important poles of Dakar-Plateau and Diamniadio. In reality, this scenario corresponds to the continuation of the current trend, which remains marked by the increasing importance of Diamniadio. Indeed, this pole under construction will obtain important investments and already enjoys a very good level of service in terms of infrastructure for transport including the national road and the toll highway.

In addition, in the field of real estate, Diamniadio is already the location of important projects, which will allow this pole to become a business center of a scale able to compete with Plateau. The centrality of Diamniadio will also be strengthened by the envisaged transfer of administrations such as ministries and the construction of various structuring facilities such as hospitals, universities, hotels, conference centers, etc.

The preservation of this trend, however, risks heavy consequences for protected areas (classified forests) and agricultural areas with very fertile soils. The urbanization would also take a linear shape by utilizing an axis parallel to the road of Thiès, which could accelerate the process of conurbation between the urban areas of Thiès and Dakar.

Due to the configuration of the site and its type, flood risks will be important if the land use is not preceded by the elaboration of detailed town planning schemes and the realization of drainage works for rainwater.

Besides the negative impact that it might have, the realization of this scenario will have some positive impacts. In fact, with all the many functions (academic, industrial facilities, services, residential) this

pole will enable, we offer a spatial reorganization that will result in an easing of the pressure on land that is already very important in the fragile areas of the urbanized region. Indeed, given the low availability of land, the forest massifs, the Niayes, the *Casuarina* strip and the coast are all very threatened by the progress of the built frontier.

In due course, we will also attend to the decline in traffic and air pollution in the city center of Dakar.

Scenario A-1 has many advantages in many domains, but environmentally its implementation could jeopardize the protected areas (forests in Pout and Thiès) and very fertile farmlands.

Scenario A-2: A multipolar urban structure

Scenario A-2 is based on an urban structure built around three poles, including the promotion of the new urban pole of Daga-Kholpa, besides those of Diamniadio and Dakar-Plateau. It supposes that some of the investments that could drain the urban pole of Diamniadio would be directed to Daga-Kholpa, in particular in the field of aeronautics services.

The choice of this scenario could also reconfigure the regional space and reorient the direction of progress of the urbanization frontier toward the southeast of Diamniadio and along National Route 2. The agricultural sites in the north of Diamniadio and the surrounding forests could thus be protected.

At the industrial level, the attraction exercised by this urban center could decrease the concentration of firms in Dakar and Diamniadio. It will contribute to reducing air pollution and promoting thermal control.

Despite its many advantages, this scenario has some environmental risks. There is not enough emphasis on mitigation measures for some negative effects, such as the creation of green networks within and around the urban poles.

Scenario B: A multipolar urban structure that preserves the environment

In terms of proposals, Scenario B has several similarities to Scenario A-2. It retains an urban structure model based on three poles, but insists on the preservation of environment and farmland and offers real levers to stop the urbanization frontier moving toward these protected areas. It proposes to make Niayes a green belt connected to the classified forests and reserves an important place for green spaces inside the urban poles.

Scenario B has several advantages over other planning scenarios. It offers a balanced development with a multipolar structure and includes measures to protect the environment.

Table 8.2.1 Summary Table of Comparative Analysis of the 2025 Master Plan and the Proposed Spatial Development Scenarios

Plan/ scenarios	Natural environment		Social environment		Economic aspect	
	Advantages	**Inconvenient**	**Advantages**	**Inconvenient**	**Advantages**	**Inconvenient**
PDU Horizon 2025	Protected areas are excluded from urbanization (Forest at Mbao, *Casuarina* strip, lakes, etc.).	Insufficient protection of sensitive areas (Niayes, agricultural land in the rural areas, forests, coastline, etc.). No proposals of countermeasures against floods and coastal erosion.	Restructuring and land regularization of traditional villages.	Competition for land use and loss of agricultural jobs in the rural area due to urbanization. Accentuation of the pressure on land tenure in the central part of the city.	Important proposals in terms of infrastructure and superstructure. Renovation of old urban cores. Proposal of many proximal poles.	Loss of agricultural potential. Multitude of unstructured urban centers, which are unable to compete with Plateau.

Plan/ scenarios	Natural environment		Social environment		Economic aspect	
	Advantages	**Inconvenient**	**Advantages**	**Inconvenient**	**Advantages**	**Inconvenient**
		Absence of relevant proposals to fight against all forms of pollution.				
Scenario A1	Decrease of urban pressure on wetlands, forests in the center and the west of the city of Dakar. Transfer of polluting industries to Diamniadio.	Important threats to agricultural lands and the classified forests of Diamniadio and Pout. High risk of flooding. Risk of pollution of Diass and Pout water tables.	Satisfactory supply of a portion of the housing demand. Improved equipment standards. Employment opportunities.	Threats to agricultural jobs. Social tensions arising from the demand for lands among local communities (residents, project developers, local authorities, etc.).	Strengthening of the urban pole of Diamniadio. Settlement of new companies. Improved physical links. Spatial recomposition.	Bipolar structure. Decline of downtown Dakar. Ribbon urbanization along Dakar-Thiès axis. Decline of horticultural production in the Diamniadio area. Disintegration of the local economy.
Scenario A2	Preservation of sensitive areas in the departments of Dakar and Pikine. Decrease of all forms of pollution.	Threats to agricultural areas and to the classified forests of Diamniadio, Daga-Kholpa and Pout. High risk of flooding. Risk of pollution of Diass and Pout water tables.	Satisfactory supply of a portion of the housing demand. Improved equipment standards. Employment opportunities.	Threats to agricultural jobs. Social tensions arising from the demand for lands among local communities of Daga-Kholpa and Diamniadio (residents, project developers, local authorities, etc.).	Multipolar structure. Well-balanced land use. Less congestion and fewer traffic jams in Dakar. New opportunities for the private sector. Enhancement of the attractiveness of the Senegalese capital.	Decline of Plateau. Disintegration of the local economy (Diamniadio and Daga-Kholpa). Decline of horticultural production in the Diamniadio area.
Scenario B	Preservation of sensitive areas in the entire Study Area (forests, wetlands, shoreline). Decrease of all forms of pollution. Reduction of car traffic in Dakar.	High risk of flooding in Diamniadio and Daga-Kholpa areas. Threats to groundwater operated by SDE.	Satisfactory supply of housing plots to meet demand. Improved equipment standard. Employment opportunities.	Threats to agricultural jobs. Social tensions arising from the demand for lands among local communities of Daga-Kholpa and Diamniadio (residents, project developers, local authorities, etc.).	Multipolar structure. Well-balanced land use. Less congestion and fewer traffic jams in Dakar. New opportunities for the private sector. Enhancement of the attractiveness of the Senegalese capital.	Decline of Plateau. Disintegration of the local economy (Diamniadio and Daga-Kholpa). Decline of horticultural production in the Diamniadio area.

Source: JICA Study Team based on "First Phase Report of the SEA" of Dakar PDU

8.3 Evaluation and Comparison of PUD Candidate Sites

In order to confirm or deny the evaluation of PUD candidate sites based on the various criteria elaborated in the PDU study, an environmental analysis was also conducted for a comparison of the candidate sites. The reserve approach is based on the confrontation of environmental issues with implications for the development of each site according to the following criteria:

- Absence of significant risks of biodiversity loss and encroachment on natural areas
- No risk of social conflict or deterioration of quality of life
- No risk of pollution of natural environment
- Absence of risk of disturbance of activities (agricultural, livestock and fishery) by the housing environment

The results of the environmental comparison, integrated and summed with the scores resulting from the other selection criteria, are shown in Table 8.3.1 below. The addition of environmental criteria confirms the selection of Daga-Kholpa as target PUD site.

Table 8.3.1 Selection Criteria Results for Score with Environmental Evaluation

Selection Principles	Selection Criteria	Dakar New City	Daga-Kholpa	Diamniadio	Dakar New City	Pikine Urban Center	Rufisque	Diacksao Bambilor	Déni Biram Ndao	SODIDA	Yenne
Overarching Principles											
In line with PNAT long-term vision	Promoting decentralization (enhancing urban management in suburban area)		x	x		x	x	x	x		x
In line with SRAT long-term vision	Strengthening the regional structure		x	x			x				x
In line with the long-term vision and goals of Dakar 2035 Master Plan	Promoting Dakar PDU	x	x	x	x	x	x	x	x	x	x
Development-Related Criteria											
Supporting actions already initiated by the government of Senegal		x	x	x	x	x				x	x
Responding to a real and urgent need for a detailed plan			x					x	x		x
Setting the pace for new development trends		x	x	x	x	x	x			x	x
Promoting new economic activities (ICT, Logistics Platforms, etc.)		x	x	x	x	x					x
Promotion of new urban area for population growth			x	x			x	x	x		x
Upgrading existing urban areas		x			x	x	x			x	
Control-Related Criteria											
Absence of an approved PUD (Detailed Urban Plan)		x	x	x	x	x	x	x	x	x	x
Reducing encroachment on farms (tackling sites with critical issues in terms of development control, protection of areas facing imminent development pressure, controlling urban sprawl and land speculation)								x	x		
Improvement of disaster prevention and urban resilience			x				x				
Promoting Capacity Building and Local *Communes*' Involvement											
Capacity building of DUA (replicating experience in other *communes*)			x	x		x	x	x	x		x
Usefulness for urban management by local governments			x	x			x	x	x		x
Score without Environmental Evaluation		6	12	10	6	8	10	8	8	5	11
Environmental Criteria											
Absence of significant risks of biodiversity loss and encroachment on natural areas		x	x		x	x	x			x	x
No risk of social conflict or deterioration of quality of life		x	x		x	x	x			x	
No risk of pollution of natural environment		x			x	x	x			x	
Absence of risk of disturbances of activities (agricultural, livestock and fishery) by housing environment.		x			x	x				x	
Score with Environmental Evaluation		10	14	10	10	12	13	8	8	9	12

Source: JICA Study Team based on "First Phase Report of the SEA" of Dakar PDU

8.4 Evaluation of the Impacts of Development Strategies and Spatial Organization adopted by the PDU

8.4.1 Overall Summary of the Results of the Impact Assessment

After having chosen the Scenario B as the most appropriate spatial development model, the land use plan has been sketched and the development strategies have been drafted, the Strategic Environmental Assessment aims to assess the impacts of these two components of the PDU. It should be noted that, in the iterative process of the SEA, the assessment of the draft PDU has led to the refining of the strategies towards more realistic implementation at the final stage. The criteria adopted for impact assessment, which are most relevant to reflect both local characteristics of Dakar region and urban issues dealt with the PDU, are the following:

- Quality of surface water and groundwater;

- Air quality and reduction in noise:
- Biodiversity conservation;
- Access to basic social services (health, education, transport, communication, etc.);
- Ecological value of the site;
- Level of soil erosion;
- Soil quality and pollution;
- Landscape quality and quality of life of populations (quietness, space, etc.);
- Land use (agriculture, livestock, housing, etc.).

The following table shows the overall summary of the results of the assessment of the impacts of all the aspects of the PDU regarding the adopted criteria.

Table 8.4.1 Overall Summary of the Results of Impact Assessment of the PDU

		Development strategies / spatial organization					
		Economic Development Strategy	Strategy and Spatial Organization of Infrastructure Development	Strategy and Spatial Organization of Urban Development	Strategy for Environmental Management	Strategy for Social Development	Risk Management Strategy Related to Urban Disasters
Adopted criteria	Quality of surface water and groundwater	B-	**A+**	B-	**A+**	D	D
	Air quality and quietness of populations	C+	**A+**	B+	**A+**	D	**B+**
	Biodiversity conservation	B-	C-	B-	**A+**	B-	**A+**
	Access to basic social services	B+	**B+**	**A+**	C+	**A+**	D
	Ecological value of the site	B+	C+	B+	**A+**	C+	**A+**
	Level of soil erosion	D	C+	C+	**A+**	D	B+
	Soil quality and pollution	C+	**A+**	**A+**	**B+**	D	D
	Landscape quality and quality of life	**B+**	**B+**	**B+**	**B+**	D	**B+**
	Land use	**B+**	C-	C±	**A+**	C+	D

Note: A+/-: Remarkable Positive / Serious Negative Impact is predicted.
B+/-: Positive / Negative Impact is expected to some extent.
C: Extent of the impact is unknown (a further examination is needed and the impact might be defined as study progresses).
D: Impact is very small or nil and further survey is not required.

Source: JICA Study Team based on "Second Phase Report of the SEA" of Dakar PDU

For each type of strategy and in terms of spatial organization developed in the PDU, the general

evaluation will be completed by a more detailed evaluation of the impacts, presented in a table in which each impact will be justified by a comment. By doing so, both a global and a fine-grained approach to the impacts will be ensured.

8.4.2 Evaluation of the Economic Development Strategy

In the field of economic development, development strategies usually focus on industry and tourism, while fishing, which mobilizes thousands of people and provides significant financial windfall in the regional economy, is rarely taken into account.

For the industrial sector, the guidelines of the document tend toward the direction of the development of industrial zones, special economic zones and SMEs, as well as the strengthening of human capacity building.

The document also suggests the formulation of rules and regulations for industries as well as the preparation of ETFP infrastructures in the industrial area and the ZES in association with the private sector. This strategy will facilitate the transfer of the heavily polluting companies located in Hann Bay and some residential zones. It will also reduce the risk of industrial disasters in the conglomeration of Dakar.

However, the development of spaces dedicated to industries will necessarily be accompanied by an appropriate management of the environmental dimension (PUD, SEA, Environmental and Social Impact Assessment, etc.) to ensure a balance in land use.

The companies that will be transferred into these new industrial zones (Diamniadio and/or DISEZ) should be supervised by stricter regulations favoring cleaner technologies.

Regarding tourism, the proposed strategy will improve the living environment and make Dakar Region more attractive for tourists. Indeed, it suggests the protection of natural areas, waste disposal management and the creation of adequate housing areas, as well as the development of urban pedestrian walkways and bicycle networks.

The following table shows the results of the detailed assessment, based on adopted criteria, of the impacts caused by the economic development strategy:

Table 8.4.2 Detailed Assessment of the Impacts caused by the Economic Development Strategy

	Detailed assessment of the impacts caused by the economic development strategy				
	General impact	Short term	Medium term	Long term	**Comment**
Quality of surface water and groundwater	**B-**	C-	B-	B-	The development of industries in very sensitive regions such as Diamniadio or Daga-Kholpa will threaten surface water and groundwater quality. Furthermore, the development of economic activities such as agriculture and industry may also increase water consumption and disrupt the supply of drinking water to the populations of the region.
Air quality and quietness of populations	**C+**	B+	C-	C+	This strategy will facilitate the transfer of heavily polluting companies located on the Bay of Hann and within some residential areas to some more appropriate locations, which, in the short term, will have a generally positive impact on the reduction of air pollution on the whole target area. However, the transfer of these highly polluting industries will not be enough because their relocation to new sites still will generate pollution if these industries are not modernized and upgraded to environmental norms. This strategy will also reduce the risk of industrial disasters due to chemical industries in the Greater Dakar area.
Biodiversity conservation	**B-**	B-	B-	B-	The biodiversity will inevitably be affected in the short term by the establishment of industrial units on new sites that were formerly natural areas. However, the development of new green areas could offset potential loss of biodiversity.
Access to basic social services (health, education, transport, comm., etc.)	**B+**	B+	B+	B+	Globally positive.
Ecological value of the site	**B+**	B+	B+	B+	The transfer of polluting industries will not signify a simple transfer of pollution from one site to another. This is why the expected positive impact of the transferral of former industrial sites must not be offset by the negative impacts that could be expected by new sites of ecological value receiving these polluting industries. Furthermore, the creation of green spaces with a certain ecological value in themselves may have tourism potential.
Level of soil erosion	**D**	D	D	D	No impact.
Soil quality and pollution	**C+**	B+	C+	C-	This strategy will promote agriculture and industry transfer and therefore an increase in soil pollution could be expected on new sites, although the old sites will become less polluted after transfer.
Landscape quality and quality of life of populations (quietness, space, etc.)	**B+**	B+	B+	B+	An improvement in the landscape quality and quality of life of residents could be expected in the surroundings of the former industrial sites and in particular in the coastal area of Hann bay, which has a strong potential in terms of landscape, tourism and identity at regional level.
Land use (agriculture, livestock, housing, etc.)	**B+**	B+	B+	B+	Globally positive.

Source: JICA Study Team based on "Second Phase Report of the SEA" of Dakar PDU

8.4.3 Evaluation of the Strategy and Spatial Organization of Infrastructure Development

The infrastructure development strategy mainly targets the sectors of urban transport, logistics, water resources, sanitation, electricity, etc.

In **urban transport**, the strategy will ensure promotion of public transport (PTB, BRT) to reduce the number of passenger cars and pollution. The PDU is moving toward the establishment of an urban transport system that supports transfer and intermodal public transport corridors such as the BRT.

The document advocates the improvement of the road network. This will help to avoid an excessive concentration of traffic on certain axes, which often leads to economic and time losses.

Regarding **waste management**, the strategy is moving toward closing Mbeubeuss, reopening Sindia and identifying a new discharge (treatment and deposit). This could be achieved by two options: one is to build a new regional CET covering Dakar Region and the other would be to enlarge the CET of Sindia. However, this strategy will have to solve the problem of the reluctance of the population, who have so far halted all efforts toward opening the CET at Sindia.

The improvement in the sewer connection rate will reduce pollution of water resources. The collection of household waste water will be ensured and the management of water discharges from polluting industries will be improved significantly. This development strategy would also open up significant possibilities for the reuse of wastewater in agriculture.

In the field of **electricity**, the main orientation to retain is the promotion of renewable energy. This will probably ensure a reduction in pollution and the promotion of temperature regulation by encouraging the energy mix to reach significant levels (40% to 50% by 2035).

Regarding the aspects related to **logistics**, the recommendations of the strategy that could be decisive for the Study Area concern the port, the airport and the railway.

As for Dakar Port, strengthening its efficiency and its competitiveness will have some economic impact, but also some negative effects on the environment that could be significant. Indeed, to achieve this goal, it will be necessary to carry out works that could have an accelerating impact on coastal erosion in the regions of Mbao and Rufisque, which are already very affected by this phenomenon.

It will also be necessary to better manage the risk of pollution in the harbor water perimeter due to internal and external illegal discharges (boats, sewage, etc.).

In the longer term, it is possible that the improvement of the competitiveness of the port will cause an increase in air pollution as well as wholesale carriers including traffic on the old road at Rufisque and National Road 1. It is also very likely that this risk will spread to the roads that run to the border with Mali.

The accompanying measures advocated by the strategy for AIBD that aim to facilitate access and optimize its benefits are already effective or under implementation. Indeed, the extension of the motorway to the airport is almost complete and the Regional Express Train project from Dakar to AIBD is making significant progress. On another level, the special economic zone will allow the area to receive facilities that can support the development of the airport. These projects, despite their many economic benefits, could cause damage to the environment. The desirability of lands now occupied by the classified forests of Pout and Diass, etc., could significantly increase.

Furthermore, due to the settlement of **industries** in the special economic zone and in the urban centers of Diamniadio and Daga-Kholpa, there could be an increase in air pollution and contamination of groundwater even if the reverse phenomenon occurs in Dakar's former center.

The resurgence of industrial activities and the increased vehicle flow could also have negative effects on thermal regulation.

The improvement of the **Dakar-Bamako railway line** is consistent with the proposal concerning Dakar Port. It will have a positive economic impact since the railway has the capacity to transport large quantities of goods to Mali. Furthermore, it is likely that it will cause a reduction in road traffic and therefore of air pollution in the regional corridors usually used by large Malian trucks.

The strategy regarding **water resources** will strengthen their protection against various forms of pollution and promote judicious use. The treatment and recycling measures could reduce water consumption through reuse in activities such as gardening. This would provide opportunities for the pre-operation of water tables such as the one in Thiaroye.

The following table shows the results of the detailed assessment, based on adopted criteria, of the impacts caused by the strategy and the spatial organization of infrastructure development:

Table 8.4.3 Detailed Assessment of the Impacts caused by the Strategy and the Spatial Organization of Infrastructure Development

	Detailed assessment of the impacts caused by the strategy and the spatial organization of infrastructure development				
	General impact	Short term	Medium term	Long term	**Comment**
Quality of surface water and groundwater	**A+**	A+	B+	C+	The solid waste strategy is oriented toward the closing of Mbeubeuss, the reopening of Sindia and identification of a new landfill site (treatment and deposit). This could be done by two options: one is to build a new regional CET covering the Dakar region and the other would be to expand Sindia CET. This strategy employs the remediation of surface water and groundwater because the waters around the Mbeubeuss area are contaminated. However, there is uncertainty in the long term regarding the capacity of the site of Sindia to actually take care of the entire volume of Mbeubeuss activity.
Air quality and quietness of populations	**A+**	B+	B+	A+	The transport strategy will ensure the promotion of public transport (PTB, BRT), which will reduce the use of private cars and consequently air pollution. It thus avoids the excessive concentration of traffic on certain roads, which often results in time loss and consequently economic losses for people. The quietness of roads will also thereby be improved. The maximum impacts will only be achieved in the long term because public transport policies take a lot of time to materialize and because transportation habits of users (modal shift from car to public transport) take even more time to evolve.
Biodiversity conservation	**C-**	C-	C-	C-	The PDU is moving toward the establishment of an urban transport system that promotes intermodal transfer and public transport corridors alongside the opening of a new landfill site. The implementation of these plans, including an all-important right-of-way, would certainly cause moderate negative impacts on biodiversity.
Access to basic social services (health, education, transport, comm., etc.)	**B+**	B+	B+	B+	The PDU promotes the improvement of the road network, which will allow improved access to basic services. In addition, the moving of the Mbeubeuss landfill, which was too close to homes, will improve the health of a population affected by air and groundwater pollution.
Ecological value of the site	**C+**	C+	C+	C+	Ecology in its broad sense (special ecosystem, forest, etc.) will not be significantly affected.
Level of soil erosion	**C+**	C-	C+	B+	In the short and medium term, except for the redevelopment works of Dakar port, which might cause some risk of coastal erosion, infrastructure plans will have almost no influence on soil erosion. In the long term, the perfection of infrastructure, such as roads equipped with drainage systems, will even accompany a better overall rainwater management and therefore will impact soil and shoreline conservation more positively.
Soil quality and pollution	**A+**	A+	B+	C±	The closing of Mbeubeuss and the opening of a new landfill (treatment and deposit) will improve soil quality, especially in the surroundings of Mbeubeuss.
Landscape quality and quality of life of populations (quietness, space, etc.)	**B+**	B+	B+	B+	The infrastructure development strategy, which promotes the development of urban transport, logistics, water resources, sanitation and electricity, could help improve the quality of life of populations. This improvement has the potential to be accompanied by a greater care of the landscape of these infrastructures.
Land use (agriculture, livestock, housing, etc.)	**C-**	C-	C-	C-	It is possible that the rights of way of the various infrastructures, especially BRT corridors and the new landfill site, might cause negative social impacts of resettlement for some populations.

Source: JICA Study Team based on "Second Phase Report of the SEA" of Dakar PD

8.4.4 Evaluation of the Strategy and Spatial Organization of Urban Development

The strategy of urban development in the PDU advocates effective control of land use. The application of this policy will carefully determine the areas to be urbanized to limit encroachment into conservation areas and agricultural zones such as the Niayes.

The urban development strategies encourage the continuation of the policy of development of poles in the image of that of Diamniadio. Indeed, it is suggested that other poles be created, such as Daga-Kholpa, which is one of the candidate sites to benefit from a Detailed Urban Plan.

As regards the already urbanized zones, the strategy recommends that operations of restructuring and urban renewal be conducted.

Currently, many of the major services (hospitals, ministry, etc.) remain concentrated downtown (Plateau) or in the department of Dakar. To remedy this imbalance within the regional space, the PDU recommends the transfer of some state services to the urban pole of Diamniadio. As for equipment, the PDU gives the example of some hospitals and schools whose transfer could reduce the flow of private vehicles to the city center while awaiting the provision of alternative means of transport, such as a system of parking lot relays and ride systems using electric vehicles for public transportation (PTB, BRT). The decrease in the flow of cars moving daily to the downtown area and the promotion of alternative transportation will contribute to a significant drop in air pollution.

The urban development strategy proposes the redevelopment of industrial areas situated in the coastal and residential zones. Thus, new features could offer opportunities to improve the living environment and land availability to achieve collective social facilities (green spaces, commercial spaces, etc.).

Irregular or worse-off neighborhoods will also be restructured (Niaye Thioker, Rebeuss, Médina Gounass, etc.). These operations will make it possible:

- To improve the level of equipment (collective social equipment, sanitation, etc.) and the mobility of these neighborhoods.
- To reduce the sometimes very high densities of occupation of these areas.
- To decrease pollution and to act on thermal regulation.

The following table shows the results of the detailed assessment, based on adopted criteria, of the impacts caused by the strategy and the spatial organization of urban development:

Table 8.4.4 Detailed Assessment of the Impacts caused by the Strategy and the Spatial Organization of Urban Development.

	Detailed assessment of the impacts caused by the strategy and the spatial organization of urban development.				
	General impact	Short term	Medium term	Long term	**Comment**
Quality of surface water and groundwater	**B-**	B-	B-	B-	The implementation of this orientation could foster the deterioration of the quality of the water table of future housing areas, especially given that potential expansion areas are located close to agricultural lands (Diamniadio, Daga-Kholpa and Lac Rose), where there is already a high use of pesticides.
Air quality and quietness of populations	**B+**	B+	B+	B+	The constitution of a multipolar urban structure, the control of land occupation, early warning and resettlement, the "respiration" of the urban fabric through green and cultivated spaces, the promotion of mass transit and improvement of water supply and electricity may lead to an amelioration of the air quality at the regional level.
Biodiversity conservation	**B-**	B-	B-	B-	The strategy recommends the implementation of an urban renewal operation, which will not affect biodiversity. However, the development of new areas such as Daga-Kholpa, Diamniadio and Lac Rose will affect biodiversity.

Access to basic social services (health, education, transport, comm., etc.)	**A+**	A+	A+	A+	Spatial organization of urban development plans, not only the construction of new collective social amenities in newly urbanized areas, but also the upgrading of basic social services in the existing city.
Ecological value of the site	**B+**	B+	B+	B+	Unlike the previous PDU, the current draft PDU dedicates significant attention to the protection and preservation of ecologically valuable sites and especially Niayes or classified forests. However, the development of new areas such as Daga-Kholpa, Diamniadio and Lac Rose will affect the ecological balance of sites with a less important value in ecological terms. Furthermore, the realization of the sustainable city envisaged by the PDU will relieve the real estate pressure recorded on the lands of Dakar and Pikine departments. This situation has also led to the urbanization of non-building areas, such as the protected forests of Mbao, Hann and *Casuarina* strip. Its implementation therefore allows the preservation of the ecological value of the sites.
Level of soil erosion	**C+**	C+	C+	B+	The urban renewal operations will certainly have a positive impact on reducing soil erosion. However the urbanization of new centers such as Daga-Kholpa that are particularly exposed to erosion require special arrangements based on good land use to avoid any form of erosion.
Soil quality and pollution	**A+**	A+	B+	C±	The strategy tends to preserve soil quality because it promotes effective control of land use. The application of this policy will carefully determine the areas to be urbanized in order to limit the encroachment on natural areas, parks and fertile farmlands such as the Lac Rose area.
Landscape quality and quality of life of populations (quietness, space, etc.)	**B+**	B+	B+	B+	Development of new housing areas will relieve pressure on land recorded in the departments of Dakar and Pikine and restrain the greed over the classified forests Mbao, Hann and *Casuarina* strip. The landscape quality of the site and people's quality of life will increase. Promoting regional development through initiatives similar to the PSE, constructing a multipolar urban structure, controlling occupation, early warning and resettlement, promotion of mass transit and improving water supply and electricity service will curb the influx of people to the capital and promote a peaceful environment. The implementation of this approach also implies some resettlements including those living in areas prone to flooding. The displaced people will live in a safer and more comfortable environment outside of the flood-prone zone.
Land use (agriculture, livestock, housing, etc.)	**C±**	C±	C±	C±	The implementation of this strategy allows the determination of areas to be urbanized in order to limit encroachment on conservation areas and fertile agricultural areas such as Diamnadio or Lac Rose. The strategy contributes to a better organization of land use. However, unplanned speculative urbanization as well as irrelevant recommendations by previously adopted city planning documents may jeopardize the balanced land use model developed in the PDU.

Source: JICA Study Team based on "Second Phase Report of the SEA" of Dakar PDU

8.4.5 Evaluation of the Strategy for Environmental Management

The protection of wetlands, coastal areas and the balance of the large-scale agricultural and natural urban spaces are the three most important components of the environmental management strategy. To achieve this management, several approaches are proposed in the environmental management strategy, such as the adoption of regulatory protection measures in the PDU with a particular zoning that would encourage the continuation of activities such as market gardening and fishing. Wetlands are fragile ecosystems that will not accommodate certain human activities likely to affect the natural balance. That is why the proposal for their regulatory protection combined with fiscal and financial tools is

deemed relevant.

This strategy also discusses provisions for alternative sanitation including the promotion of soil sealing mitigation techniques. This will contribute to the better management of flood risks, especially alongside the development of public spaces, parking areas and roads with permeable materials. Rainwater management of plots should also be promoted by favoring infiltration.

The implementation of an environmental management strategy, in conjunction with coastal protection and the creation of buffer zones, will contribute considerably to the reduction of the advance of the sea and facilitate people's access to the beach. To reinforce these measures, laws and regulations are being considered, including the introduction of a law relating to the coast that would, among other measures, limit or prevent new constructions in the public maritime domain.

The orientation of the environmental management also focuses on the necessary balance between large-scale urban, agricultural and natural spaces. Indeed, urban agriculture, despite its positive impact on the local economy, like urbanization generates negative impacts due to the use of pesticides, which can destroy wildlife and deplete the quality of water resources.

Given its policy and the regulatory functions of urban development, the PDU must establish an intelligent balance between these three types of space.

The following table shows the results of the detailed assessment, based on adopted criteria, of the impacts caused by the strategy for environmental management:

Table 8.4.5 Detailed Assessment of the Impacts caused by the Strategy for Environmental Management

	Detailed assessment of the impacts caused by the strategy for environmental management				
	General impact	Short term	Medium term	Long term	**Comment**
Quality of surface water and groundwater	**A+**	A+	A+	A+	The implementation of an environmental management strategy will improve the necessary balance between urban, agricultural and natural on a large scale, in order to control the negative impacts from the use of pesticides in agriculture can destroy wildlife and the quality of water resources.
Air quality and quietness of populations	**A+**	A+	A+	A+	Land use projected to 2035 emphasizes the need for balance and separation of housing areas and industrial sites. This should qualitatively improve the tranquillity of the population in terms of noise and air pollution. Land use plans of subsequent city planning documents (PUD, subdivision plans) will reflect these concerns.
Biodiversity conservation	**A+**	A+	A+	A+	Protection of wetlands, coastal areas and balance between urban, agricultural and natural spaces on the large scale are the three most important components of environmental management strategy. These three components are directly correlated with the preservation of biodiversity.
Access to basic social services (health, education, transport, comm., etc.)	**C+**	C+	C+	C+	Indirectly, the balance of urban, agricultural and natural spaces facilitates access to basic services.
Ecological value of the site	**A+**	A+	A+	A+	The implementation of this strategy favors the protection of wetlands and coastal areas and the management of green spaces, which contributes to the preservation of environmentally sensitive areas.
Level of soil erosion	**A+**	A+	A+	A+	This strategy favors the management of rainwater to the plot and infiltration. The implementation of this strategy, in conjunction with coastal protection and the creation of buffer zones, will greatly contribute to coastal protection.
Soil quality and pollution	**B+**	B+	B+	B+	The reduction of soil pollution requires support in the environmental management strategy of aspects such as solid waste management, wastewater and misuse of pesticides.
Landscape quality and quality of life of populations (quietness, space, etc.)	**B+**	B+	B+	B+	This strategy contributes to a better management of flood risks, especially through the development of public spaces, parking areas and roads with permeable materials. It thus contributes toward improving the tranquillity of the environment, landscape quality and living conditions of the populations.
Land use (agriculture, livestock, housing, etc.)	**A+**	A+	A+	A+	The balance of agricultural and natural urban spaces on a large scale is the most important component of environmental management strategy.

Source: JICA Study Team based on "Second Phase Report of the SEA" of Dakar PDU

8.4.6 Evaluation of the Strategy for Social Development

Socially, the strategy advocated by the PDU supports an improved level of access to certain services. In the field of education, it will adapt the training provision to the needs of the labor market. Indeed, among the recommended measures is the creation of a university town in Diamniadio for the promotion of science and technology, as well as the establishment of cooperation between the state, industrialists and the academic community.

In the field of health, the creation of a medical city in Dakar, which could enhance its attractiveness in the health sector in Senegal and in the sub-region, is also suggested.

The following table shows the results of the detailed assessment, based on adopted criteria, of the impacts caused by the strategy for social development:

Table 8.4.6 Detailed Assessment of the Impacts caused by the Strategy for Social Development

	Detailed assessment of the impacts caused by the strategy for environmental management				
	General impact	Short term	Medium term	Long term	**Comment**
Quality of surface water and groundwater	**D**	D	D	D	No impact.
Air quality and quietness of populations	**D**	D	D	D	No impact.
Biodiversity conservation	**B-**	C-	C-	C-	There is a moderate risk of negative impact on local biodiversity when new sites formerly occupied by fauna and flora will be developed for the creation of new infrastructure, such as the university town in Diamniadio and the Medical City in Dakar.
Access to basic social services (health, education, transport, comm., etc.)	**A+**	A+	A+	A+	This strategy favors the improvement of the level of access to basic social services with the creation of a university town in Diamniadio for the promotion of science and technology and the creation of the Medical City of Dakar.
Ecological value of the site	**C+**	C+	C+	C+	There is a moderate risk of negative impact on the areas of ecological value where new sites formerly occupied by fauna and flora will be developed for the creation of new infrastructure, such as the university town in Diamniadio and the Medical City in Dakar.
Level of soil erosion	**D**	D	D	D	No impact.
Soil quality and pollution	**D**	D	D	D	No impact.
Landscape quality and quality of life of populations (quietness, space, etc.)	**D**	D	D	D	No impact.
Land use (agriculture, livestock, housing, etc.)	**C+**	C+	C+	C+	This strategy may cause the loss of highly fertile farmland such as in Diamniadio.

Source: JICA Study Team based on "Second Phase Report of the SEA" of Dakar PDU

8.4.7 Evaluation of the Risk Management Strategy Related to Urban Disasters

The orientations of the PDU are in the direction of a better integration of disaster issues in urban design and urban planning. It indeed suggests the strengthening of the coordination between town planning services and entities responsible for coastal management. The proliferation of buildings in the maritime public domain could be reduced by more rigorous urban regulations. This could favor a slowing down of coastal erosion, protect the *Casuarina* strip and allow the population to benefit from better access to the beaches of the region.

The risk management strategy for disaster will also make the Study Area more resilient to the risks of flooding. The continuation of the policy of carrying out drainage work in the image of that of PROGEP is indeed recommended.

The following table shows the results of the detailed assessment, based on adopted criteria, of the impacts caused by the risk management strategy related to urban disasters:

Table 8.4.7 Detailed Assessment of the Impacts caused by the Risk Management Strategy related to Urban Disasters

	Detailed assessment of the impacts caused by the risk management strategy related to urban disasters				
	General impact	Short term	Medium term	Long term	**Comment**
Quality of surface water and groundwater	**D**	D	D	D	No impact.
Air quality and quietness of populations	**B+**	B+	B+	B+	Risk management related to natural disasters (floods and coastal erosion) will preserve the tranquillity of the people living in the most exposed areas.
Biodiversity conservation	**A+**	A+	A+	A+	This strategy favors a slowdown of coastal erosion and protection of the *Casuarina* strip and thus plays a role in preserving biodiversity.
Access to basic social services (health, education, transport, comm., etc.)	**D**	D	D	D	No impact.
Ecological value of the site	**A+**	A+	A+	A+	This strategy favors a slowdown of coastal erosion and protection of the *Casuarina* strip and thus plays a role in protecting environmentally sensitive areas.
Level of soil erosion	**B+**	B+	B+	B+	The strategy plays a important role by slackening coastal erosion.
Soil quality and pollution	**D**	D	D	D	No impact.
Landscape quality and quality of life of populations (quietness, space, etc.)	**B+**	B+	B+	B+	This strategy favors a slowdown of coastal erosion, the protection of the *Casuarina* strip and the reduction of the proliferation of buildings on the maritime public domain. Therefore, it plays an important role in the improvement of landscape quality and the quality of life of populations.
Land use (agriculture, livestock, housing, etc.)	**D**	D	D	D	No impact.

Source: JICA Study Team based on "Second Phase Report of the SEA" of Dakar PDU

8.4.8 Evaluation of the Cumulative Effects of the Implementation of All Strategies

Overall, the strategies advocated in the context of the development of the PDU 2035 are in line with an improvement of living conditions in Dakar and a strengthening of the economic competitiveness of the Senegalese capital. The implementation of the strategies will meet the needs of the population and establish a well-balanced urban structure and a well-connected infrastructure network.

From an environmental perspective, despite some risks, these strategies do not constitute fundamental obstacles for the "major environmental issues" identified (see Chapter 2.1.1).

During the implementation of the strategies advocated by the PDU 2035, some measures should be put in place to mitigate the negative impacts. Indeed, the social costs and threats to very fertile agricultural land and exploited aquifers deserve special attention.

8.5 Mitigation and Amplification Measures

The following tables show the results of the mitigation measures for negative impacts and the amplification measures for positive impacts.

Table 8.5.1 Mitigation and the Amplification Measures for the Impacts of the Economic Development Strategy

Affected item	Potential impact	Impact level	Mitigation or amplification measures	Predicted efficiency
Water resources	The development of economic activities such as agriculture and especially industry will have negative impacts in terms of resource consumption and degradation of quality.	(-) average	It will be necessary to establish an industrial discharges treatment system, especially for those that will be implemented in the Diamniadio area. The water requirements of agriculture could be met by using different sources of treated water.	(-) low
Air quality	The air quality will be affected by emissions from industries that will be installed in the Diamniadio area.	(-) average	It will be necessary to modernize and implement a policy of environmental compliance of industries to limit their emissions. In areas affected by industry, tree plantations shall be made to better manage pollution linked to air pollution.	(-) low
Biodiversity	The relocation of Dakar industries on formerly natural sites will result in a loss of biodiversity.	(-) average	The development of new green spaces with similar characteristics to former natural areas could offset potential losses of biodiversity. It will be necessary to ensure that the share and the layout (connections, corridors etc.) of natural green spaces in the land use plan of subsequent city planning documents (PUD, subdivision plans) are sufficient, especially in urban development areas.	(-) low
Soil	The development of agriculture and the transfer of industries will affect soil quality, especially in certain areas (Niayes area and Diamniadio, due to the use of pesticides and industrial emission.	(+) low	In order to limit the negative impacts, rigorous norms for industrial discharge shall be prescribed, emissions shall be limited and industrial wastewater treatment units shall be installed. Regarding agriculture, the use of pesticides should be supervised. In the detailed land use plan of subsequent city planning documents (PUD, subdivision plans), industrial zones shall benefit from a special attention in terms of distance (buffer) from cultivated reserve lands.	(+) average

Source: JICA Study Team based on "Second Phase Report of the SEA" of Dakar PDU

Table 8.5.2 Mitigation and the Amplification Measures for the Impacts of the Strategy and Spatial Organization of Infrastructure Development

Affected item	Potential impact	Impact level	Mitigation or amplification measures	Predicted efficiency
Biodiversity	The opening of a landfill in a new site requires deforestation, destruction of natural habitat and the disappearance of some animals.	(-) average	It will be necessary to develop new areas dedicated to nature and conduct reforestation around the new landfill site.	(-) low

Source: JICA Study Team based on "Second Phase Report of the SEA" of Dakar PDU

Table 8.5.3 Mitigation and the Amplification Measures for the Impacts of the Strategy and Spatial Organization of Urban Development

Affected item	Potential impact	Impact level	Mitigation or amplification measures	Predicted efficiency
Water resources	The urbanization of new areas affecting the quality of groundwater, particularly in areas where groundwater is exploited (as well as Diamniadio and Daga Kholpa), due to the discharge of wastewater (domestic and industrial).	(-) low	It will be necessary to establish a sanitation system that will limit infiltration of discharges. Charging points of the water table should not be occupied by urbanization and will be dedicated to nature. This requirement will be reflected in the land use plan of subsequent city planning documents (PUD, subdivision plans) of zones to be opened to urban development.	No impact
Biodiversity	The urbanization of formerly natural areas will affect fauna and flora, especially in the areas of Daga-Kholpa, Diamniadio and Lac Rose.	(-) average	It will be necessary to develop new areas dedicated to nature inside the newly developed urban poles.	(-) low

Source: JICA Study Team based on "Second Phase Report of the SEA" of Dakar PDU

Table 8.5.4 Mitigation and the Amplification measures for the Impacts of the Strategy for Social Development

Affected item	Potential impact	Impact level	Mitigation or amplification measures	Predicted efficiency
Biodiversity	The construction of new infrastructure, such as University City of Diamniadio and the medical citym will be at the expense of natural areas.	(-) low	It will be necessary to provide natural spaces and amenities within and around those infrastructures.	No impact
Land use	The building of infrastructure will lead to a reduction in spaces dedicated to agriculture in Diamniadio, Lac Rose and Daga-Kholpa.	(-) low	The areas dedicated to agricultural activities must be preserved. The land use plan of subsequent city planning documents (PUD, subdivision plans) of zones to be opened to urban development shall reserve more space for this type of land use.	No impact

Source: JICA Study Team based on "Second Phase Report of the SEA" of Dakar PDU

APPENDIX TO CHAPTER 8

Table 8.5.5 Comparative Analysis of 2025 Master Plan and Master Plan Proposed for 2035: Prepared by JICA Study Team

Factors	Master Plan 2025	Draft Master Plan Proposed for 2035
Characteristics		
	• Most areas are planned for urbanization, thus creating a sprawling type of urban structure. • Urbanization proceeds in all directions. • Growth poles are created in seven locations.	• The Niayes area is preserved for agriculture and conservation. • Major urbanization is directed toward the southeast direction, thus creating more compact land use. • Two major growth poles are created, one in Diamniadio and the other in Daga-Kholpa, while other growth poles play supporting and secondary roles. • A compact land use pattern will be developed in combination with public transportation development and upgrading.
Advantages		
Environmental aspect		• Biodiversity is preserved. • Food mileage is lower due to urban agriculture, which enables transportation of agri-products over shorter distances (from Niayes to Dakar). • CO_2 emissions will be lower due to shorter length of trips by individual vehicles and more efficient public transportation by more compact land use. • Air pollution by vehicle exhaust gas will be reduced by the greater number of trips made by public transportation.
Social aspect		• People, especially those not using vehicles, will enjoy better access to urban facilities (shops, hospitals, etc.) and mobility. • People will enjoy better health with more walking and bicycle riding. • People will enjoy increased nature-oriented recreational opportunities.
Economic aspect	• Administrative cost for controlling land use will be limited.	• Productivity of workers will be higher due to shorter commuting time. • Green jobs (new businesses concerning the environment) will increase. • Job opportunities will be created in the agricultural sector. • Costs for investment, operation and maintenance of infrastructure facilities will be lower. • There will be more chances to attract skilled labor due to the better quality of life. • There will be more chance of economic growth due to agglomeration of various urban functions.
Disadvantages		
Environmental aspect	• Biodiversity will be significantly reduced. • Food mileage will be higher because agri-products need to be transported for long distances from outside the Study Area.	

	• CO_2 emission will be higher due to longer distance trips by individual vehicles and less efficient public transportation by sprawling land use. • Air pollution by vehicle exhaust gas will be increased due to more trips made by individual vehicles.	
Social aspect	• People, especially those not using vehicles, will have difficulty in accessing urban facilities (shops, hospitals etc.) and mobility. • People will have limited opportunities to enjoy nature-oriented recreational opportunities.	
Economic aspect	• Productivity of workers will be lower due to long commuting time. • Agricultural activity will be low, limiting job opportunities for people. • Costs for investment, operation and maintenance of infrastructure facilities will be higher.	• Administrative cost and efforts to properly control land use will be higher and more demanding.

Source: JICA Study Team

CHAPTER 9 DETAILED URBAN PLAN FOR DAGA KHOLPA

9.1 Project Area Selection

9.1.1 Objective of Detailed Urban Plan Preparation

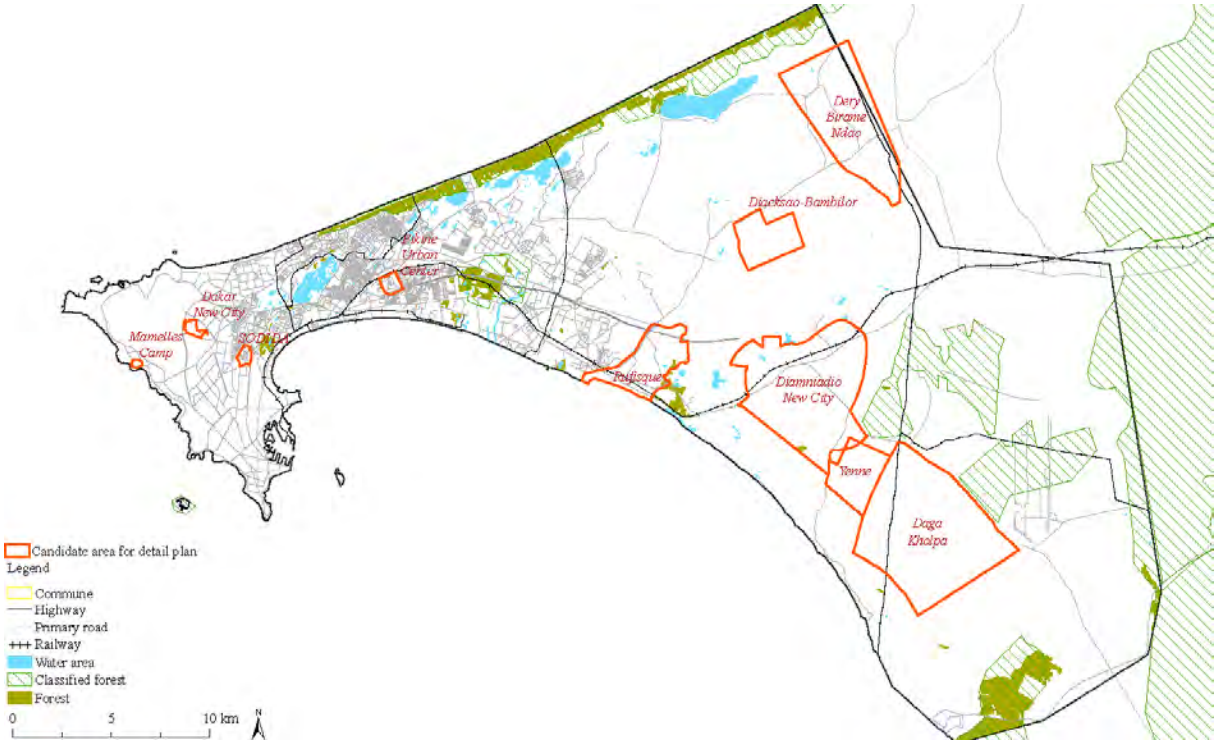
Preparation of a detailed urban plan became the responsibility of communes and villes under Act III of the Decentralization policy as explained earlier. These local governments, however, are not familiar with detailed urban plans and moreover lack the technical capacity and financial resources. It is envisaged that it will take some time and effort before the government's decentralization policy starts to bear fruits in such a way that urban environments in the cities of Senegal are well planned and maintained in a desirable condition by the initiatives of local governments. An initial step towards creating this kind of state would be to create a successful model of detailed urban plan preparation and implementation and share it with urban planners, officers and people in Senegal. The DUA's capacity needs to be developed to start this process. Development of DUA's capacity needs to be developed to start this process. With the enhanced capacity, DUA will be able to disseminate the successful models throughout Senegal and provide guidance to local governments in preparing a detailed urban plan in an appropriate manner. The components of the detailed urban plan preparation were included in the Study with this background information.

9.1.2 Candidate Areas

A total of 10 areas, listed below, were selected as candidates for detailed plan preparation. They include Daga Kholpa, Bambilor, and Rufisque for which the DUA sought technical asisantce to formulate detailed urban plans. Those three areas are located in the suburbs with a high possibility of new urban areas to develop. These candidates were selected in consideration of the needs of the DUA and related government offices to improve the existing built-up areas for urban renovation as well as to prepare for the urban expansion in the near future.

They were identified through field surveys and information provided by the DUA and related government offices. The perspectives adopted in selecting these areas considered the following: (i) contribution to the vision, policies and strategies presented in Chapter 6, (ii) contribution to the renewal of existing built-up areas, (iii) need to preserve farm areas, (iv) growth poles proposed by the ongoing 2025 PDU, and (v) importance of supporting new urban areas.

- Dakar New City
- Daga Kholpa
- Diamniadio
- New Dakar City
- Pikine Urban Center
- Rufisque
- Diacksao Bambilor
- Déni Biram Ndao
- SODIDA
- Yenne



Source: Urban Master Plan of Dakar and its Adjacent Area Horizon 2035

Figure 9.1.1 Candidate Areas for Detailed Plan Preparation

9.1.3 Selection and Criteria

A number of criteria were laid out in the form of a score sheet (Table 9.1.1) to help select a target area for preparing a Detailed Urban Plan. After scrutiny and evaluation, a target area was selected based on the highest collected number of essential attributes and matching characteristics.

In general, the matrix was divided into four different parts, each containing a different set of criteria. Firstly, a number of overarching principles are defined as essential requirements for the selection process. These mainly include the conformity of each target area to the respective visions and strategies of both the national PNAT and the regional SRAT Master Plans in terms of promoting decentralization, strengthening the regional urban structure, enhancing urban management in suburban areas, and achieving balanced development at both levels. At a lower but more important tier, also taken into account is compliance of the target areas with the newly formulated long-term vision and strategies of the Master Plan of Dakar and its adjacent area up to 2035.

The second group of criteria mainly focuses on the development potentials of each targeted area. Potential areas are evaluated for their relevance in relation to the following: support of actions already initiated by the government of Senegal; the real and urgent need for preparing a detailed plan; the embedded potentials for setting the pace for a new development trend; the promotion of new economic activities such as ICT, logistics platforms, etc.; the promotion of new urban area development for population growth; and finally the upgrading of existing urban areas.

The third set of criteria is defined in relation to regulatory and territorial planning measures as well as development control. Specifically, these criteria are: the availability of an approved detailed plan; the need to reduce encroachment on farmlands; the necessity to protect areas facing imminent development pressure; controlling urban sprawl; and addressing land speculation issues.

Finally, the fourth group of criteria is formulated to allow the evaluation of each candidate area in terms of its aptitude to promote capacity building for the local governments or communes, as well as for the DUA in terms of replicating the collected experiences, for example learned urban management skills.

Table 9.1.1 Selection Criteria: Results of Scoring

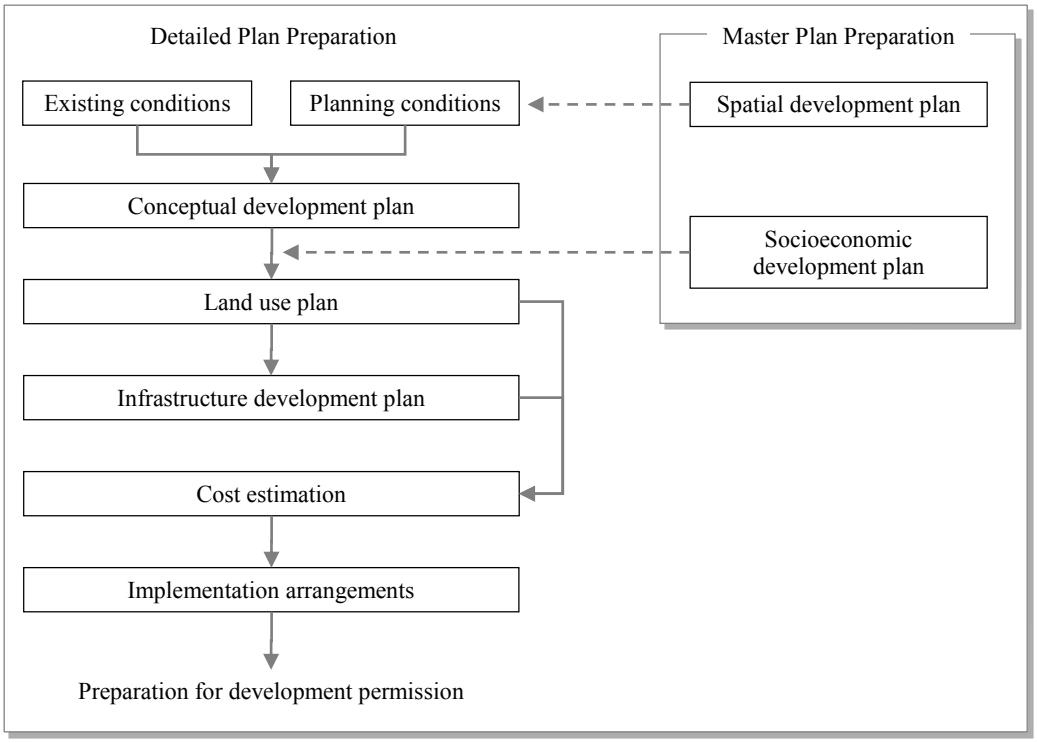
Selection Principles	Selection Criteria	Dakar New City	Daga Kholpa	Diamniadio	New Dakar City	Pikine Urban Center	Rufisque	Diacksao Bambilor	Déni Biram Ndao	SODIDA	Yenne
Overarching Principles											
In line with the PNAT's long-term vision	Promoting decentralization (enhancing urban management in suburban area)		x	x		x	x	x	x		x
In line with the PNAT's long-term vision	Strengthening the regional structure		x	x			x				x
In line with the long-term vision and goals of the Dakar 2035 Master Plan	Promoting Dakar PDU	x	x	x	x	x	x	x	x	x	X
Development-Related Criteria											
Supporting actions already initiated by the government of Senegal		x	x	x	x	x				x	x
Responding to a real and urgent need for a detailed plan			x					x	x		x
Setting the pace for new development trends		x	x	x	x	x	x			x	x
Promoting new economic activities (ICT, logistics platforms, etc.)		x	x	x	x	x					x
Promotion of new urban area for population growth			x	x			x	x	x		x
Upgrading existing urban areas		x			x	x	x			x	
Control-Related Criteria											
Absence of an approved PUD (Detailed Urban Plan)		x	x	x	x	x	x	x	x	x	x
Reducing encroachment on farms (tackling sites with critical issues in terms of development control, protection of areas facing imminent development pressure, controlling urban sprawl and land speculation)								x	x		
Improvement of disaster prevention and urban resilience			x				x				
Promoting Capacity Building and Local *Communes*' Involvement											
Capacity building of DUA (replicating experience in other *communes*)			x	x		x	x	x	x		x
Usefulness for urban management by local governments			x	x			x	x	x		x
Score		**6**	**12**	**10**	**6**	**8**	**10**	**8**	**8**	**5**	**11**

Source: JICA Study Team

The evaluation process reveals that Daga Kholpa achieved the highest total score (12 points), and it is therefore selected for the preparation of a detailed plan. This does not reduce the urgency to equip other areas with an updated Detailed Urban Plan, especially those to be planned by the public sector that remain at present without such a planning document. The need today is to realign planning actions in the Study Area with the newly formulated vision and strategies of the Master Plan 2035.

9.2 Detailed Plan Preparation Process

A Detailed Urban Plan (PUD: Plans d'Urbanisme de Détails) is formulated for the Daga Kholpa area, which was selected as a priority area for PUD preparation. The PUD is a tool to achieve the 2035 Master Plan. Figure 9.2.1 shows the planning process of PUD preparation, with a description given below.



Source: JICA Study Team

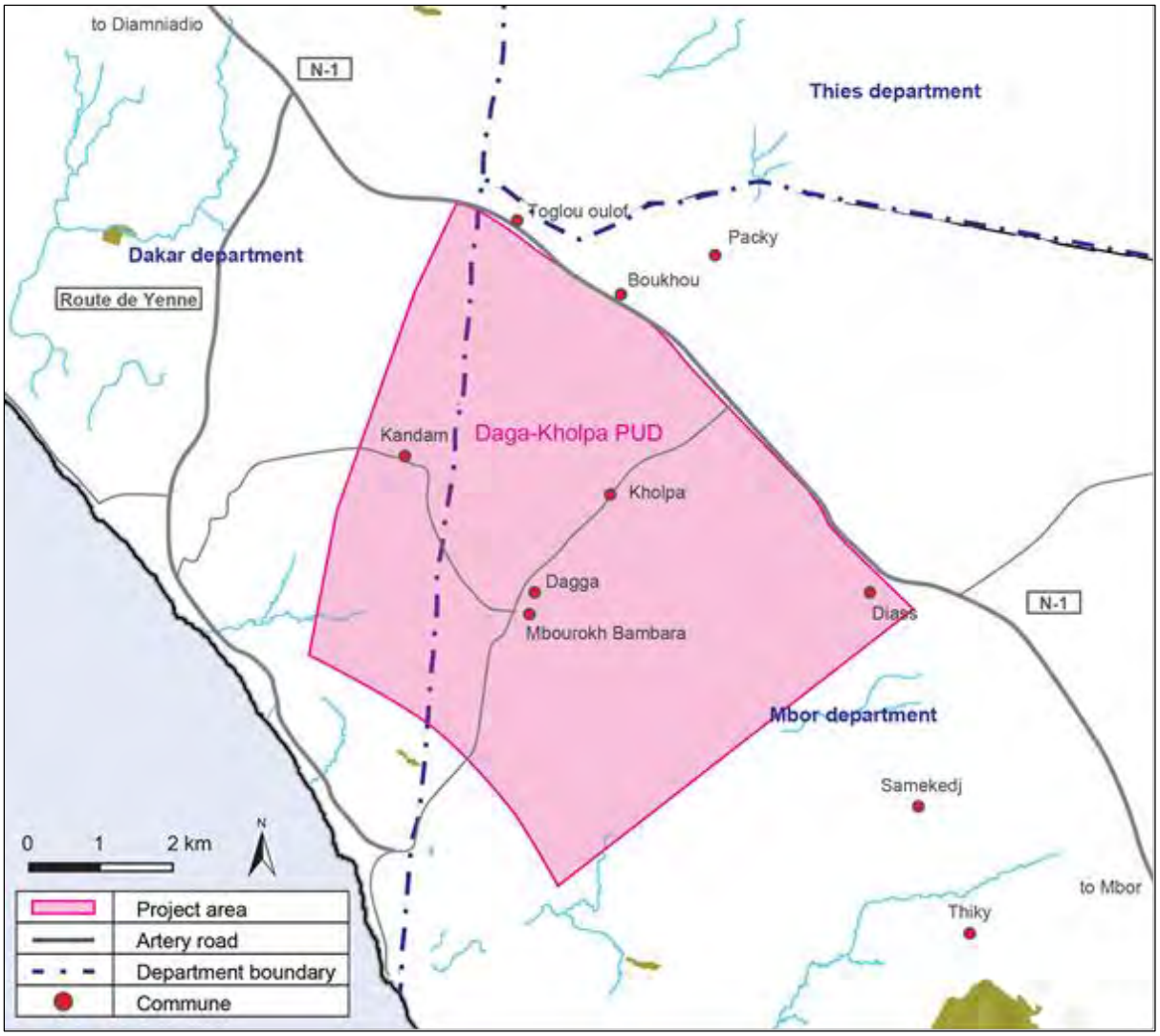
Figure 9.2.1 Planning Process of the Detailed Plan

(a) A survey of existing conditions is conducted of the natural environment, the living environment, socioeconomic factors, spatial factors, and cultural heritage.
(b) Planning conditions should be clarified to cover the development direction specified in the 2035 Master Plan, the regulations which will affect land use in the PUD, existing development plans for adjacent areas, implementation methods, and land ownership.
(c) A conceptual development plan is proposed and created to show the development direction in the discussions with stakeholders.
(d) A land use plan is prepared on a scale of 1/5,000.
(e) An urban infrastructure development plan is formulated to specify the estimated demand for water supply, waste, sewage, discharge and electricity. The land use plan will indicate the possible location of the main infrastructure.
(f) The construction cost is preliminarily estimated to cover the main infrastructure development.
(g) The implementation arrangement is examined to show possible methods based on the institutional set-up and implementation costs.

9.3 Existing Conditions of Daga Kholpa

9.3.1 The Project Area

The DUA has prepared the Daga Kholpa Schematic Zoning Concept as shown in Figure 9.4.2 later, covering the whole perimeter of Daga Kholpa, the AIBD, Kirene and Yene. The target area for planning a detailed urban plan in the Study ("the Project Area" hereafter) is limited to Daga Kholpa with an area of 3,891 hectares, for which a decree for public utility declaration was issued by the government in 2013 as shown in Figure 9.3.1 below. The area within this decree boundary originally measured by DUA was 3,123 hectares. The JICA Study Team, however, confirmed from geo-reference data that the accurate area of the decreed area was 3,891 hectares in the course of the Study. So the detailed urban plan presented hereunder is based on this Project Area.



Source: JICA Study Team

Figure 9.3.1 Location Map of the Target Area

9.3.2 Environmental Sensitivity Analysis

In the Strategic Environmental Assessment (SEA) of the 2035 Master Plan, which was conducted from March to May 2015 by SOTERCO, a Senegalese consultancy company approved by the DEEC, the various PUD candidate sites were evaluated and compared from the environmental viewpoint. The

Daga Kholpa site showed the greatest environmental relevance. An environmental sensibility analysis was conducted to initiate the preliminary baseline works of the PUD study. This analysis, which revealed the environmental conditions and possible risks created by urban development in the Project Area, is summarized below.

(1) Environmental Sensibility

The area of Daga Kholpa does not show great vulnerability, with an absence of threatened fauna or flora and sensitive ecosystems. The PUD will therefore not present a significant risk to the environment. The vegetation and wildlife are already highly degraded and the continuation of the current trend is only likely to accelerate this process of destruction. Therefore, if the project is realized, the losses in terms of biodiversity will not be significant.

Regarding groundwater resources, the Project Area can rely on high-quality underground water resources. However, ongoing urbanization and the establishment of many extractive industries are already threatening the quality of the Maastrichtian aquifer, exploited volumes of which could decline significantly in the future. The elaboration and implementation of a PUD would have little impact on the phenomenon of degradation of the quality of groundwater resources, especially if the project is carried out with consideration for the preservation of the environment by providing a sanitation system to prevent the infiltration of wastewater.

The issue of storm-water drainage is the most serious problem for the development of Daga Kholpa. Indeed, the configuration of the site, with a succession of valleys, presents important runoffs, which will entail risks of flooding if appropriate measures are not taken to drain rainwater properly. There is a risk that urbanization of this site may block the flow paths of water to the outlets.

The proximity of Blaise Diagne International Airport (AIBD) also requires the development of proposals that take into account not only the advantages that this will provide, but also the many nuisances it will generate, such as noise, as well as the numerous risks.

(2) Social Sensibility

In social terms, the acceptability of the PUD does not seem to be a problem, but the authorities will have to consider the consequences of urban development, especially in terms of loss of agricultural lands and the restriction of resource accessibility. As revealed by land-cover analysis, there is a predominance of land used for rain-fed agriculture or orchards. Although those lands belong to the nation, they have been exploited by villagers for generations, and continue to provide a significant share of their income.

Despite the risk of disruption to the social environment that could result from land use change, the population seems generally very favorable towards the PUD. The authorities' determination to create a PUD to support the development of the area surrounding the airport seems to have been well understood. A participatory approach will be adopted; involving the local population in the whole development process and above all allowing the villagers to benefit from the plots and equipment that will be created as part of this PUD.

(3) Conclusion of Environmental and Social Sensibility Analysis

The proposed realization of a PUD in the Project Area does not raise any major problems from the environmental and social points of view. On the contrary, the PUD will allow the rationalization of the urbanization process at the site, which is likely to increase in intensity with the opening of the AIBD and the completion of the highway extension works. It will also help to slow down the phenomenon of

uncontrolled space occupation, to organize urban extensions, and especially to provide appropriate facilities and equipment in line with the characteristics of the site and proximity of the airport.

The elaboration of the PUD is also an opportunity to improve the living environment of the surrounding villages, which are currently undeveloped, through restructuring that will enhance spatial organization.

However, the risks of flooding and water erosion remain important due to the succession of hills and gently sloping valleys in the area. To tackle this threat, the PUD shall propose subdivision plans involving efficient storm-water management techniques and measures towards limiting the risk of floods. Thus, the designs of outflow and storage infrastructure as well as building and street orientation, according to contour lines or landscaping, will be based on thorough research.

Finally, the overlap of the PUD perimeter with that of the Dakar Integrated Special Economic Zone (DISEZ) shall also be dealt with promptly by the administration, especially MURH and APIX. The logic and principles of the development of the DISEZ might compete with that of the PUD.

9.3.3 General Conditions

(1) Topographical map

Based on the satellite images and the output of the topographical survey, the 1/5,000-scale topographical map for the area within the Project Area was prepared by the JICA Study Team.

(2) Historical background

In this Project Area, the two biggest *communes* are Daga and Kholpa. According to the Daga *commune* local authority, the history of Daga dates back to the 14th century, when it was founded by a group of settlers from the village of Dialaw. The head of this group belonged to the Serer Lemou family. According to the Kholpa *commune* local authority, the history of Kholpa dates back to the 16th century, when a couple belonging to the Serer Daya family emigrated from the village of Fouta (the present Kholpa *commune* chief also belongs to this family). When the couple arrived in the forest that used to occupy the site of the *commune*, they cut down a big tree and built the first hut there. The name of the *commune*, Kholpa, originates from “Kholya”, the name of that tree in Serer.

(3) Nature

1) Geology

According to the SEA, the Project Area belongs to the horst of Diass, the characteristics of which include a succession of plateaus and small valleys.

Since there are no perennial streams, the surface water is poor in the dry season. On the other hand, in the rainy season, intermittent streams are active and temporary ponds form in lower areas or in valleys fed by the runoff water from plateaus and hills. The groundwater resources of this area are mainly connected to the Maastrichtian table contained in the Upper Cretaceous formations.

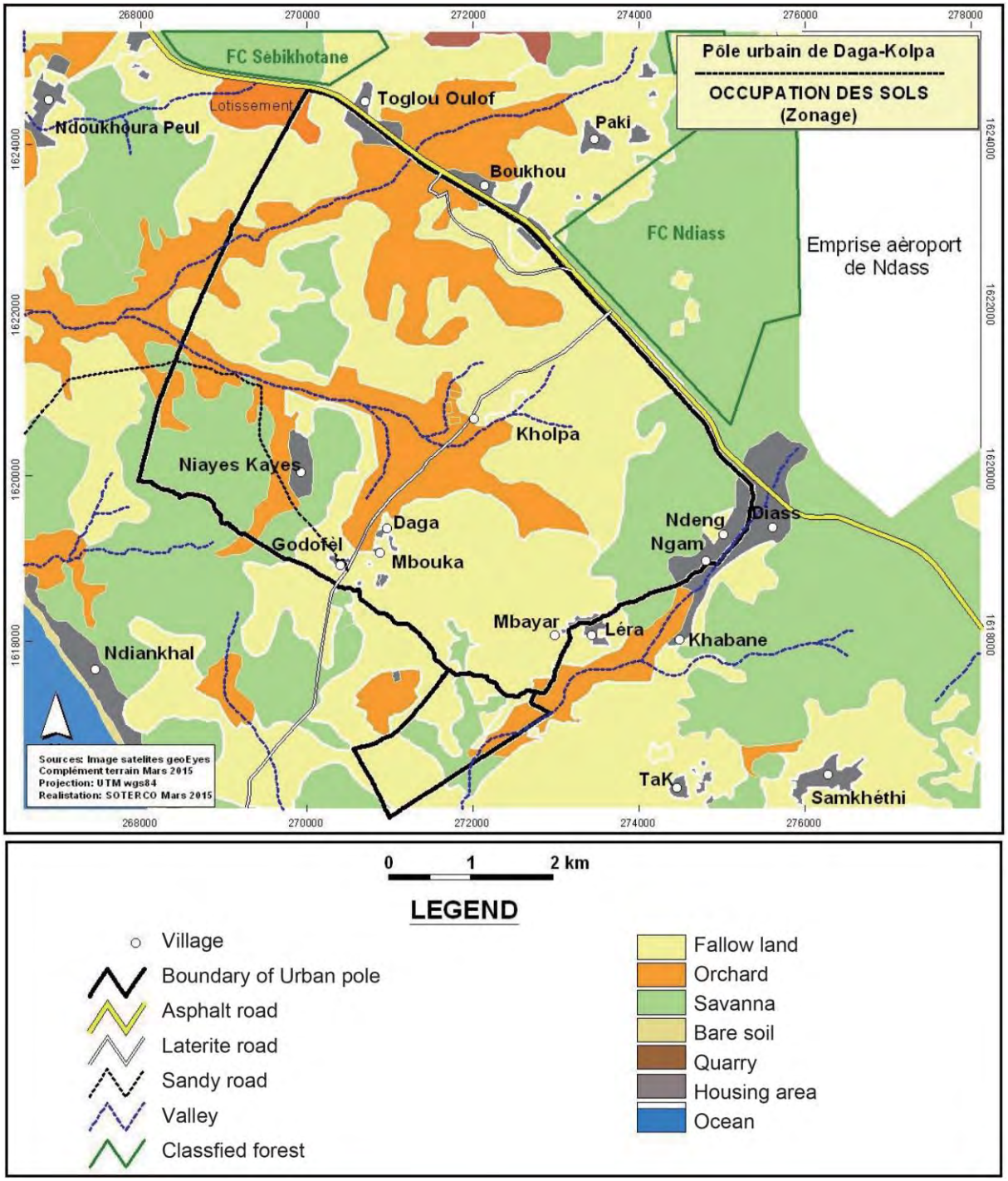
2) Climate

According to the SEA, the Project Area is a Sahel-Sudanese eco-geographical area, with a three month rainy season which lasts from July to September, and a long dry season which lasts for the rest of the year. Due to its proximity to the ocean, the site is frequently under the influence of maritime trade winds. A series of interviews with the *commune* established that the wind direction is northerly in the

dry season and westerly in the rainy season.

3) Land cover

The outcome of the SEA shows that the soil quality is good enough for agricultural activities and building construction. The land cover of the Project Area is shown in Figure 9.3.2 below.



Source: SEA report

Figure 9.3.2 Land Cover of the Project Area

4) Biology

Since the Project Area does not feature many niches or shelters for animals, according to the outcome

of the SEA, this area has no large wild animals. The fauna is composed of 1) small rodents, 2) reptiles, and 3) birds. The area also features few plant species, with the exception of shrub flora. Given these circumstances, the agricultural land that occupies more than 70% of this area will encounter no negative impact on the existence of wild species.

(4) Living environment

According to the SEA, the villagers live in relative peace, since the villages are located far from the national road and there is very little traffic running through them.

It has been a concern of farmers for several decades that the demand for drinking water is not always met, as it is for example in Pout, Sébikhotane and Mbour. The villages of Daga and Kholpa are connected to the SDE (*Sénégalaise des Eaux*) system, yet many households are not catered for because of the insufficient quantity of water available. Nowadays, wells are allowed to be approximately 20 m deep to capture high-quality water, which is then managed and redistributed by a management committee.

(5) Socioeconomic factors

1) Statistics

The Diass *commune* consists of 19 villages. Of these villages, 1) Boukhou, 2) Daga, 3) Diass, 4) Kandam, 5) Kholpa, and 6) Mbourokh Bambara are located inside the Project Area. The total population of these six villages is 10,406. In addition, some unnamed small villages are also located in the Project Area.

Table 9.3.1 Statistics of Diass Commune in 2013

Village	Population
Bandia Bambara	134
Bandia Sessene	1,058
Boukhou	**2,178**
Daga	**1,602**
Diass	**4,794**
Gandoul	622
Kandam	**814**
Kholpa	**951**
Kirène	2,353
Mbayard	871
Mbourokh Bambara	**67**
Ndayane	4,331
Packy	1,691
Popenguine	3,334
Raffo	445
Samekedj	1,390
Thicky	3,391
Toglu Serere	2,748
Lu Wolof	936
Total	33,710

Source: Report of *Programme d'eau potable et d'assainissement du Milenaire*

Economically, rain-fed agriculture is the main activity, which is practiced by the majority of villagers. This is followed by cattle breeding and small-scale trade.

2) Education

An elementary, a middle and a Koranic school exist in the Daga village, and there are a French and an Arabic school in the Kholpa village. These schools are easily accessible from both villages.

3) Social welfare

Both Daga and Kholpa *communes* have a health hut. However, neither have any medical personnel.

(6) Spatial factors

1) Land use

In the process of developing the Daga Kholpa Schematic Zoning Concept (Figure 9.4.2), the DUA arranged a field survey to prepare land use in 2014. Since the initiation of the detailed plan work in the middle of 2015, the JICA Study Team visited the Project Area a number of times and collected information from local stakeholders in cooperation with DUA, taking advantage of the stakeholder meetings and during separately arranged field visits. An important finding was the existence of some existing villages and farm lands in the middle of the Project Area, which required careful consideration later. Except the villagea reas, most of the areas is classified as agriculture land, including the fallow land, orchard, savanna or even the areas that are not suitable for agriculture, as shown in Figure 9.3.2.

2) Transport

There is no public transport in the Project Area. The main method of transport is taxi-sharing in order to get to Diamniadio or Mbour. This taxi is a private car and costs 1,000 FCFA/journey, i.e., when a taxi is shared by five people, the fee is 200 FCFA/person. This taxi fee is almost the same as the general fee for the public bus in downtown Dakar.

3) Urban facilities

Large mosques are located in both Daga and Kholpa *communes*. There is no public cemetery, and some villagers requested that the JICA Study Team take this into consideration in their detailed plan during the stakeholders' meeting held in Diass.

4) Disaster and environment

The extension of the watershed and increase in the flow velocities can cause washouts, thus exposing the site to erosion in some areas. Regarding pollution, although quarrying operations have been performed close to the Project Area, there has been no negative impact on the quality of the soil. The ambient air is clear. Although a laterite track runs through the area from north to south across the highway, car traffic releasing significant pollution is almost non-existent.

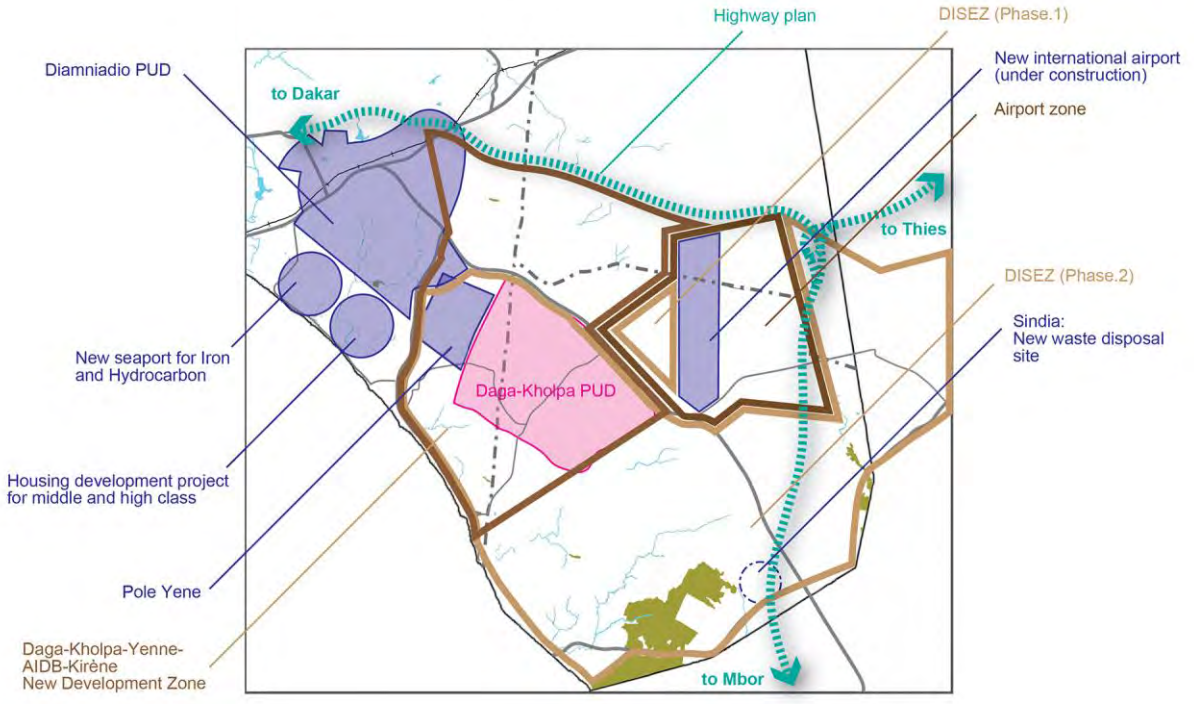
5) Heritage

A series of SEA surveys has been unable to identify any cultural heritage in the Project Area. However, interviews with members of the *commune* indicated certain objects to be preserved, including specific stones – known as "Padiokhane" or "Ndioorokh" – as well as the trees known as "Kove" in Sener, which are located in the Fogne house and in Hine.

9.4 Existing Development Projects and Plans in Adjacent Area

(1) Special Economic Zone (DIZES) and Daga Kholpa

Situated 55 km to the east of Dakar between the Diamniadio urban pole and the AIBD, and a few kilometers away from the Petite Côte, the Project Area is strategically located at the intersection of two major access roads linking Mbour and Thiès to Dakar, as shown in Figure 9.4.1. It therefore constitutes the main gateway to Dakar and has untapped development potential, especially with the new highway being constructed and a planned integrated special economic zone (DISEZ) that seeks to serve the AIBD and contribute to the development of different businesses and activities. In this context, Daga Kholpa has become a major priority for the government of Senegal, which opted for the preparation of a PUD on a designated 3,891 ha stretch of land.



Source: JICA Study Team

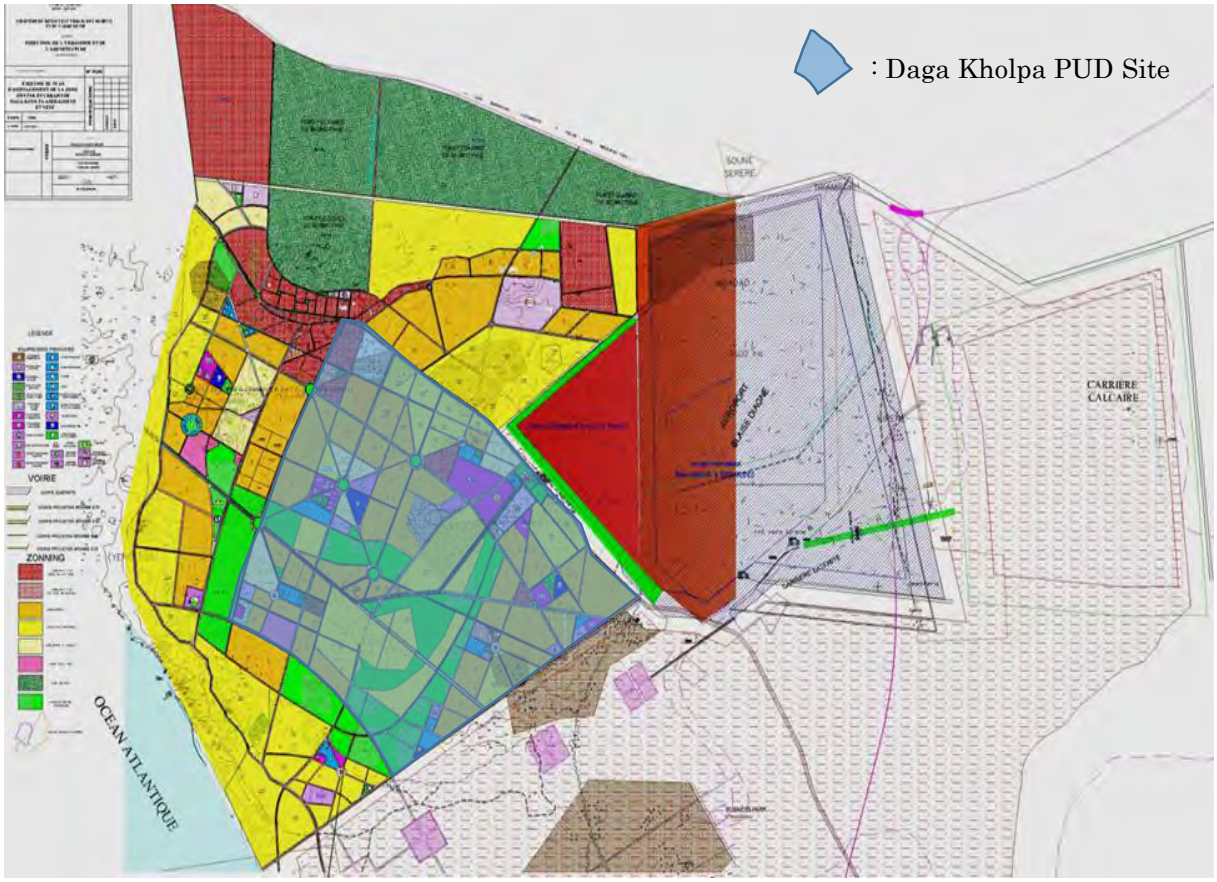
Figure 9.4.1 Daga Kholpa-Yenne-AIBD-Kirène New Development Zone, Yenne Pole Development

(2) Preliminary PUD Concept for Daga Kholpa prepared by the DUA

The DUA has recently prepared a preliminary planning concept, as shown in Figure 9.4.2 and Table 9.4.1, consisting of a broad subdivision of different large blocks structured by a hierarchized road network and spatially distributed zones, with a preliminary allocation of public equipment and large facilities. The total area of 3,123 hectares shown in Table 9.4.2 was originally used by DUA, but it was corrected to 3,891 hectares later. Within this distribution, existing villages and settlements are preserved within a growth boundary set for their future extension, taking into account the need for restructuring and urban renewal. In general, the concept is based on the following breakdown.

Sixty percent of the land area has been allocated for collective housing, while the remaining 40% is destined for high-end housing projects. The collective housing area has been assigned a minimum height of R+4 (ground floor plus four floors) and a maximum height of R+10 (ground floor plus 10 floors). In addition, the concept plan designates industrial and handicraft production zones, artistic

handicraft zones (traditional handicraft villages and handicraft centers), agricultural activity zones, tourist zones, zones for collective equipment and facilities, and protected green zones and public spaces.



Source: *Esquisse du plan d'aménagement de Daga Kholpa*, DUA, 2015

Figure 9.4.2 Daga Kholpa Schematic Zoning Concept

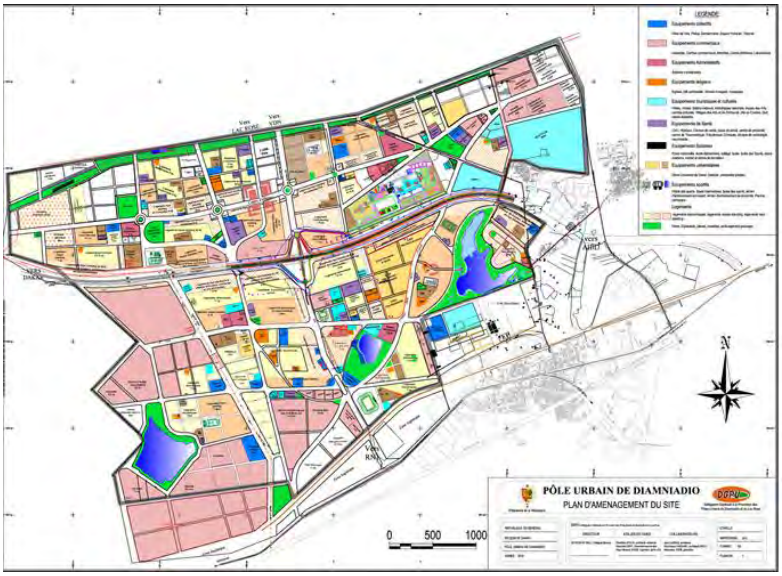
Table 9.4.1 Breakdown of Allocation Zones and Areas

Designation	Area (ha)	Percentage (%)
Housing zone	1,765	56.5
Activity zone	390	12.5
Public buildings and services	518	16.6
Roads and infrastructure	450	14.4
Total	**3,123**	**100.0**

Source: *Esquisse du plan d'aménagement de Daga Kholpa*, DUA, 2015
Note: The total land area is estimated to be 3,891 ha based on the geo-referenced map of Daga Kholpa.

(3) Development Plan of Diamniadio

One of the government of Senegal's priority projects for accelerating economic growth and reducing poverty is the construction of a large-scale industrial, commercial and residential platform outside the capital city, Dakar. The development of Diamniadio, a territory of over 4,000 ha located 35 km inland and southeast of the capital, seeks to transform the town into an urban node (urban pole).



Sources: DGPU

Figure 9.4.3 Development Plan of Diamniadio Urban Pole

The first planning studies for Diamniadio were undertaken in the mid-1990s as part of the Master Plan for the Dakar Region. Subsequent projects in detailed urban planning have centered on the town. At both the large and detailed scale, these plans anticipate the urbanization of the territory, which has traditionally been an area of mixed rural activities.

The Diamniadio urban pole is supported by the development of several nearby national projects. East of the area, towards the city of Thiès, the construction of a new international airport (AIBD) is about to be completed, and north of Diamniadio the new campus of the University of the African Future is also nearly finished. The international conference center located to the north of the project site has already hosted the 2014 Francophone Summit. The second stretch of the highway linking Dakar to the AIBD is similarly in its final construction phase.

The concept of peripheral urban "nodes" (*Pôles Urbains*) was introduced in the Dakar PUD for 2025. The development plan for Diamniadio, prepared in 1999, named the area as one such "node" and set a 50-50% division of the urbanized land, based on a future residential population of 73,000. This first plan was soon superseded by a new concept, formulated in response to region-wide studies on mobility and obstacles to investment. In order to break the bottlenecks of congestion and lack of land to expand industry in Dakar, the planners envisioned the relocation of many Dakar-based producers to a large-scale industrial/activity and logistics center in Diamniadio, served by a modern highway and railway. A new development plan was drafted in 2002-2004, anticipating a total population of 400,000 by 2025 living in four neighborhood units comprising residential areas, industrial zones, business and tertiary centers, urban renewal low-density zones, public services, and green areas. Today the Diamniadio urban pole is attracting major international and public investments, and is being steadily transformed into a second-tier center of the Dakar area. The latest development plan was updated in 2014, as shown in Figure 9.4.3.

(4) New International Airport Plan

The AIBD is located in Diass, 47 km southeast of Dakar, as shown in Figure 9.4.4. It is meant to replace the Leopold Sedhar Senghor Airport. The project's objectives are summarized as follows:

- Reducing Dakar's congestion
- Hosting an international business park for global headquarters
- Promoting the creation of an economic pole outside of Dakar
- Creating a major hub for the region and the continent
- Creating the proper conditions to welcome 1.5 million tourists per year
- Increasing export flow and attracting foreign investments

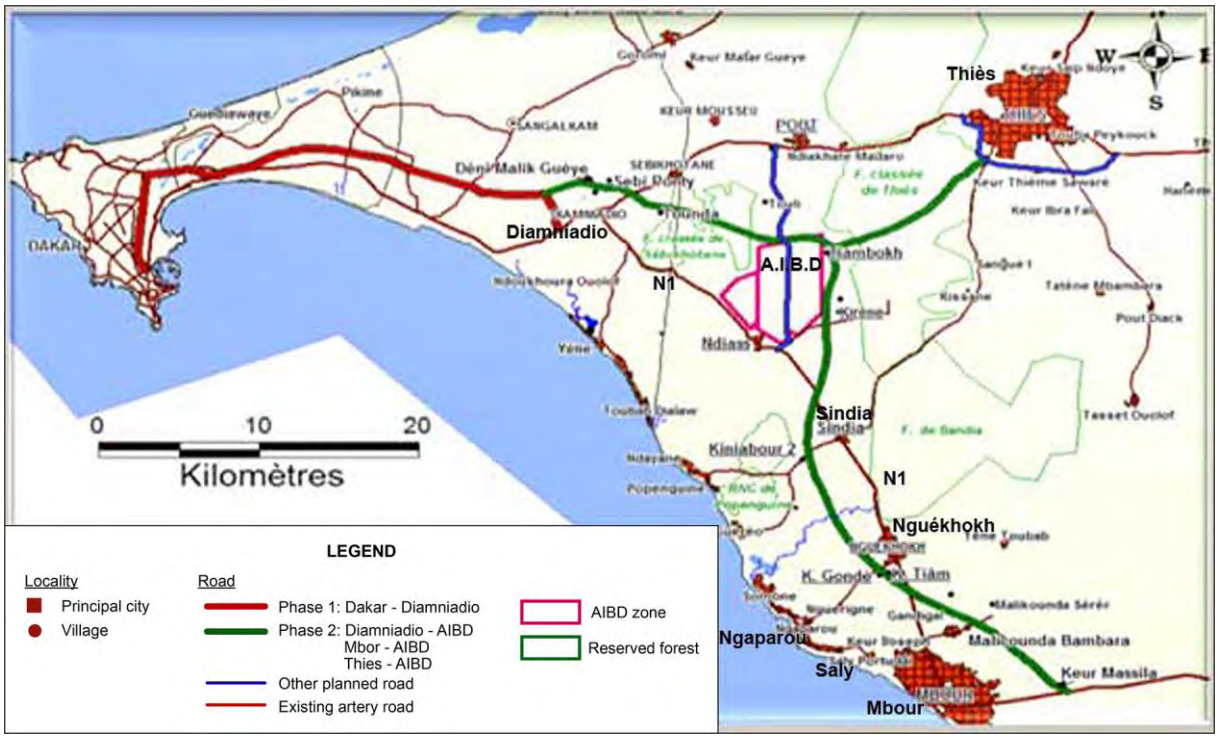
Source: AIBD website

Figure 9.4.4 View of the AIBD under construction

This project is part of a global strategy that will help Senegal to become an emerging market that is able to compete with other growing areas in the continent. The new airport is being built on a 4,500 ha area and will be able to welcome three million passengers per year (compared to 1.7 million at the current airport). The 3,500 m long runway will accommodate large passenger airliners, such as the Airbus A380. The main terminal will be 42,000 m², and an additional terminal is planned for a second phase. The new airport boasts capacities of 80,000 plane movements per year, 50,000 tons of freight/year, 44 plane parking spots, six jetway positions, and seven connections between the taxiway and runway. Moreover, there are on-site parking facilities for 700 passenger cars, 60 buses and 60 taxis. The site's capacity will allow the development of complementary infrastructures such as the Dakar Integrated Special Economic Zone (DISEZ). The project is expected to create 3,000 direct jobs and 12,000 indirect jobs. Initially planned for early 2011, completion has been postponed until 2016.

(5) Highway Plan

This project aims to provide Dakar with a 32 km, double three-lane highway to facilitate the flow of goods and people between the capital, the rest of the country, and the wider sub-region (Figure 9.4.5).



Source: http://www.00221.info/tak2/node/1821

Figure 9.4.5 Different Phases of the Highway Project

The Diamniadio-AIBD highway stretch (phase 2) is a direct continuation of Phase 1 of the highway project (25 km Dakar-Diamniadio). Once the second phase is completed, the highway will be operated as a single toll road without differentiation between the two phases. The main objective of Phase 2 is to connect both the AIBD and the Diamniadio urban pole, currently under construction, to the center of Dakar and to the port. Phase 2 will significantly improve the country's infrastructure network in addition to providing better access to the coastal and inland areas of Senegal. The project implementation will offer the following benefits:

- Improved access to the airport and greater opening up of local areas
- Improved urban mobility and development of trade
- Intensification of economic and commercial activities around the site
- The creation of jobs for young people, especially at local level
- The promotion of small and medium enterprises (SMEs) specializing in road construction and maintenance

9.5 Development Concept for Daga Kholpa

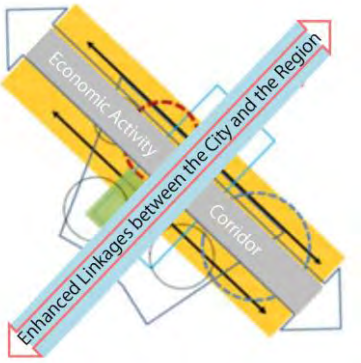
(1) Development Concept and Role

The PUD needs to reflect the PDU vision of a "City of Hospitality", that is characterized by a comfortable living environment, easy communication, and innovative creation. In order to achieve this vision, the PUD development concept is set out as follows:

- In order to achieve a "comfortable living environment", Daga Kholpa will be planned such as to 1) avoid developments in the flood-prone area, 2) provide a secure living environment, and 3) provide abundant open space and parks, including areas for sports.
- In order to achieve "easy communication", Daga Kholpa will be planned such as to 1) provide adequate community spaces, 2) prepare a favorable environment for tourists, and 3) provide a logistical area for the smooth transportation of commodities.
- In order to achieve "innovative creation", Daga Kholpa will be planned such as to 1) attract companies, 2) locate prestigious schools, and 3) preserve the existing villages and their culture.

The Daga Kholpa Project Area needs to combine all the potential advantages in order to position itself as a key player within the development corridor that is being created between the Diamniadio urban pole and the AIBD, as shown in Figure 9.5.1. Accordingly, the general goals of the Daga Kholpa development are established as follows:

- To help balance the growth of the city of Dakar
- To complement AIBD activities
- To support the growth of the Diamniadio urban pole



Source: JICA Study Team

Figure 9.5.1 Development Concept of Daga Kholpa

Daga Kholpa has significant strategic importance due to its proximity to the newly developed airport, which represents a rare opportunity in terms of development choices, especially given the inherent potential that the airport could generate and sustain, not only in its immediate vicinity but also at both the city and the sub-region levels. In such a context, Daga Kholpa is well placed to attract airport-related activities, and could soon become part of a larger airport city, since it is situated along the national road and has

easy access to the new highway linking Dakar to the AIBD and the rest of the country. Moreover, the Project Area, with its 3,891 ha, offers a significant land bank that will be relatively easy to develop, and which can build its reputation on the adjacent DISEZ promoted by APIX.

(2) Proposed Functions to Attract to the Specified Zones

The Project Area needs to attract specific functions and businesses that can sustain the airport activities, such as logistics centers and specialized industrial zones, flow-through and e-fulfillment facilities, wholesale merchandise display marts, shopping, leisure and entertainment activities, and business and hotel districts. However, this is not to forget residential areas, green parks and public spaces, as well as administrative equipment and all related services and amenities that will give Daga Kholpa a sense of place and promote it as a residential and activity cluster.

Consulting closely with the DUA, the following specific functions are proposed:

(a) Central Business District (CBD)
- ✓ Administration buildings and public services
- ✓ Company headquarters
- ✓ Hotels
- ✓ Supporting services and amenities
- ✓ Prestigious schools
- ✓ Residential buildings
- ✓ Green parks and open spaces, etc.

(b) Business parks
- ✓ ICT centers for outsourcing information technologies (IT) and business processes
- ✓ Business incubators
- ✓ Regional cloud server for West Africa
- ✓ Supporting services and amenities, etc.

(c) Industrial and logistics zone
- ✓ Light industries (industrial packaging, repackaging, conditioning)
- ✓ Flow-through and e-fulfillment facilities
- ✓ Wholesale merchandise display, etc.

(d) Large economic activity zone/wholesale and entertainment
- ✓ Shopping mall serving Dakar, the AIBD and adjacent areas
- ✓ Theme park
- ✓ International fair ground, etc.

Most importantly, the Project Area should provide a varied choice of housing to attract different social groups and clientele, especially given that both the AIBD and the DISEZ are expected to generate significant and varied housing demands in the short- and medium-term. The provision should include individual and row housing, low-rise and medium-rise housing developments, and condominiums. These should be supported by public facilities (schools and universities), and retail and leisure facilities (shopping centers and restaurants).

Nature parks, green spaces and agricultural activities are also considered to be main elements of the development, and substantial areas are reserved for them in the land use plan.

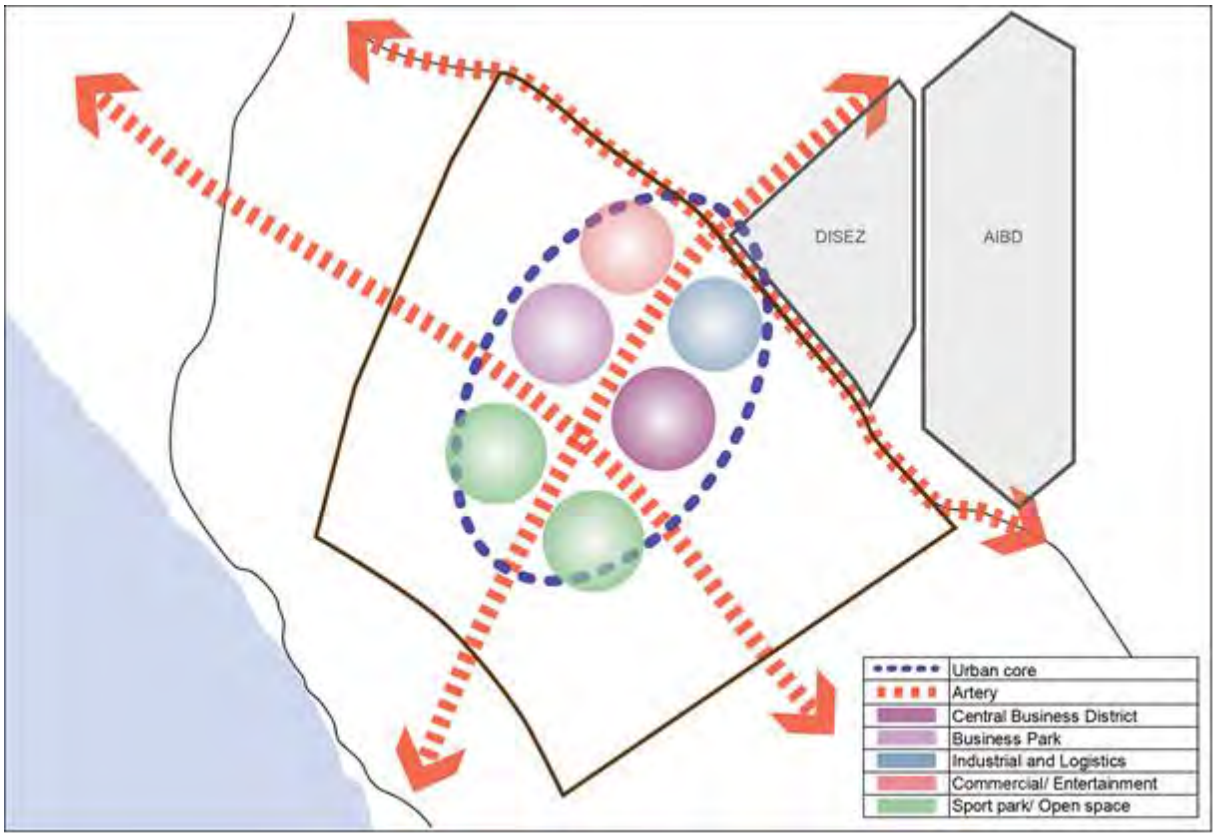
(3) Road Network

The existing road infrastructure needs to be supplemented in future by a modern road network that can ensure better linkages at all regional, secondary and local levels, and thus multiply the chances for

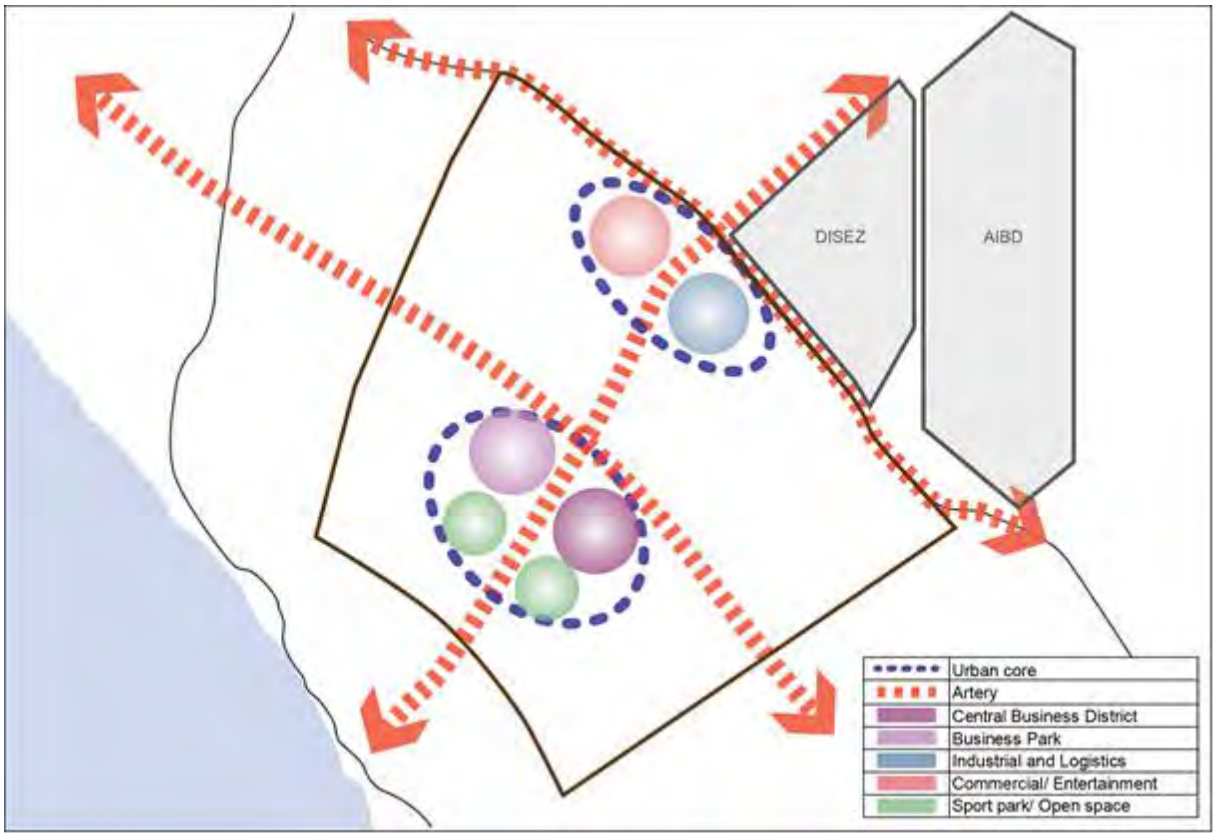
successful development. In that sense, also respecting the policy of the existing esquisse for Daga Kholpa prepared by the DUA, which has a north-south and an east-west main road, the JICA Study Team proposes: 1) to upgrade the existing national road which connects Diamniadio to the AIBD highway, exiting at the level of Daga Kholpa; 2) to lay out an east-west artery parallel to the national road and south of the main street; and 3) a major structuring secondary road passing through the center of Daga Kholpa to connect the town of Toubab Dialaw, situated to the south of Daga Kholpa on the northern side of the Dakar development site.

(4) Urban Structure

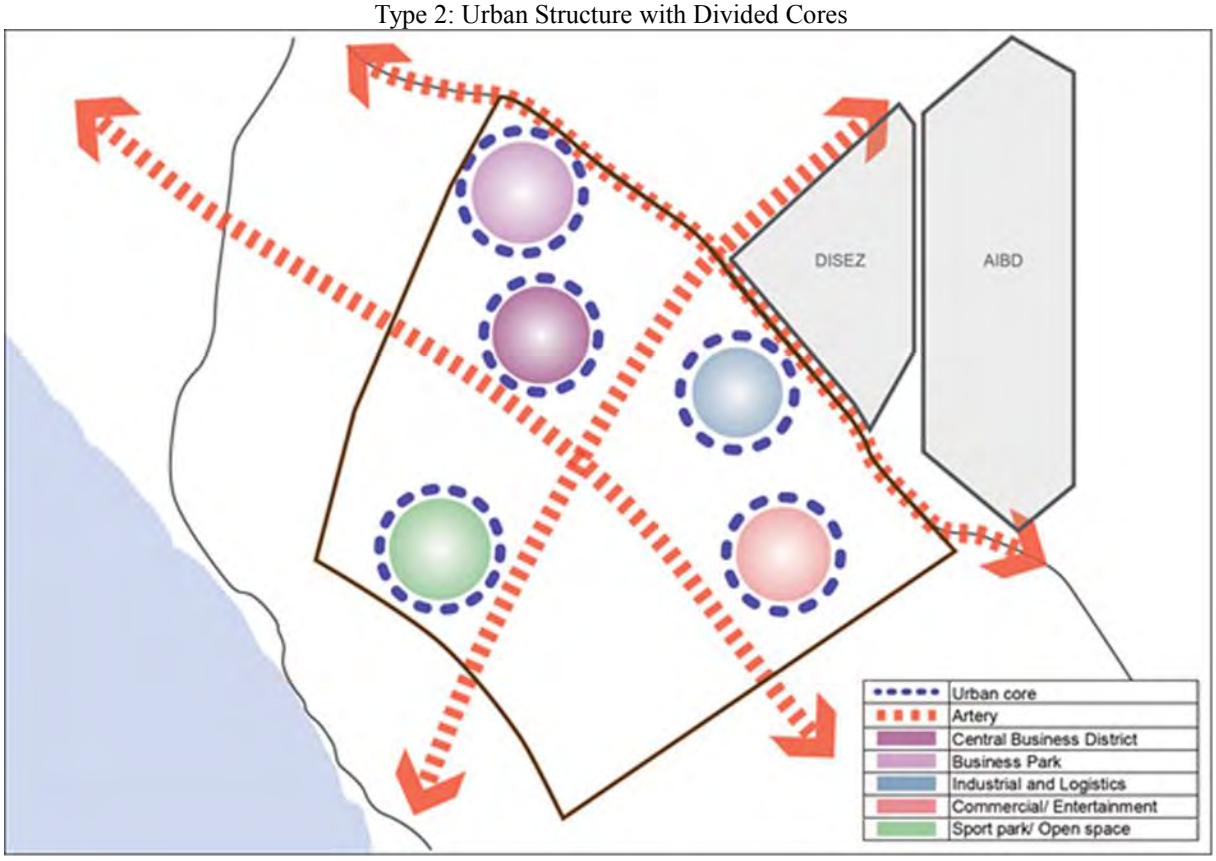
Along with the proposed functions and the road network, the following three types of urban structure were analyzed by the DUA and the JICA Study Team: urban structure with a centralized core (Type 1), urban structure with divided cores (Type 2), and urban structure with decentralized cores (Type 3). The DUA and the JICA Study Team established Type 1 as the preferred urban structure for Daga Kholpa. The idea is that a new town requires a clear and compact urban core. An important task in the subsequent process is to integrate the important elements of the existing condition, such as the existing villages, into this urban structure. The planned SEA for Daga Kholpa will make a more detailed comparison of the three types of urban structure.



Type 1: Urban Structure with a Centralized Core



Type 2: Urban Structure with Divided Cores



Type 3: Urban Structure with Decentralized Cores

Source: JICA Study Team

Figure 9.5.2 Type of Urban Structure

9.6 Development Frameworks

Development frameworks can guide local development and yield recommendations regarding the appropriate scale of the overall project, and help to match the scale and grain of existing developments within an overall boundary. The proposed development framework is delineated from the larger land use plan and tries to maintain a complementary relationship between the Diamniadio New City development and the development of the Daga Kholpa Project Area, as stated previously in relation to the overall vision and goals. The proposed population distribution figures are maintained at a lower level than those suggested for Diamniadio (220,900 inhabitants in Daga Kholpa, compared to 542,400 inhabitants in Diamniadio in 2035), as shown in Table 9.6.1. However, the intention remains to make Daga Kholpa a sustainable and viable place with all the necessary functions and activities.

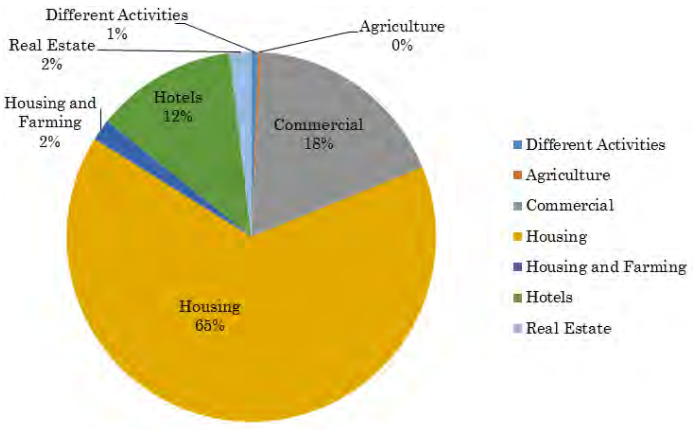
Table 9.6.1 Projected Population Distribution for 2035

Zone		Diamniadio	Daga Kholpa	Project Area
Area	ha	6,608	7,955	3,891
Population 2013	1,000	28.7	23.9	13.1
Density 2013	pers/ha	4	3	3.4
Maxiumu Populaiton	1,000	626.1	432.4	321.8
Density of Maximum Population	pers/ha	95	49	82.7
Growth Rate 2025	%/year	18	12	16
Growth Rate 2035	%/year	10	9	9
Population 2025	1,000	209.1	93.3	77.7
Population 2035	1,000	542.4	220.9	183.9
Density 2035	pers/ha	82	28	47

Source: JICA Study Team

(1) Existing Land Demand

The development of Daga Kholpa is the main focus of the government of Senegal and has recently attracted attention from many potential investors as shown in Figure 9.6.1. In the process of calibrating the allocation of lands to different purposes, due attention was paid to these existing land demands, currently estimated at around 800 ha based on the expressed intentions of potential investors who have already filed their requests with DUA. The information collected from local stakeholders also indicates active demands for lands in Daga Kholpa. These tendencies were taken into consideration in planning the allocation of lands in the Project Area.



Source: JICA Study Team

Figure 9.6.1 Potential Land Demand for Development

9.7 Detailed Plan for Daga Kholpa for 2035

9.7.1 Land Use Plan

(1) Preparation of Planning

1) Organization of Planning Team

A detailed plan for Daga Kholpa was prepared through collaborative work by the DUA planners and the JICA Study Team. The DUA appointed 17 DPUR and DOA officers as the members of the Daga Kholpa PUD planning team. This formation provided the DUA with opportunities to develop the capabilities of the officers, and helped the JICA Study Team to gain an accurate grasp of local conditions.

Table 9.7.1 Schedule of Drawing Sessions

	Date	Agenda
1st session	Jul. 9, 2015	Study of existing condition and planning conditions
2nd session	Jul. 16, 2015	Discussion of planning policy
3rd session	Jul. 21, 2015	Planning

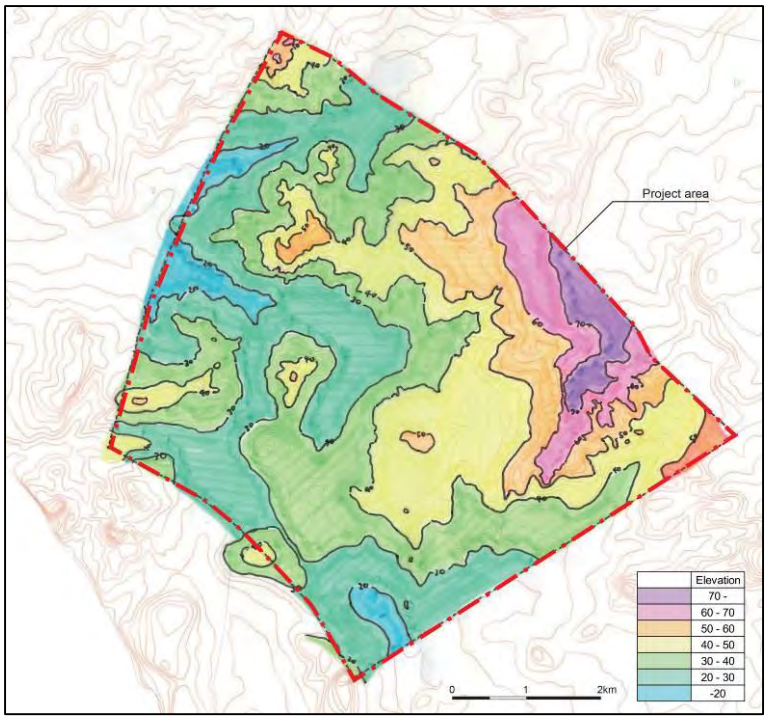
Source: JICA Study Team

Subsequent to the drawing sessions, the DUA planning team and the JICA Study Team continued discussions on a daily basis.

2) Topographical Conditions

The topographical conditions should be reflected in a detailed plan in order to preserve the existing landscape and minimize construction costs.

Figure 9.7.1 shows the elevations of the Daga Kholpa area in 10-meter intervals. The figure indicates that (i) the elevation becomes lower towards the coast, (ii) there is a hill in the eastern part of the area, and (iii) the area between 20 meters and 50 meters of elevation is relatively flat. This area can be called the medium-height area.



Source JICA Study Team

Figure 9.7.1 Colored Topographical Map

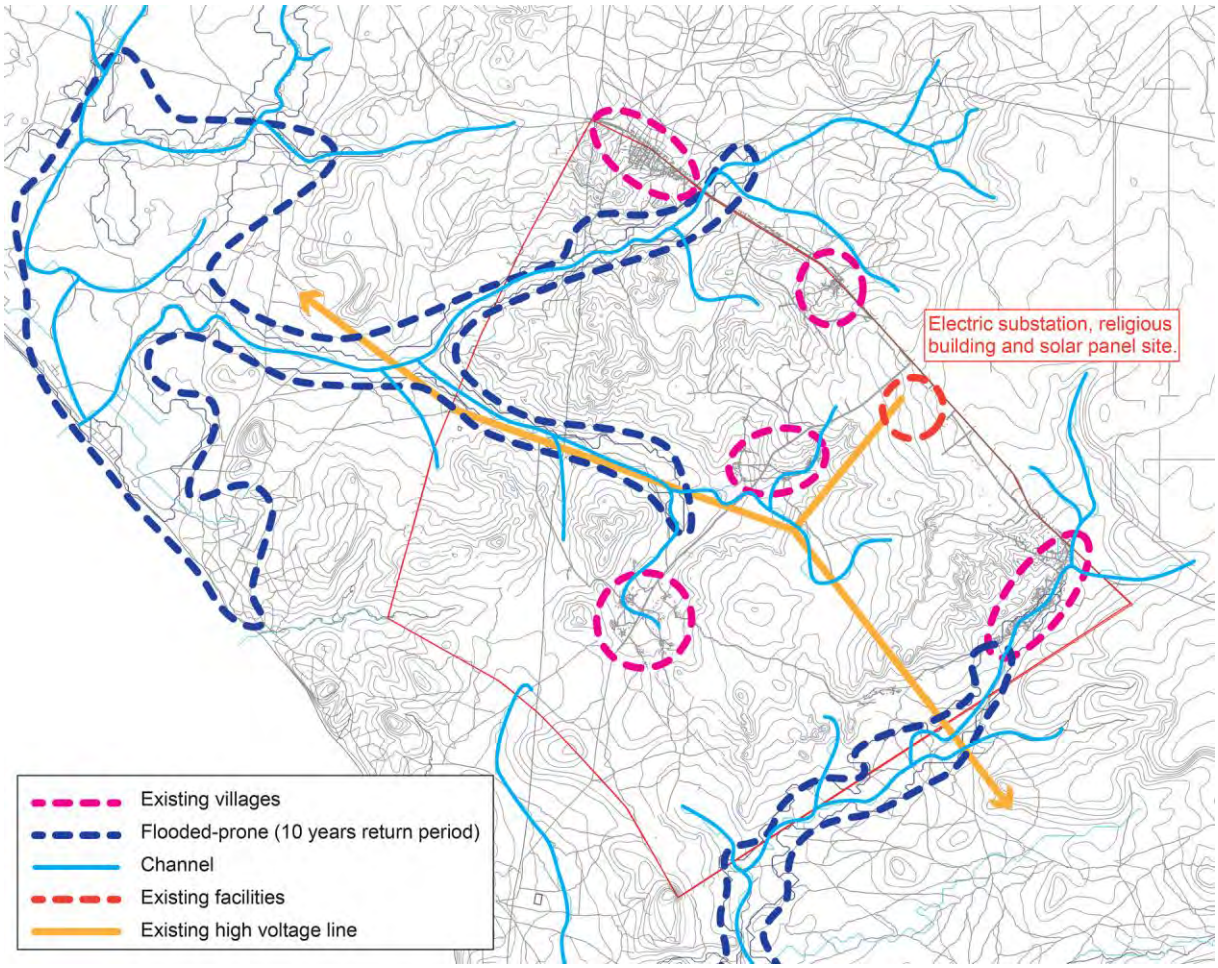
In this medium-height area, the natural condition can be preserved without difficulty. A green area with an urban park can be planned there. It is also found that the arterial roads in the 2035 land use plan and the urban structure with the centralized core shown in Figure 9.5.2 could fit into this area without drastic changes to the topography, and therefore with minimal additional construction costs.

3) Unsuitable Areas for Urbanization

Based on the interviews with related organizations, the topographical map, and the environmental sensitivity analysis, the areas unsuitable for urbanization are identified as follows:

(a) Flood-prone area in the event of rainfall with a 10-year return period and existing channel
(b) Existing villages
(c) Existing substation
(d) Existing religious buildings
(e) Existing high-voltage line
(f) Solar panel site

The locations of the unsuitable areas are shown in Figure 9.7.2.



Source: JICA Study Team

Figure 9.7.2 Unsuitable Areas for Urbanization

In addition, some consideration was given to respective requests by the DUA and APIX to reserve an area of 40 hectares for the fire station training center and an area of 20 hectares for the expansion of the existing solar panel site.

(2) Planning Policy

1) Target Ratios of Land Use

The urban code in Senegal regulates the land use ratios for residential development to a maximum of

70% for residential areas and a minimum of 15% for social services and roads, respectively. In the planning session, the DUA planning team and the JICA Study Team agreed to use these ratios as the target land use ratios in Daga Kholpa, while also attempting to secure 10% for open space. In Senegal, open space can be included in the social services or road area. The target ratios for land use are therefore set as shown in Table 9.7.2.

Table 9.7.2 Target Ratios of Land Use

Land Use	%
Residential area	70
Public services (includes 5% open space)	15
Road (includes 5% open space)	15

Source: JICA Study Team

2) Neighborhood Design Concept

For the Daga Kholpa development project, the concept of a neighborhood unit has been identified as a holistic planning and design strategy that addresses the configuration of the major physical components of the community. This includes the land uses, transportation systems, public spaces, and green infrastructure, each of which have a clear place in an organizational hierarchy within a defined area. The configuration of these components in a cohesive manner can help to create synergies among land uses, activate the public realm, and create opportunities for housing and mobility choice. This results in a livable community with a clear sense of identity.

Typically, the neighborhood unit is defined by the following characteristics:

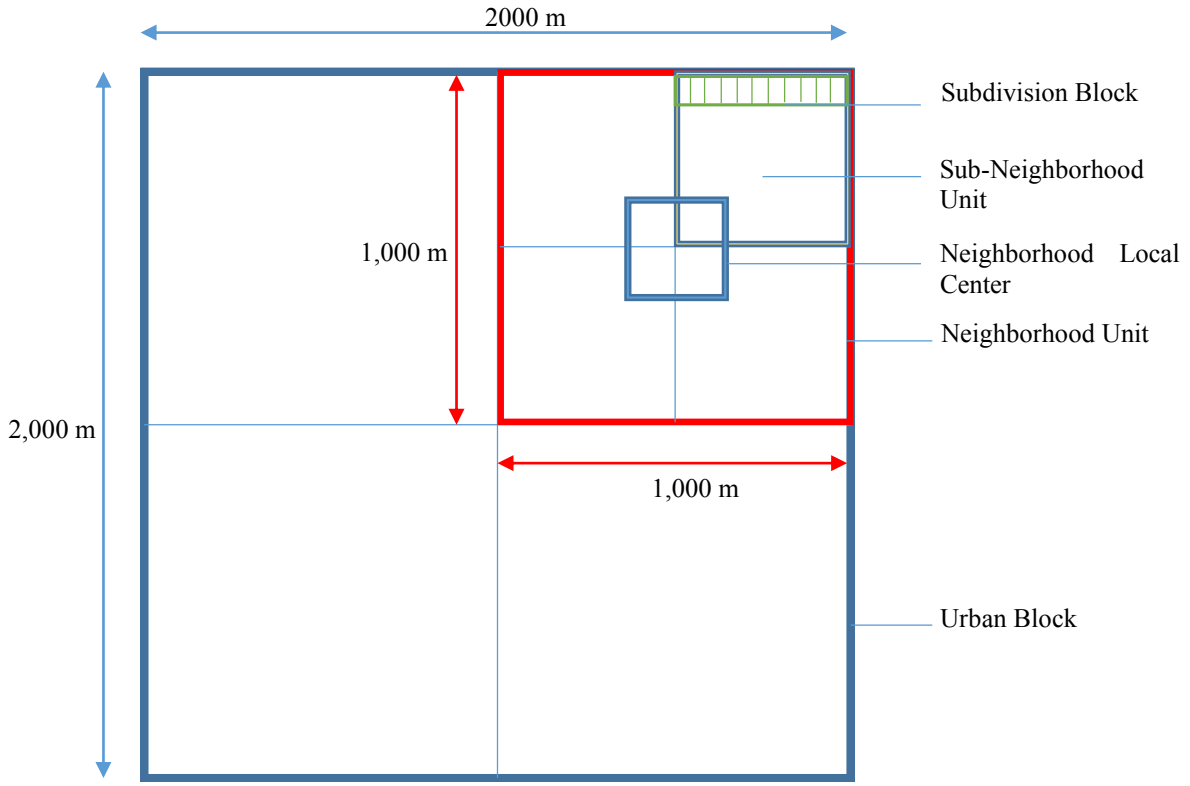
- a mix of uses and building types
- a range of mobility choices
- a dynamic relationship between the elements of the public and private realm
- a clear organizational hierarchy

A mix of uses in a neighborhood provides residents with the opportunity to live, work, and address the daily needs and services within their community. This mix provides a community focal point, which helps to create a locational identity for the new community. Commercial and community uses are to be located at important junctions within the neighborhood. The relationship between transit and land use is important. Mixed uses and higher intensity uses are concentrated around major junctions and along important roads - especially around public transit stops. Ideally, most of the daily needs and services in the neighborhood need to be located a five to 10 minute walk away for most residents. This requires that non-residential uses be clustered in a neighborhood.

3) Hierarchy of Different Planning Components

Based on the aforementioned design strategy, the neighborhood unit is considered as the basic component of the development project as shown in Figure 9.7.3. On average and depending on the site conditions, each neighborhood unit has an approximate area of 100 ha, (+/- 1000 m x 1000 m). One neighborhood unit is divided into four sub-neighborhoods containing residential buildings of different typologies and they all share one central communal space where public services and commercial amenities are located. This gives residents a sense of centrality and a place for congregation. As a general rule, 10% of the total neighborhood unit area is reserved for such communal centers. In addition, 5% of the total neighborhood unit area is dedicated to open and green spaces, and outdoor recreational areas. Within each neighborhood unit, the subdivision block which includes several contiguous plots of homogeneous sizes and uses represents the smallest design module. Moreover, the

project area is also organized into several clusters of 3 to 4 neighborhood units that are referred to as urban blocks. These components will concentrate large public buildings and services, such as high schools, local hospitals, public markets, sports playing fields and other large social structures.



Source: JICA Study Team

Figure 9.7.3 Hierarchy of Planning Components

4) Road Network

It is important in this process for the designer to adopt the perspective of the driver. Well-designed roads allow drivers to drive smoothly and easily, so that eventually both the traffic congestion and the number of accidents will be reduced making for a safer city.

Following this idea, the DUA planning team and the JICA Study Team agreed: 1) to essentially keep the road straight and smooth up and down, and yet put in place moderate changes, such as curves or junctions, so that drivers stay alert while driving; 2) to make junctions intersect at right angles as much as possible; and 3) to follow the topographical conditions in order to save on construction costs.

5) Disaster Area

In a series of sessions, the DUA planning team suggested not developing the flood-prone area and keeping the area natural, and the JICA Study Team agreed with this proposal. The land use in this area will be dedicated to providing open space. In addition to this, the JICA Study Team's flood disaster management expert proposed keeping a buffer zone of a maximum 30 m width along the existing channels.

6) Residential Area

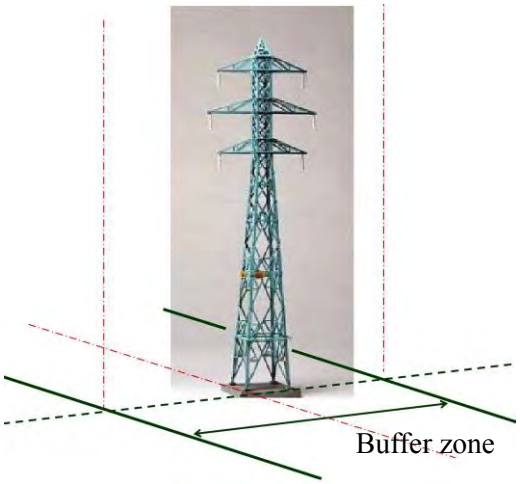
It is preferable for the residential area to be systematically divided into appropriately sized neighborhood units to ensure the equal distribution of infrastructure supply and to maintain residents'

access to urban facilities. Since there is no standard for the neighborhood unit in Senegal, the unit size of 100 ha for 10,000 people was preliminarily established to prepare esquisse of a land usen plan that shows the possible locations of the neighborhood units. The unit size and population density should be reviewed in the subsequent stages toward implementation. In addition to this, the DUA defined the target size of housing plots as 200 m^2, 300 m^2 or 500 m^2.

7) High-voltage Line

The Project Area contains wire paths for 225 kV electric power cables, as shown in Figure 9.7.4, and 66 kV electricity distribution lines.

In Senegal, building construction under a high-voltage line distributing over 90 kV is regulated; furthermore, the buffer zone, whose width ranges from 30 to 44 m, needs to be laid out. Based on this, the DUA and the JICA Study Team agreed to keep the 44 m width of the buffer zone throughout the PUD Project Area.



Source: JICA Study Team

Figure 9.7.4 Buffer Zone around Tower

8) Earthwork

The earthwork volume should have a proper balance throughout the development area. Taking into account the compaction effect of the earthwork, the cut volume needs to be 10% plus the fill volume.

(3) Proposed Land Use

1) Land Use Plan

The DUA planning team and the JICA Study Team agreed on the land use plan shown in Figure 9.7.6. The following explains its characteristics.

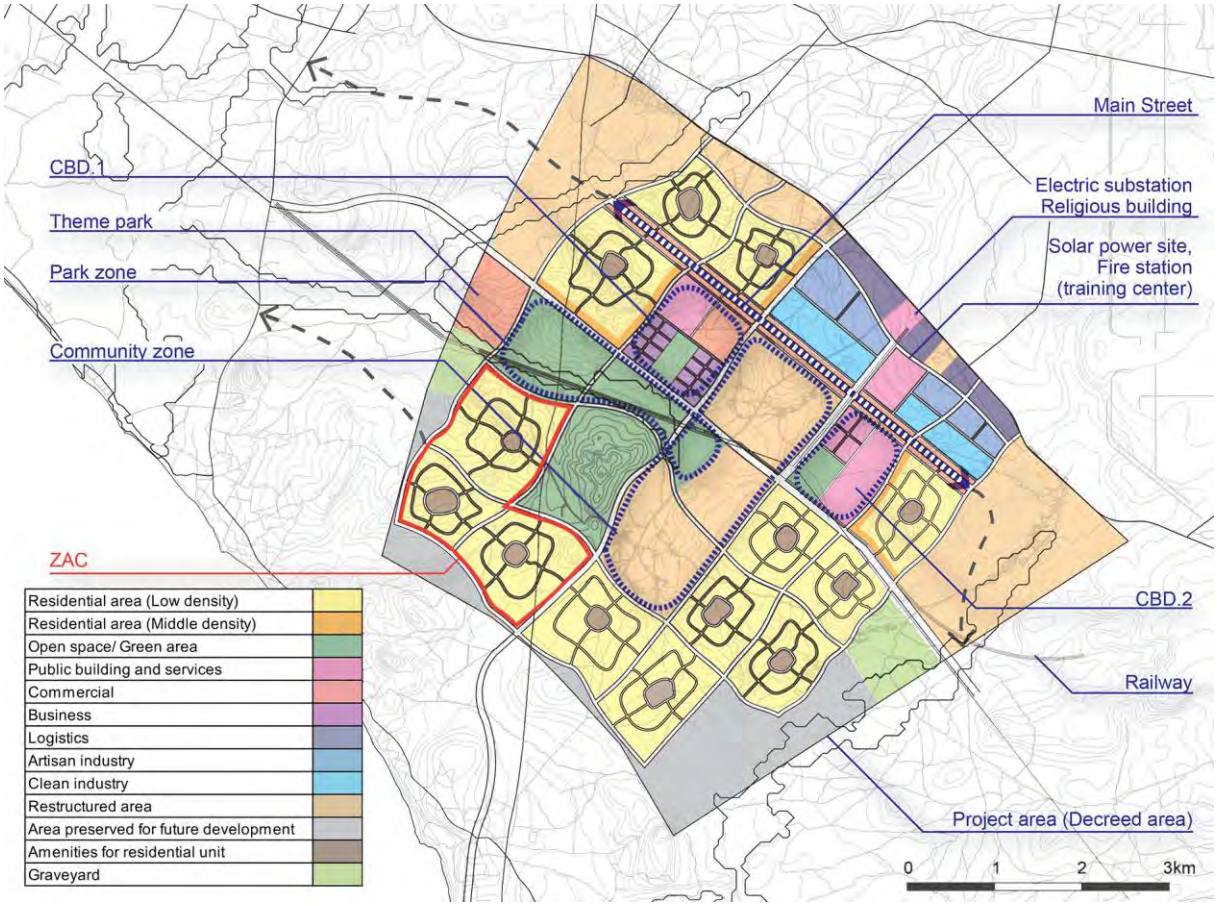
Source: https://en.wikipedia.org

Figure 9.7.5 Photo of the Champs-Élysées

The main street, with a length of approximately 5 km, is aligned in parallel with the national road in the south. Along this street, a commercial area is planned so that retail shops can be opened, stimulating the circulation of pedestrians. This street is planned to ensure pedestrians can safely and quietly stroll around, rather than to support logistical networks. The Champs-Elysees in Paris could be a good model. Along the main street, two CBDs and the existing village are located, providing pedestrians with new and old landscapes of Senegal. At the center of this Project Area, the park zone and the community zone cross, and the overlapping area is planned as a sports park. These zones create the core of the Project Area. Residential areas surround this main core, allowing all residents equal access to the core. A logistical

zone expands from the junction of the national road and the main north-south road eastward along the national road with high accessibility to and from the international airport ensured. A theme park is proposed at the western end on the southern side of the arterial road leading to Diamniadio. Having the theme park in this location will give a sense of it "welcoming" visitors coming from the Diamniadio direction, as the face of Daga Kholpa.

It was agreed in the drawing sessions that the existing villages and the surrounding agricultural area need to be preserved, so these are integrated in the detailed plan. These areas will be restructured with an improved settlement pattern and better infrastructure. It will be important to keep some room for demands for land development that may arise in the near future.



Source: JICA Study Team

Figure 9.7.6 Proposed Land Use Plan 2035

The land use ratios in the plan proposed above are shown in Table 9.7.3 below.

Table 9.7.3 Proposed Land Use Ratio

Land Use	Details	Area (ha)	Ratio (%)
Residential area		1,265	49
Publicly used facilities	Open space/ Green area	319	13
	Public buildings and services	128	5
	Commercial and business	176	7
Road		439	17
Logistics		238	9
Sub Total		2,565	100
Restructured area	Reorganization of the land uses and improvement of the infrastructures in the existing villages and surrounding areas including farm lands	916	-
Other areas	Cemetery, reserved area for future development	410	-
Total (Project area)		3,981	-

Source: JICA Study Team

Some parts of the restructuring areas fall under the areas unsuitable for development such flood risk areas as shown in Figure 9.7.2. The restructuring activities will be avoided in these areas.

A distribution of public facilities is shown in Figure 9.7.7 below. Such facilities as schools, health centers, community facilities and fire stations are to be distributed in these locations. The planning conditions for these facilities are shown in sub-section 9.7.5.

Source: JICA Study Team

Figure 9.7.7 Allocation of Public Facilities

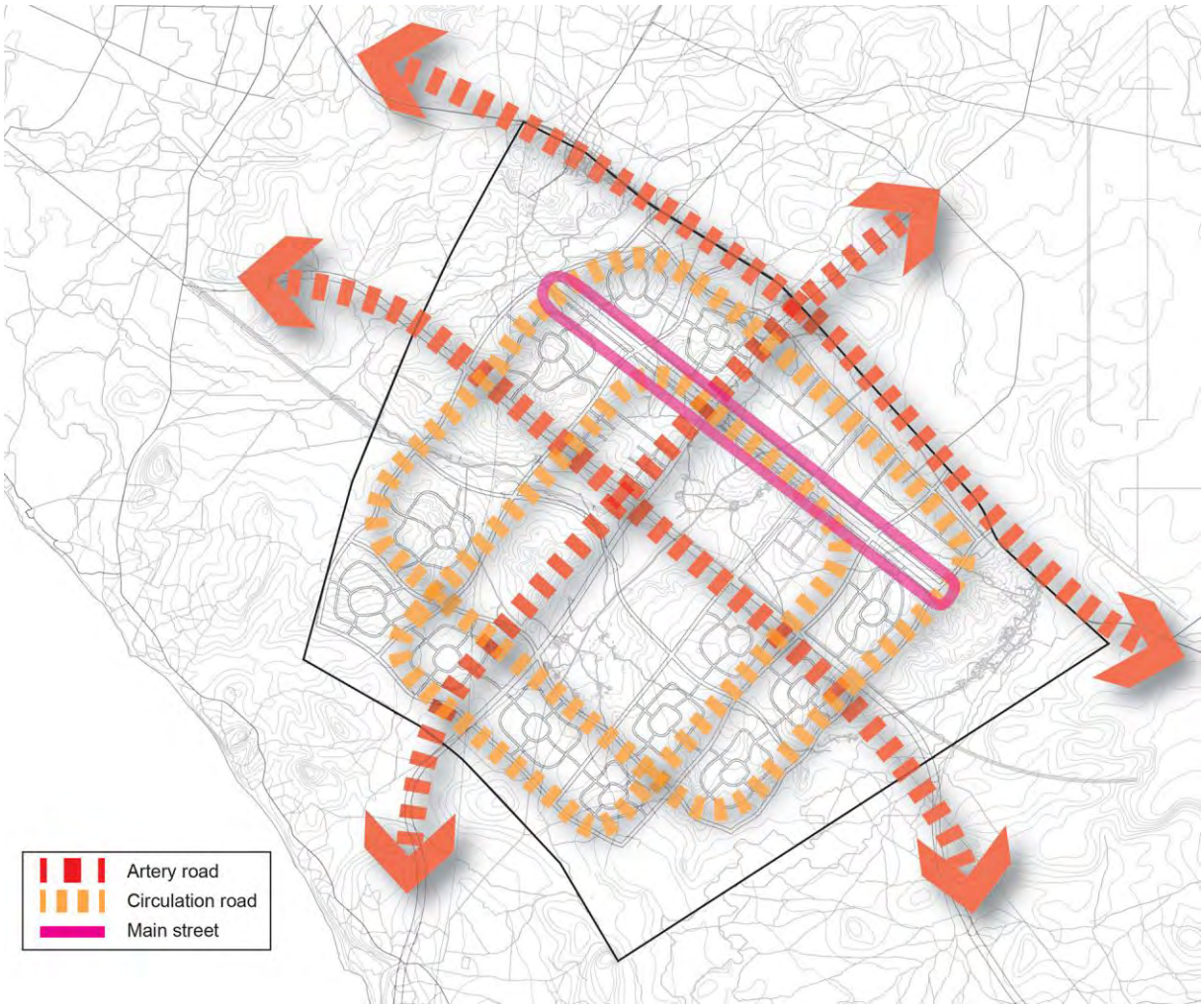
2) Road Network Plan

The road network is formulated with clear definitions of the functions of the respective road classes. The main road network comprises the following three classes in the Project Area (Figure 9.7.8 shows a diagram of the road network):

(a) The artery road is the major route to interlink Daga Kholpa with urban poles and sub-centers. The artery road will accommodate a large amount of traffic comprising through traffic and heavy traffic (Figure 9.7.9).

(b) Apart from the artery, which will accommodate many heavy vehicles passing through Daga Kholpa, the main street for pedestrians is designed mainly for internal traffic and to accommodate roadside developments such as commercial and business activities. The main street provides spaces for traffic lanes, parking lanes, pedestrian ways, and public transport. While it is planned mainly for the traffic generated in or coming from and going to other parts of Daga Kholpa, in the future it may need to accommodate through traffic as well, in the event that the volume of through traffic surpasses the capacities of National Road No. 1 and the arterial road to/from Diamniadio (Figure 9.7.10).

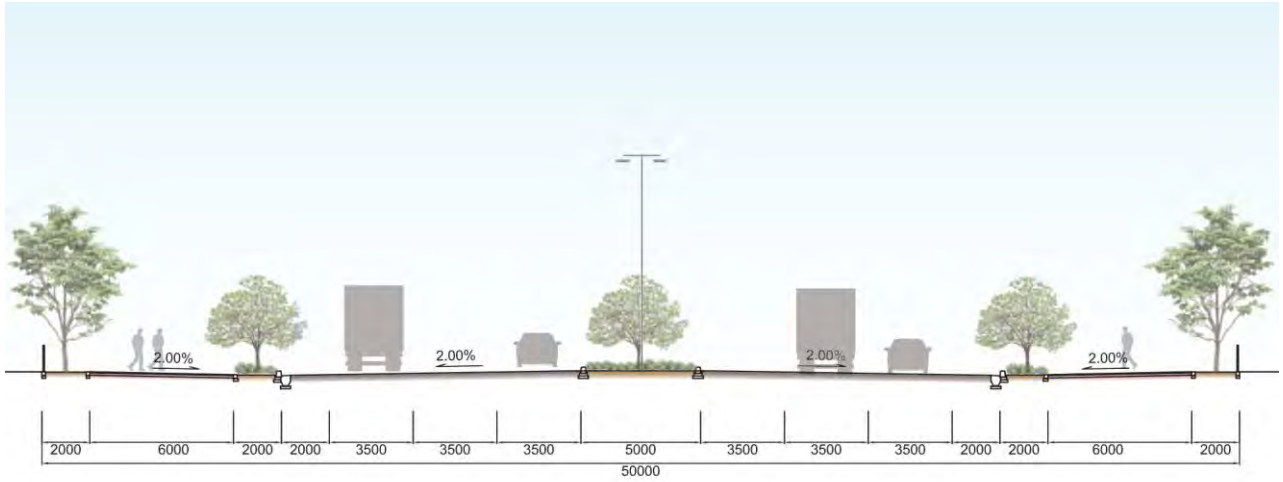
(c) The circulation road serves to distribute the traffic from the artery roads to urban centers and the main neighborhood units (Figures 9.7.11 and 9.7.12).



Source: JICA Study Team

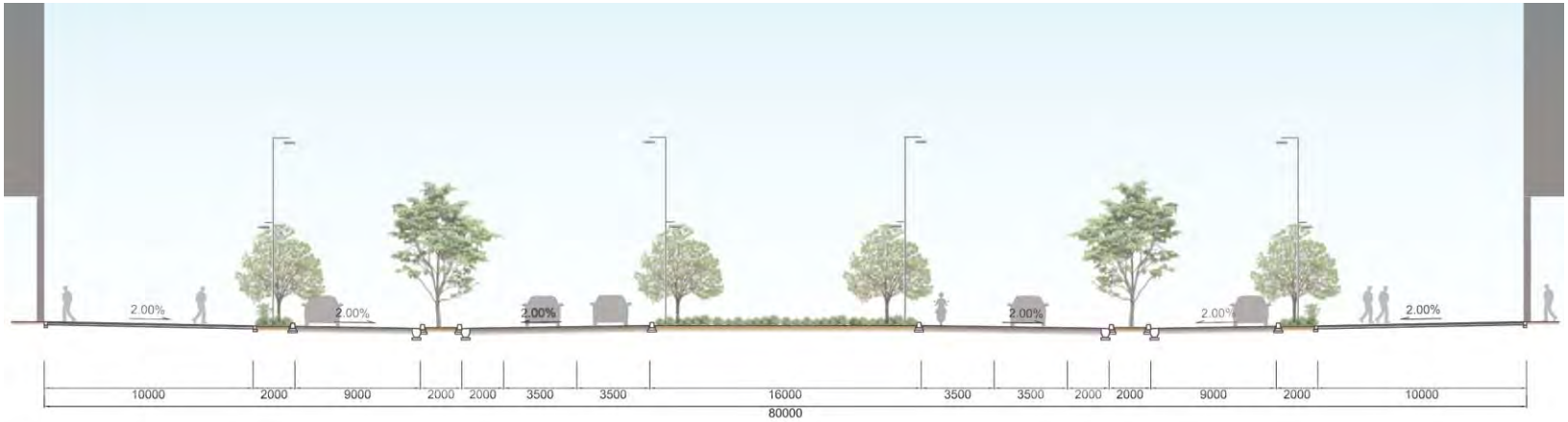
Figure 9.7.8 Road Network Plan

The roads lower down in the defined hierarchy are not shown here since these need to be planned by developers. The DUA will need to provide guidance to developers to secure a minimum right-of-way width of 15 meters.



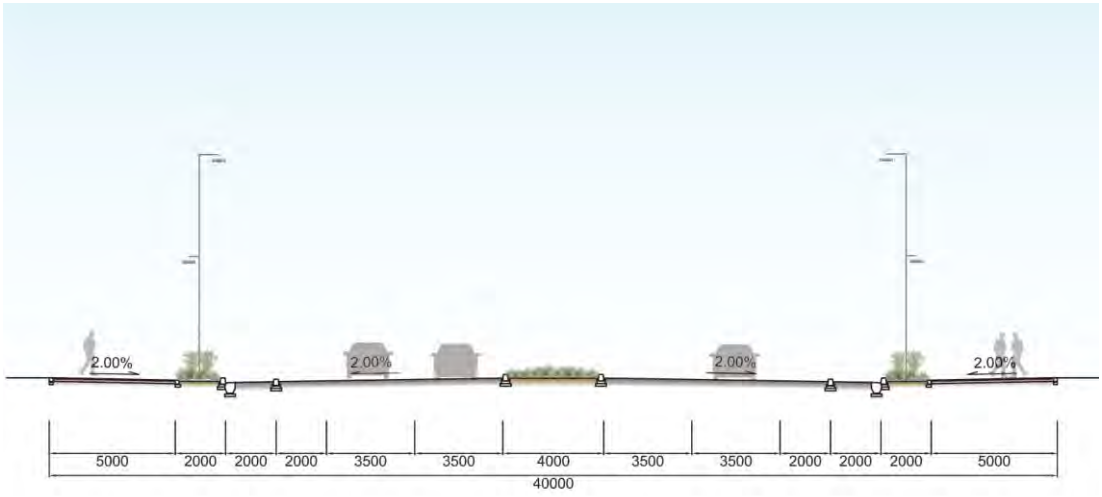
Source: JICA Study Team

Figure 9.7.9 Road Section of Artery Road



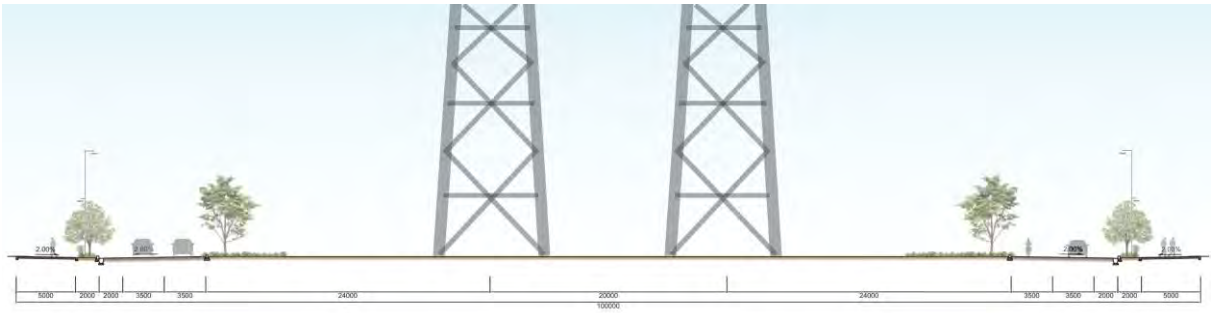
Source: JICA Study Team

Figure 9.7.10 Road Section of Main Street



Source: JICA Study Team

Figure 9.7.11 Road Section of Circulation Road



Source: JICA Study Team

Figure 9.7.12 Road Section of Circulation Road with Transmission Line Tower

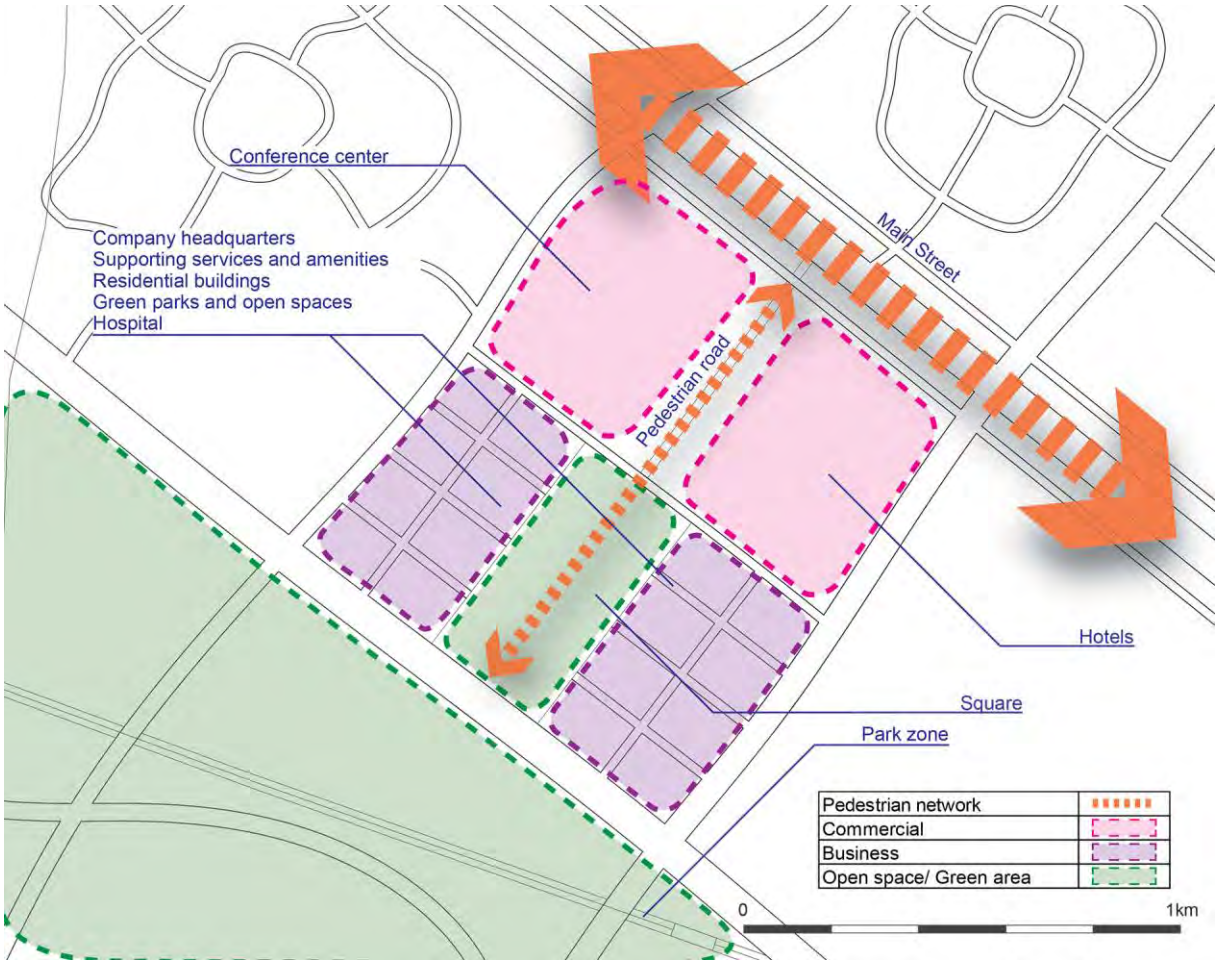
3) Two CBDs

CBD 1 is planned as the main business district, consisting of a business zone, a commercial zone, and an open space/green area. By planning a pedestrian road in the center of the area connecting the main street and the park zone, clear zoning and a better circulation network for the pedestrian are secured. It will be a boulevard where people can relax and enjoy their spare time away from their busy days.

Source: Minato Mirai 21 official website

Figure 9.7.13 Image of the Pedestrian Road

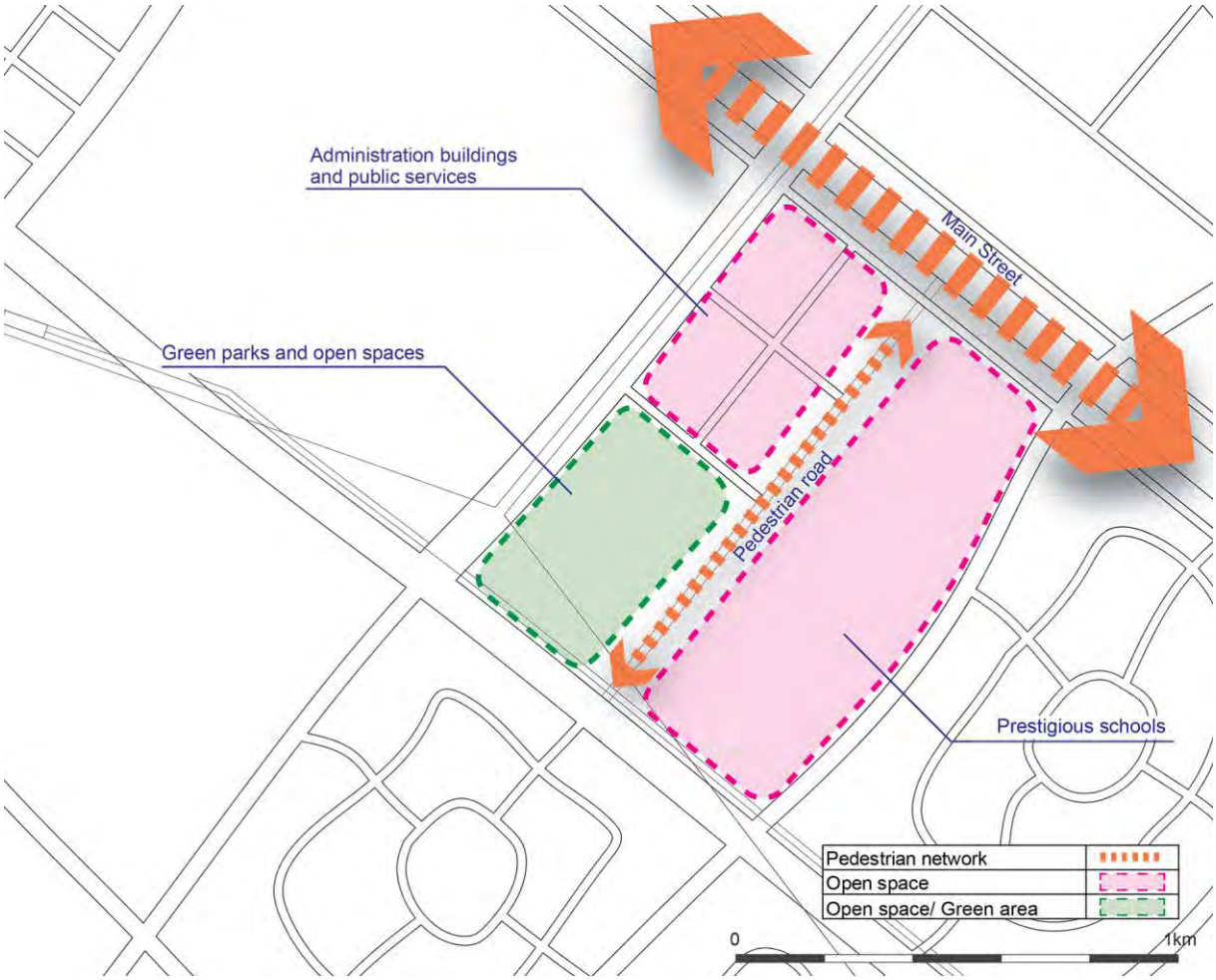
On either side of this pedestrian road, a business and a commercial zone are laid out. In the business zone, 1) company headquarters, 2) supporting services and amenities, 3) residential buildings, 4) hospitals, and 5) open spaces are expected to be located. In the commercial area, 1) an international conference center, and 2) high-class hotels are expected to be located, taking advantage of the area's good accessibility from the international airport through the national road.



Source: JICA Study Team

Figure 9.7.14 Detail of CBD 1

CBD 2 is planned as a quieter district than CBD 1, targeted at local people rather than international businesses. Government offices and prestigious schools are laid out following this idea. As in CBD 1, a pedestrian road is designed in the center of this district for clear zoning. This pedestrian road will guide locals and students to the green parks, where they will be able to communicate with each other in comfortable, natural surroundings.



Source: JICA Study Team

Figure 9.7.15 Detail of CBD 2

Source: http://london.navi.com

Figure 9.7.16 Image of the Green Park

Source: http://www.nishogakusha-u.ac.jp

Figure 9.7.17 Image of the Prestigious School

4) Residential Area

Population density

In the Master Plan 2035, the population of the Project Area in 2035 is estimated as 183,900, and gross

population density is calculated at 145 people per hectare. Based on the policy agreement between the DUA planning team and the JICA Study Team, all neighborhood units are planned to be 60 to 100 hectares in size. Table 9.7.4 below presents a plan for the residential area in the two phases: 2016-2025 and 2026-2035.

Table 9.7.4 Population Density of the Residential Area

			Phase 1 (2016 - 2025)	Phase 2 (2026 - 2035)	2035
Population[1]		1,000	77.7	106.2	183.9
Area of the residential area		ha	387	878	1,265
Population density (gross)		person/ha	201	121	145
Average population per unit		1,000	19.4	11.8	14.1
Housing area	Independent housing	ha	878	878	1,149
		%	70	100	91
	Low-rise apartment	ha	116	0	116
		%	30	0	9

Source: JICA Study Team

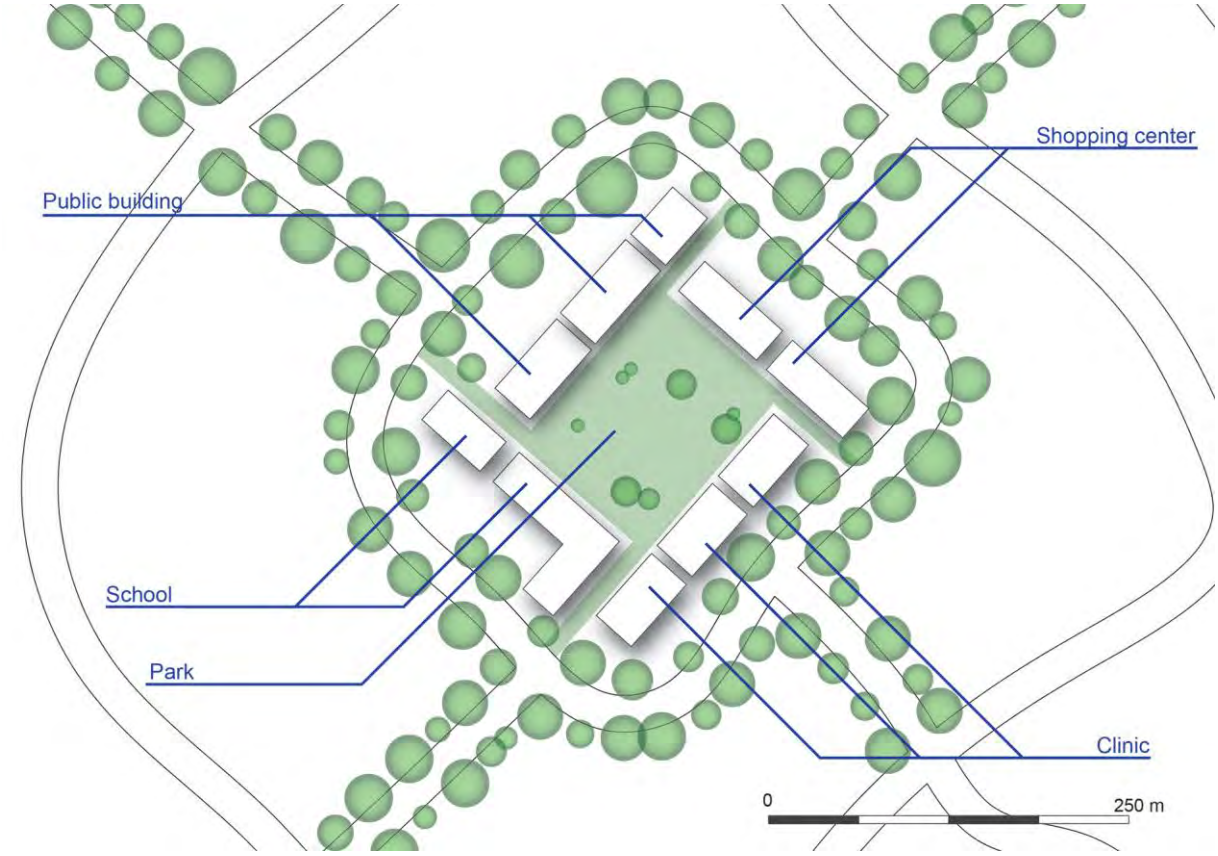
Setting the population density as 1) 170 people/ha for the independent housing area, and 2) 250 people/ha for the low-rise apartment housing area, until the target year of 2025 (Phase 1), at least 60% of the area needs to be prepared with low-rise apartment housing in each neighborhood unit. Until the target year of 2035 (Phase 2), all housing can be supplied as independent housing. However, from the point of view of preserving the open space and the houses for low-income workers, low-rise apartment housing is desirable.

The core of the residential area

Each neighborhood unit is planned to function as a self-supporting unit with its own amenity zone, where such facilities as shopping centers, schools, health centers and parks are located. Based on the agreement reached in the drawing session, a primary school will be established for every 10,000 people of the population and a secondary school for every 20,000. Based on the residential development plan shown in Table 9.7.4, for example, on average every neighborhood unit will need to have two primary schools and one secondary school in Phase 1.

A schematic of an amenity zone is shown in Figure 9.7.18.

[1] The Master Plan 2035.

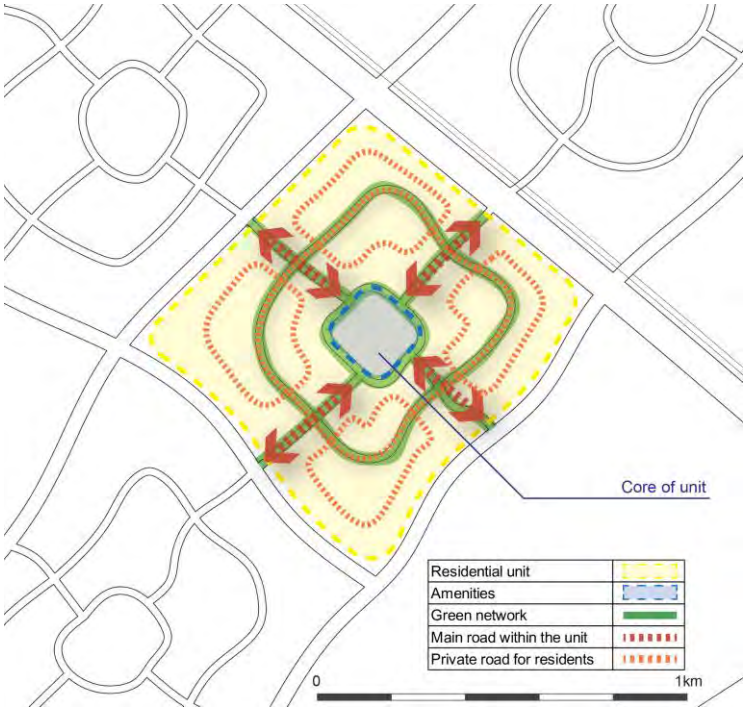


Source: JICA Study Team

Figure 9.7.18 Amenity Zone (example)

Security

In order to realize the vision of a "comfortable living environment", it is preferable to limit the access of through traffic to the neighborhood unit for security reasons. A cul-de-sac road network is proposed from this perspective. Access for residents and visitors to/from outside is made possible only by a main road, shown in red in Figure 9.7.19, starting from the circulation road and bending there at 90 degrees to reach the other end; thus it is only linked to the circulation roads at two points. The private roads shown in orange in Figure 9.7.19 are linked with the main road and will ensure access to service roads for final access to houses for residents. In addition, pedestrian ways linking neighboring neighborhood units are



Source: JICA Study Team

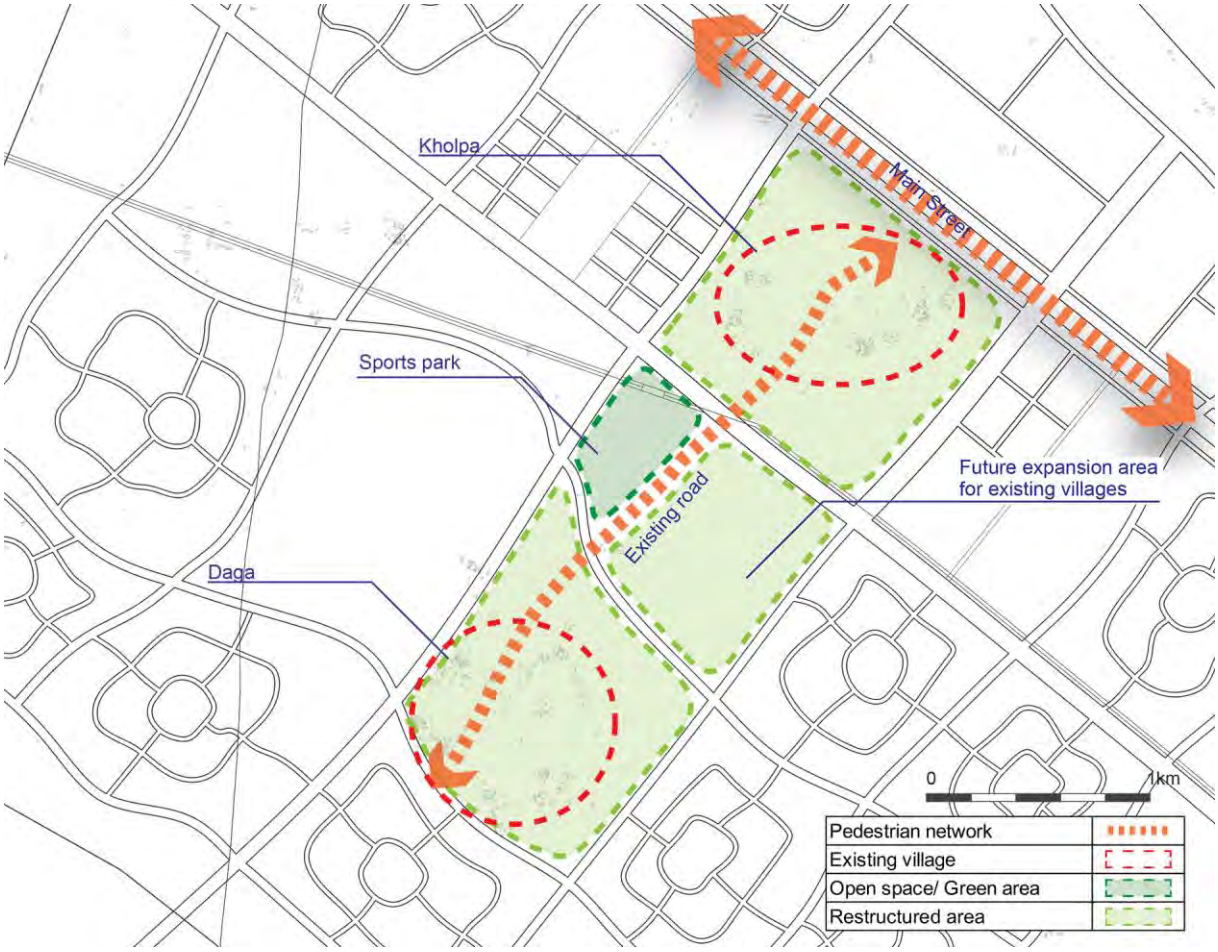
Figure 9.7.19 Example of the Neighborhood Unit

proposed, thus forming a green network for all of Daga Kholpa.

Service roads for residents to access their own houses are not shown here, since these roads need to be planned by developers. It is advised that the DUA needs to provide guidance to developers to follow the planning policy shown above.

5) Community Zone

The concept of this community zone is to preserve the existing landscape and human communities. Following this idea, the existing road is planned to remain, connecting the two existing villages, Daga and Kholpa, just as at present. Between these two villages, a sports park is planned, where 1) an Olympic-standard national stadium, an indoor stadium and an indoor swimming pool, 2) a training gym and a jogging and cycling course for residents, and 3) cafés and restaurants are expected to be located. Bringing the new residents together and being located between two existing villages, this sports park is expected to be the key area that allows new and existing residents of the Project Area to communicate with each other and to enjoy exercising together. In the event of future demands for an extension of the existing village, the eastern side of the sports park would be available.



Source: JICA Study Team

Figure 9.7.20 Detail of the Community Zone

Source: https://kurera.jp

Figure 9.7.21 Image of the Jogging Course

Source: JICA Study Team

Figure 9.7.22 Photo of Kholpa Village

9.7.2 General provisions on planning applicable to all areas

General design provisions applicable to all sectors are as follows:

1) A key objective of the development framework is to ensure that the land allocation is brought forward in a strategic and comprehensive manner. The development framework provides guidance and further detail to the development principles set out in the adopted design concept.

2) Alternative solutions and land use arrangements could come forward as part of the planning application process and should explain the reasons for any significant differences in approach.

3) In order to ensure that the strategic land allocation is brought forward in a strategic and comprehensive manner, planning permission should only be granted for developments respecting the development framework. Design codes will also be required for each phase or site, to be prepared by the developer and approved by the DUA (or the implementing agency to be appointed).

4) The number of accesses on public roads may be limited in the interest of public safety. Especially when the terrain is served by several roads, buildings may only be allowed provided that access is established on a road where obstructing traffic will be reduced.

   To be constructible, land must have access to a public or private road open to traffic and be in good condition for viability.

   The access characteristics must meet safety, fire and civil defence requirements.

5) A subdivision is any transaction which has the effect of planning, providing infrastructures and dividing into lots of one or more land properties for sale, free transfer or lease. For subdivisions, divisions should be organized to provide contiguous plots provided that the total length of the facades does not exceed 120 m. In the case of subdivision of a high standing housing area, the cumulative length of the frontage cannot exceed 60 m.

6) The various rights-of-way defined by the detailed urbanization plan are essential and need to be respected in all development projects. Accesses to neighborhood units and other development units (such as CBD1, CBD2, the industrial area, etc.) should be carefully planned and designed to avoid any obstruction or potential hazards.

7) Parking areas must be secured during any construction operation according to the following characteristics:

Length:	5.0 m
Width:	2.5 m
Clearance:	6.00 m

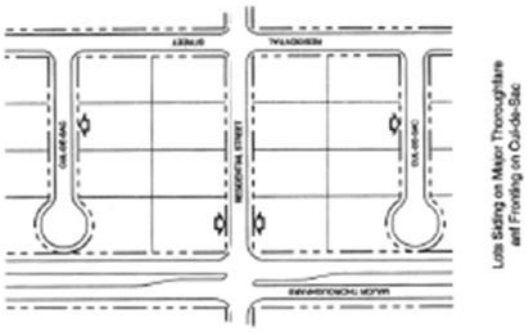
The minimum parking areas are as follows.

Individual housing:	1 place for 1 house
Apartment building:	1 place for 100 m^2 (gross floor area)
Commercial and office use:	1 place for 50 m^2 (gross floor area)
Hotels:	1 place for 10 rooms
Industries:	1 place for 100 m^2 (gross floor area)

For buildings open to the public, at least 20% of the gross floor area will be reserved for parking spaces.

8) As a general rule, similar building types and heights should face one another across major streets; transitions between substantially different building types ideally occur on back alleys or across side streets.

The most important aspects of a typical subdivision design are that major roads bound the residential neighborhood area and residential lots are not allowed to face directly onto these roadways as shown in Figure 9.7.23. Many lots back on to the major roads and cul-de-sacs are used to open up the neighborhood and to provide access to residences from interior streets rather than directly from the major roadways. Collector streets are not continuous, but are instead offset within the interior of the neighborhood, which discourages cut-through traffic. Services such as schools, shopping areas, dispensaries, etc. are located at the center of the neighborhood unit along the collector streets.



Source: JICA Study Team

Figure 9.7.23 Sample of preferred subdivision

9.7.3 Special provision on planning applicable to specific areas

(1) Central Business District CBD1

Authorized building types

The following types of buildings are authorized:

- Corporate headquarters and office use buildings
- Tertiary services and support facilities such as shops, pharmacies, restaurants and bars, banks, etc...
- Major urban facilities and religious buildings
- Residential buildings
- Conference centers
- Hotels
- Hospitals

Prohibited building and subdivision

The following types of building and subdivision are prohibited:

- Subdivisions for the purpose of constructing individual residential houses
- Individual residential houses
- Subdivisions for the purpose of constructing industrial buildings
- Industrial buildings and activities
- Subdivisions for handicraft and light industries
- Handicraft activities

Plot area

A minimum area of 1,800 m^2 is required for all types of use and the shortest side of the plot should not be less than 30 meters.

Land use conditions

The BCR (building coverage ratio) is variable with a minimum of 60% and may reach 100% of the total land area. This stems from a desire to give more flexibility to developers who will propose a preliminary design layout for each development area. The draft will be submitted to DUA, or any other agency responsible for the implementation of the Daga Kholpa development project. The same developers are required to propose a FAR (floor area ratio) in consistency with the densities proposed for each activity, and with the maximum height set at 10 stories (or 40 meters maximum height) and a proposal of a massing layout for the entire area.

Landscaping treatment

In order to create a distinctive image of the city, landscaping should be incorporated into the design of each building. Thus, an area equivalent to the surface of the plot should be processed in the form of terraces and green roofs. The roofs and terraces of buildings should be considered as a fifth façade and be designed to complement the general form and can thus be used as outdoor space.

All service areas, parking lots and machinery rooms such as electrical substations, mechanical rooms, water tanks, etc. must be fully integrated into the overall building envelope and be visually well designed from the top and from all sides.

Night lighting

All buildings within the CBD1 business zone should include night lighting that expresses the architectural design and building's form in order to contribute to the nightlife of the city.

Pedestrian network

The CBD1 Planning Area is planned as a pedestrian-friendly area with a comprehensive pedestrian network at the ground floor level. This network provides convenient, comfortable, and seamless connections between developments, transport facilities, and key spaces and attractions, and ensures all-weather comfort for pedestrians.

Parking areas

For all developments (within CBD1) including those situated at key approaches to the CBD1 and fronting onto major roads and open spaces, all car parking areas are required to be located at the basement levels.

Alignment

To create distinctive and well-defined streets, all developments are generally to be built-up fully to the lines of road reserves to a minimum height of 24 m (6 stories). Up to 40% of the length of the building facades can be set back from the lines of road reserves to allow for articulation of the building form.

Beyond 24 meters, a mandatory set back of the façade of at least 4 meters should be planned.

Party wall

In the business area, party walls are not permitted. Each building shall be independent of any another, and an opening in the frontage allowing access to the back of the plot must be provided on a 60 meter interval.

Fences

No fences are authorized in this area and all residual space should be accessible and be part of the public realm.

(2) Administrative and Cultural District CBD2

Authorized building types

The following types of building are authorized:

- Administrative and public utilities buildings (sub-prefecture, police, city hall, etc...)
- Tertiary services and support facilities such as supermarkets, shops, pharmacies, restaurants and bars, banks, etc...
- The major urban facilities and religious buildings
- Residential buildings
- Schools and universities
- Surface and underground parking areas

Prohibited building and subdivision

The following types of building and subdivision are prohibited:

- Subdivisions for the purpose of constructing individual residential houses
- Individual residential houses
- Subdivisions for the purpose of constructing industrial buildings

- Industrial buildings and activities
- Subdivisions for handicraft and light industries
- Handicraft activities

Plot area

The minimum area of the plots is not set in this development zone. The developer should make a decision about the appropriate surface areas that can accommodate the various buildings required for this area. For a residential building, the minimum area required for a plot must not be less than 1,600m^2. The shortest side of the plot should not be less than 30 meters.

Land use conditions

The BCR is variable with a minimum of 50% and may reach 70% of the total plot area. This stems from a desire to give more flexibility to developers who will propose a preliminary design layout for each development zone. The draft will be submitted to DUA, or any other agency responsible for the implementation of the Daga Kholpa development. The same developers are required to propose a FAR in consistency with the densities proposed for each activity, and with the maximum height set at 10 storeys (or 40 meters maximum height) and a proposal of the layout for the entire area.

Landscaping treatment

In order to create a distinctive image of the city, landscaping should be incorporated into the design of each building. Thus, an area equivalent to the surface of the plot should be processed in the form of terraces and green roofs. The roofs and terraces of buildings should be considered as a fifth façade and be designed to complement the general form and can thus be used as outdoor space.

All service areas, parking lots and machinery rooms such as electrical substations, mechanical rooms, water tanks, etc. must be fully integrated into the overall building envelope and be visually well designed from the top and from all sides.

Pedestrian network

The administrative and cultural center is planned as a pedestrian-friendly area with a comprehensive pedestrian network at the ground floor level. This network provides convenient, comfortable, and seamless connections between developments, transport facilities, and key spaces and attractions, and ensures all-weather comfort for pedestrians. It is, therefore, necessary to ensure these connections when designing the project.

Parking areas

Parking areas are allowed at ground level and at the basements of buildings. Public parking lots are also allowed on easily accessible plots, however, proper landscaping should be used to mitigate the visual impact.

Alignment

No alignment is planned for this area.

Party walls

Party walls are not permitted. Each building shall be independent of any another, and an opening in the front panel allowing access to the back of the plot must be provided on a 60 meter interval.

Fences

Transparent or green fences are permitted in the area; however, it would be better to avoid the

construction of opaque fences where possible.

(3) Commercial Boulevard

Authorized building types

The following types of building are authorized:

- Shops and commercial establishments
- Tertiary services and support facilities such as supermarkets, pharmacies, restaurants and bars, banks, etc.
- Major urban facilities and religious buildings
- Mixed-use buildings (commercial, office use and residential apartments)
- Corporate headquarters and office use buildings
- Hotels

Prohibited building and subdivision

The following types of building and subdivision are prohibited:

- Subdivisions for the purpose of constructing individual residential houses
- Individual residential houses
- Subdivisions for the purpose of constructing industrial buildings
- Industrial buildings and activities
- Subdivisions for handicraft and light industries
- Handicraft activities

Plot area

The minimum surface areas of the plots are set at 1,200 m^2. The shortest side of the plot should not be less than 20 meters and must be aligned with the limits of the road right-of-way.

Land use conditions

The BCR is variable with a minimum of 80% and may reach 100% of the total land area only for the first two floors dedicated to commercial activities. However, the height of the first two floors must not exceed 10 meters. The developers are required to propose a FAR in consistency with the densities proposed for this sector. The maximum height of the building should not exceed 10 storeys (or 40 meters), the first two (R+1) of which will be dedicated to commercial activities.

Landscaping treatment

In order to create a distinctive image of the city, landscaping should be incorporated into the design of each building. Thus, an area equivalent to the surface of the plot should be processed in the form of a terraces and green roofs. The roofs and terraces of buildings should be considered as a fifth façade and be designed to complement the general form and can thus be used as outdoor space.

All service areas, parking lots and machinery rooms such as electrical substations, mechanical rooms, water tanks, etc. must be fully integrated into the overall building envelope and be visually well designed from the top and from all sides.

Pedestrian network

The commercial boulevard is an integral part of the activity center. It is planned as a pedestrian-friendly area with a comprehensive pedestrian network at the ground floor level. This network provides convenient, comfortable, and seamless connections between developments, transport

facilities, and key spaces and attractions, and ensures all-weather comfort for pedestrians. It is therefore necessary to ensure these connections when designing the project.

Parking Areas

Parking areas are authorized in the basements of buildings, at ground level exclusively behind the surface areas dedicated to trade, and at the level behind the floors dedicated to commercial activities, without exceeding the height of 10 meters. However, there should be landscaping to mitigate the visual impact. Access to parking areas will be located exclusively from service roads on both sides at the rear of commercial strips.

Alignment

To create well-defined streets, all developments are generally to be built-up fully to the lines of road reserves to a minimum height of 24 m (6 stories). No withdrawal of the facade is allowed. The height of the façade along the building line must be exactly 24 meters high. Beyond 24 meters, a mandatory set back of the façade of at least 4 meters should be planned. A gallery (covered walkway) of 4 meters in depth (a 3.4 meter net at the pillars) must be included at the front along the boulevard on the first two levels (10 meters). Any level change at the passage level and any obstacles to pedestrian traffic is prohibited.

Party wall

Party walls are required along the commercial street. An opening in the façade, which enables access to the back of the plot, should be planned on a 60 meter interval. A clearing of 6 meters that goes to the end of the commercial band should be planned for every 120 meters to facilitate fire fighters' tanker truck access.

Fences

Fences are exclusively authorized at the back of the plots.

(4) Industrial, Artisanal and Logistic Zone

Authorized building types

The following types of building are authorized:

- Material warehouses and stores along the national road
- Non-polluting (air and water) light industries (industrial wrapping, reprocessing, packaging)
- Industrial companies' headquarters
- Technological industries and agglomerated work space
- Buildings, which include handicraft activities (parking, carpentry, etc…) exclusively in areas dedicated to handicraft activities.
- Industrial product stores, hardware stores, etc. exclusively in the area dedicated to handicraft activities.
- Gatekeepers' lodge building
- Sale and exhibition building
- Office buildings
- Proximity services and health posts
- Permanent parking areas solely within plot limits
- Oil stations

Prohibited building and subdivision

The following types of building and subdivision are prohibited:

- Land subdivision dedicated for individual housing
- Individual houses

Plot area

The minimum allowed plot area is 10,000 m^2, the shortest side being not less than 50 meters and should line with the limit of the road right-of-way. However, contiguous plots can be joined to form a single piece of land.

Land use conditions

The BCR is fixed to 50% of the total plot area. The building height should not exceed 12 meters (including the roof pitch). No FAR is fixed in this zone.

Landscape treatment

A landscaping plan should be included while designing a building to create a distinctive image of the area. Thus, 10% of the surface of the plot should be treated as developed green space. All parking areas should be planned within the plot of land. Truck parking is not authorized outside the plot.

Pedestrian and cycling network

It is worth ensuring there is a pedestrian and cycling link between the industrial area and other areas of the project.

Building setback

Setbacks of at least 6 meters from all sides of the plot are required.

Fences

Two meter high fences are authorized along the entire perimeter of the plot. An additional one meter high transparent fence can be added to the original fence.

(5) Residential area (neighboring unit)

Authorized building types

The following types of building are authorized:

- Individual detached houses
- Attached social houses
- Collective housing building
- Cultural, religious, social and business facilities
- Playgrounds and green spaces which are part of collective housing units
- Commercial buildings and other related activities such as neighborhood supermarkets and convenience shops, restaurants
- Residential land subdivisions for social, individual or collective buildings

Prohibited land uses

The following types of land uses are prohibited:

- Subdivisions for the purpose of constructing industrial buildings
- Industrial buildings and activities
- Subdivisions for handicraft and light industries

- Handicraft activities
- Oil stations and tank farms
- Fixed and mobile shelters used for housing or not, iron warehouses, liquid or solid fuel and materials
- Handicraft activities that could cause harm to neighbors (air pollution, water pollution, noise, heavy traffic, the use of hazardous products, etc.)
- Excavations and scouring, soil uplifting, quarrying which are not related to construction works.

Plot area

Several plot sizes are authorized so as to meet a variety of needs.

- The minimum surface area of plots is set at 200m^2; however they can reach 300m^2 and 500m^2. The shortest side of the plot is no less than 10 meters.
- Collective housing plots should not be less than 1,500m^2.

Generally speaking, each group of plots will have to be homogenous in terms of size and type of houses.

Allocation of plots of the three sizes should be planned in consideration of such factors as: (i) slope: areas with more slope for smaller plots and flat areas or areas with less slope for larger plots, (ii) balance between nature-oriented location (larger plots) and convenience-oriented location (smaller plots), (iii) income level and vehicle ownership condition (larger plots for higher income level and vehicle ownership), and (iv) accessibility to major roads (larger plots closer to major roads and smaller plots inside).

Land use conditions

Regarding social housing and individual houses, the BCR is set at 60% of the total surface of the plot. The height of the building is a one storied house (R+1). The FAR is set at 0.8%. As for collective housing, BCR is fixed at 40%. This is intended to secure enough collective space, playgrounds along with parking areas within the site. Nevertheless, there is some flexibility to enable developers/ promoters to propose alternative design proposals for each development area. The draft project will be submitted to DUA or to any other agency that is in charge of implementing Daga Kholpa's development. The same developers are required to propose an FAR in consistency with the densities proposed for each type of house. They are also required to submit a subdivision plan for all the targeted development areas. It is, however, suggested that collective housing projects are established next to road networks with 80m, 40m and 20m widths so as to create a visual and sound barrier. Public and proximity facilities will be established at the center of the neighborhood unit to make sure they are easily accessible for all residents.

Landscape treatment

In order to create a distinctive image of the residential area, landscaping should be incorporated in each land subdivision. Therefore, an area equivalent to 10% of the surface of the plot should be treated as a developed green space. All parking areas should be planned within the plot.

Pedestrian network and bikeway

It is necessary to create pedestrian and bicycle links within each residential area and between other project areas.

Parking areas

Parking areas for collective housing are authorized in building basements and on the ground floor but only at the back of the buildings; however landscaping should be incorporated in the design process in order to mitigate the visual impact.

Building setback

As far as social housing is concerned, a setback of a minimum of 3m from the separation line of the plot to the road is required. For individual housing where the plot surface is superior or equal to 300m^2, a 3m setback from all sides of the plot is required. For collective housing, a 5 meter setback from all sides of the plot is compulsory. The setback area facing major road networks should incorporate landscaping to mitigate visual and sound impacts.

Fences

Two meter high fences are authorized along the entire perimeter of the plot. However developers/ promoters, or land owners are advised to construct a green or transparent fence along the separation line of the plot with the access road.

9.7.4 Provision of public services

(1) Educational Facilities

In a new development such as Daga Kholpa, the assumption is that one fifth of the residents will be of school age (source: Diamniadio new town development project). This means 36,780 students in total are divided into four categories consisting of primary education, average education, secondary education, and higher education.

Table 9.7.5 Floor Area Requirements for Educational Facilities

Item	Assumptions	Number (people)	Land requirement per person	Total Floor Area Required
• Total population	183,900 inhabitants			
• Preschool education, nursery school 60 units	1.25% of total population	2,300	10 m^2/student	23,000 m^2
• Student population excluding nursery	36,780 (1/5 of total population)			
• Primary education, Primary schools 60 units	60% of student population	22,068	12 m^2/student	260,000 m^2

Source: JICA Study Team

(2) Health Facilities

The health facilities will include the most common health institutions which are mainly health posts, PMI centers (maternal and infant protection centers), maternal and infant protection centers, health centers and public and private general or specialized hospitals.

Health posts (dispensaries)

These health posts should be very accessible, that is to say less than 2km from one another. The logic used is one health center for each three neighborhood units (five in total) plus one health center for each surrounding village in Yenne and northwest (two in total).

Number = 7 health posts, that is (1) for 27,000 inhabitants
Surface area: 1,000 m² x 7 = 7,000 m² (0.7 ha)

Maternal and infant protection centers (PMI)

These centers should be spread out and accessible in the agglomeration. A social security service might be added to PMI centers to make them more available and operational.

They can be established next to health posts.

Number = 7 health posts, that is (1) for 27,000 inhabitants
Surface area: 1,000 m² x 7 = 7,000 m² (0.7 ha)

Hospitals

Large hospitals provide a complete range of healthcare services and specializations.

Number = 1 hospital, that is (1) for 200,000 inhabitants
Surface area: 50,000 m² x 1 = 50,000 m² (5 HA)

Summary of health facilities

Health posts: (7 U) = 7,000 m²
PMI centers: (7 U) = 7,000 m²
Hospitals: (1 U) = 50,000 m²

Total health facilities = 64,000 m² (6.4 ha)

(3) Cultural Centers

The cultural centers should be comprehensive enough and include theater rooms, conference and concert rooms, museums and exhibition galleries, libraries and reading rooms for adults and children.

This cultural facility should be designed in such a way that it can animate the various centers of all districts.

The main cultural center for the entire agglomeration will include:

- A large multi-purpose theater room, which can contain about 2,000 people along with all the related facilities
- A big municipal library
- A museum and exhibition galleries

Surface area: 30,000 m² (3 ha)

Secondary cultural centers at each urban block level will contain:

- A library
- A reading room
- A multi-purpose theater room connected to an open theater

Surface area: 3,000 m² x 7 = 21,000 m² (2.1 ha)

Total cultural facilities = 51,000 m² (5.1 ha)

(4) Social Facilities

The social facilities to be selected were determined with a view to provide Daga Kholpa with modern and social activities.

A large social center at the level of the entire development will provide social assistance including social reintegration and employment assistance offices for all residents of Daga Kholpa.

Surface area: 10,000 m² (1 ha)

Proximity centers: a youth center, a women's home and an elderly center will be provided by units of 100,000 inhabitants, that is:

Number = 3 x (200,000/ 100,000) = 6 centers
Surface area = 2,000 m² x 6 = 12,000 m² (1.2 ha)

Total social facilities = 22,000 m² (2.2 ha)

(5) Open Space Standard

The following are the open space standards:

Table 9.7.6 Area Requirement for Parks and Playing Fields

	Standard/1,000 Population	Catchment Area	Minimum Required Area ha/ Neighborhood Unit
Local Play Area	0.35 ha	300 m	3.5
Local Park	0.4 ha	600 m	4.0
Urban Block Unit Park	0.8 ha	1,200 m	8.0
Playing Fields	1.5 ha		1.5

Source: JICA Study Team

(6) Public Cemeteries

Two separate large sites have been identified to host large public cemeteries serving both the Christian and Muslim communities, not only for Daga Kholpa's current and future residents, but also for the whole Dakar area. This comes out of a need to find a solution to the already saturated cemeteries of Tioff and St. Lazarre, which are about to reach their maximum capacities. The chosen sites of 40 ha and 60 ha are located respectively to the eastern and western edges of the development along the major circulation road crossing through the middle of the project. This will facilitate access to these cemeteries, while at the same time necessary measures will be taken to buffer the two sites from surrounding settlements.

9.7.5 Demands for Infrastructure Development

Demands for infrastructure development are estimated based on the planning conditions of the present Master Plan (presented in Chapter 7) for water, electricity and sewerage, as shown in Table 9.7.5 below.

Table 9.7.7 Infrastructure Demands in the Project Area

Electricity			
Study Area*	Capacity	348	MW in 2013
	Population	3,206	thousand people
	Per capita capacity	109	W/person
Daga Kholpa	Population	183,900	people in 2035
	Per capita capacity	109	W/person
	Total capacity required	20	MW in 2035
Water			
Daga Kholpa	Population	183,900	pople in 2035
	Water consumption per capita	75	lcd (liter/capita/day)
	Non-revenue water rate	10.0%	(assuming all leakage)
	Water demand	15,325	m^3 per day
		5,593,625	m^3 per year
Sewerage			
Daga Kholpa	Water demand	15,325	m^3 per day
	Proportion of sewage to water demand	90%	of water demand
	Sewage discharge volume	14,963	m^3 per year

Note: The values for the Study Area are shown to derive the per capita capacity of power generation, which is used as the basis for estimating the power demand in the Project Area.
Source: JICA Study Team

9.7.6 Magnitude of Investment

The following is a strategic cost estimate to contribute to initial strategic advice concerning the development of the Daga Kholpa PUD. At this level the cost estimate involves minimal detail and certainty. Typically, the estimate contains relatively large risk values to account for the limited detail. Estimates at this level are typically based on benchmarked values from recent similar projects (adjusted to suit the current project); they are not intended to be used in applications for project funding, but rather for the assessment and comparison of initiatives.

The following costs estimated are those to be borne by the government; they do not include those to be borne by private developers, such as service roads, water distribution and sewerage pipes, and secondary drainage channels.

Table 9.7.8 Preliminary Cost Estimate and Price Benchmarking

Title	Total Price (Million CFA)	Total Price (Million USD)	Source
Roads & Bridges	98,852.82	166.41	PDU Tivaouane-DUA
Sewerage Treatment Plant and Network	54,528.00	91.79	PROGEP
Cost of Main Sewage Network	21,000.00	35.35	PROGEP
Water Supply	11,031.19	18.57	PDU Tivaouane-DUA
Electricity	16,236.11	27.33	PDU Tivaouane-DUA
Communication*	24,752.00	41.67	Similar Projects
Public Open Space / Green Area/Parks	19,639.92	33.06	DCVEVU
Restructuring of Existing Settlements	1,350.87	2.27	PDU Tivaouane-DUA
Total Infrastructure	**247,390.91**	**416.45**	
Cost/Hectare	*63.58*	*0.11*	
Subdivision Work by Private Developers	**227,622.81**	**383.18**	PDU Tivaouane-DUA
Cost/Hectare	*58.50*	*0.10*	
Total Preliminary Cost	**475,013.72**	**799.63**	
Total Cost/Hectare	*122.08*	*0.21*	

* Benchmarked from other similar projects
Note: Exchange rate at USD = 594.04 CFA as the average between May and July in 2015. Development area of 3,891 hectares.
Source: JICA Study Team

9.7.7 Phasing

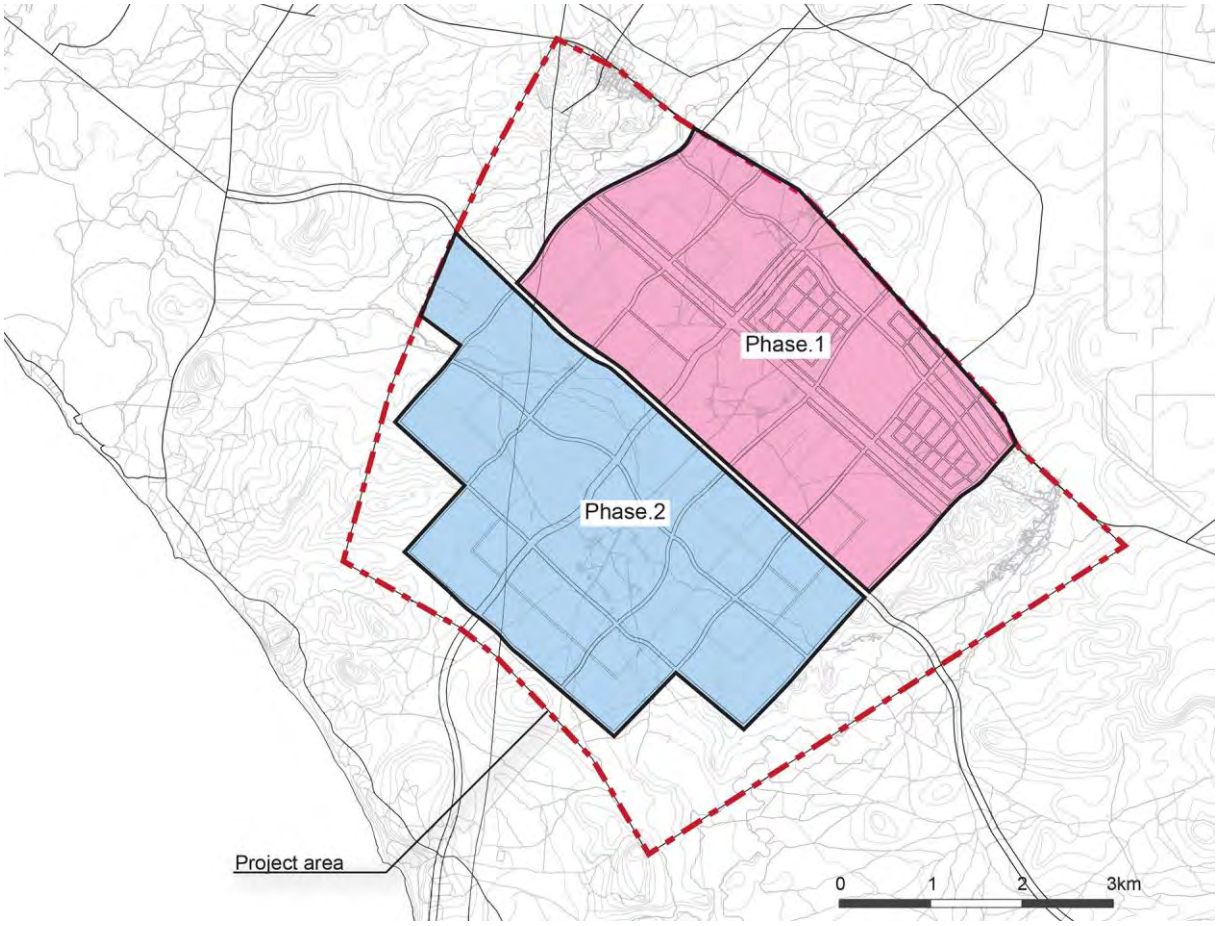
The development of Daga Kholpa should take into account the time factor, since different areas will take different periods of time to develop. For longer periods it is important that a phasing program is put in place. The purpose of phasing is to ensure that the physical and social infrastructure required is provided in tandem with the residential development. A phasing program will indicate the number of phases proposed and the enabling works that are required in each phase in order to move onto the next. Such a program will be proposed once the development concept is approved, and will reflect the DUA's readiness to develop the respective site, and at what speed the development will take place. In all cases, although the development of Daga Kholpa is programmed to take place up to 2035, it would be advisable to anticipate some recalibration during the development process. Therefore, specific areas for future development should be reserved, which will allow more flexibility at certain stages. Thus, one large block should be opened for development at a time after building the main road infrastructure; this will also eliminate land speculation.

Practically, the project will be implemented in two major phases. The land to the north of the development area adjoining the existing national road should be developed in a first phase, as shown in Figure 9.7.24, since the basic infrastructure is already available. This could alleviate certain financial and operational burdens, since the land can be made immediately available for sale and construction. Moreover, this specific development area can accommodate logistical as well as light industrial activities, and is expected to draw considerable demand, especially given that many logistics and industrial companies in search of locational visibility will prefer to relocate along the national road facing the DISEZ. They will not have to comply with some of the restrictions that could be imposed in terms of controlled access and site operations by the triangle area of the DISEZ on the other side of National Highway No. 1, which is planned as the first-phase development area by APIX. The first development phase should include sufficient housing projects with the necessary amenities, commercial structures, and, most importantly, the structuring public facilities to provide a sense of space and to anchor the potential residents into the new area. Phase 1 will also necessitate substantial undertakings in terms of investments and infrastructure development. These would include the construction of a second major road parallel to the existing national road connecting Diamniadio to the Daga Kholpa development area. This road will constitute the backbone of the development area, together with a perpendicular south-north road linking the coastal area to the northern part of Dakar. These two major road axes are planned to service most of the car-oriented activities within the development area, and are similarly designed to facilitate potential through traffic. This phase needs to be launched as early as possible, since it represents the main core of the development and includes the central business district; it is also destined to accommodate most commercial, business and administrative functions as well as the main public facilities.

The second phase should be planned once Phase 1 is almost completed in order to leave enough time and space for necessary adjustments in terms of calibrating land uses and densities depending on real demand. The designated development area within Phase 2 comprises a low area, which will necessitate additional investments in terms of drainage and infrastructure. This area should be considered as a land bank that can be used once the development reaches its saturation point.

It is important to keep in mind that all development phases will necessitate additional effort in terms of urban restructuring, and in particular that they include the existing settlements of Daga and Kholpa. It is therefore important to anticipate the necessary adjustments at the earliest stages in order to deal with the potential complications, and to try at the same time to address the needs of the existing villagers in terms of space allocation for their traditional activities and the provision of the necessary public

services.



Source: JICA Study Team

Figure 9.7.24 Development Phase

9.7.8 Institutional Set-up for Implementation

The Daga Kholpa development project should be approached as a single integrated project with top-down appointed structures for both the project initiation and implementation phases. Three different set-ups are proposed for the project implementation and management structure. The tasks to be dealt with in any of the three set-ups will include all technical, administrative and financial aspects and processes including proposing development phasing, land preparation, land acquisition, resettlement, compensation, tendering and awarding of projects, permission for development, monitoring and follow-up on major infrastructure construction projects. Tasks will also include providing management services for infrastructure, public utilities, car parks and landscaped open areas, preparation of special area development plans, delivery of construction permits, etc.

The first option is that the Daga Kholpa development plan could be led by the public sector and spearheaded by the Ministry of Planning, which would appoint a special delegate and a public managing agency to supervise and coordinate all the necessary aforementioned tasks with different government entities and executive bodies, such as the DUA, Ageroute, etc. This would also entail budgeting and the resourcing of necessary funds for project implementation.

A second option would be the installation of a public-private partnership that would involve, in addition to the Ministry of Planning, APIX, developers, construction companies, bankers and financial advisors. This structure should only be constituted after the preparation of detailed guidelines and an

investment appraisal to avoid unnecessary gridlocks and shortcomings.

A third option for project management and implementation would be to establish an independent development agency, which, in addition to performing the above stated tasks in coordination with different public and non-state actors, could add the following advantages:

- Provide clarity of purpose
- Hire skilled professionals for project implementation and follow-up
- Remove political influence
- Act as an entity for receiving funding
- Act as an entity for engaging with third parties
- Act as an entity for financing and construction of the infrastructure and public domain for the entire development area on behalf of the state

Against the provision of such services, the independent development agency could be remunerated through the payment of specific fees, or be granted ownership of specific areas for development.

9.8 Strategic Environmental Assessment

DUA and the JICA Study Team have mobilized the services of a consulting firm to implement the Strategic Environmental Assessment (SEA) of Daga Kholpa PUD, following receipt of a letter from DEEC dated June 1, 2014, which indicated that an SEA had to be realized by an agreed company. As required by the legal procedure, the Terms of Reference of the SEA have been officially submitted to DEEC, through a letter signed by the director of the DUA. The validation of the Terms of Reference was formally announced in a response letter from DEEC dated August 10, 2015.

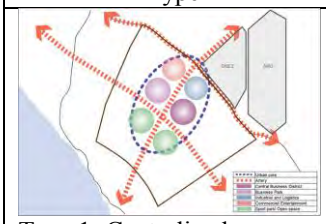
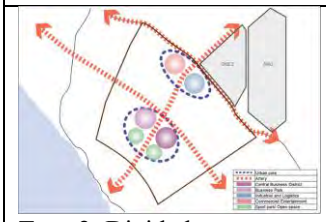
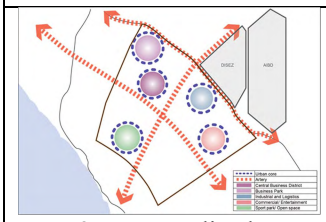
The final SEA report of Daga Kholpa PUD, drafted by a DEEC-agreed local consultant and finalized in November 2015, is a voluminous document that meets all the requirements from DEEC. Ultimately, this report will be submitted to the latter organization by DUA for official validation by the SEA through the normal administrative procedure of the Technical Committee. The following sections transcribe in a condensed way the essential results of the SEA: firstly the prospective work of comparison of (9.8.1) the different urban structure alternatives, and secondly the (9.8.2) evaluation of the impacts of the spatial organization of the PUD, for which (9.8.3) enhancement measures for positive impacts and suppression, reduction, and mitigation measures for negative impacts will be proposed.

9.8.1 Comparison of Urban Structure Alternatives

Within the framework of SEA, the assessment of alternatives is made on the basis of general environmental and social considerations.

The following table shows the results of the comparison of the alternatives in terms of urban structure proposed by Daga Kholpa PUD.

Table 9.8.1 Comparison of Urban Structure Alternatives

Urban Structure Alternatives Type	Evaluation
 Type 1: Centralized core	From a strictly environmental perspective, it seems risky to agglomerate residential and living places with industrial areas that might include potentially harmful activities (causing pollution, noise, odors, etc.) to local residents. Nevertheless, the concentration of functions will allow the distances between residential and business areas to be reduced, which will limit necessary trips and thus the carbon footprint. Also, concentration will help to increase social diversity, with the favored gathering of different population groups in an extended time range.
 Type 2: Divided cores	The idea of separating industrial and office functions from residential areas and common living spaces seems consistent with the perspective of protecting the living environment of the population against potential disturbances generated by industrial activities. However, the fact of separating functions will, firstly, increase necessary travel between residences and work places, and thus will increase the local carbon footprint. Furthermore, the industrial and business areas in the north might be completely deserted after working hours, which could lead to a situation of reduced social control and to the increase of delinquency and sense of insecurity within residents living far away.
 Type 3: Decentralized cores	Scattering of the functions, especially when they are operated across a vast area such as the Study Area of Daga Kholpa PUD, may not create the conditions of the pursued urban hospitality. Indeed, it will fix each function in large enclaves not communicating with each other. With the majority of trips being pedestrian, people will not be able to enjoy the various planned facilities, and it will be very difficult for them to reach their workplace. The necessary trips will create significant air pollution. This functionalist scenario shall be avoided.

Source: JICA Study Team based on "SEA Report" of Daga Kholpa PUD

With regards to the comparison of the different urban structure alternatives, it appears that type 1 "urban structure with a central core" is the alternative that seems to cause the least environmental and social impacts, especially because the so-called industrial areas that might have caused the problem are actually logistic zones not generating important disturbance.

9.8.2 Assessment of the Impacts of Spatial Organization

Once the choice of an urban structure has been made and the land use plan has been sketched, the Strategic Environmental Assessment aims to assess the impacts of the spatial organization proposed in the PUD. The criteria adopted for the impact assessment, which were chosen during the environmental sensibility survey[2], are the most relevant to reflect both the local characteristics of Daga Kholpa area and the urban issues crossed by the PUD.

The following table shows the overall summary of the results of the assessment on the impacts of all the aspects of the PDU regarding the adopted criteria.

[2] *Environmental and social sensibility analysis of the site of Daga Kholpa PDU*, in March 2015.

Table 9.8.2 Results of Impact Assessment of Daga Kholpa PUD

	General impact	Short-term	Mid-term	Long-term	**Comment**
Quality of surface water and groundwater	C-	C-	C-	C-	Regarding water resources, even though nothing is indicated about the sources of drinkable water for residential areas, it seems reasonable to connect them to the SDE network and not to pump up groundwater from local aquifers. Since planned industrial areas only include logistics activities and not extracting, the impact on groundwater resources will be limited. From a qualitative point of view, as it seems that the sewers will be well sized, even though nothing is really clarified in terms of sanitation techniques, untimely discards to the natural environment, that could contaminate groundwater, are always possible. The same is true regarding the storm water drainage management, whose plan does not seem to have been elaborated. The sizing of drainage pipes shall be well studied, and in terms of spatial organization, it seems worrying that the majority of the neighborhood units have artificial surfaces, without consideration for the infiltration at the plot or in nearby percolation trenches.
Air quality and quietness of populations	B-	B-	B-	B-	The impact of urban development proposed in the PUD, particularly in terms of motorized trips (fairly dense road network until inside the neighborhood units), coupled with the proximity of the new airport and its logistics areas, will be relatively negative, especially considering that air is currently extremely pure in the area.
Biodiversity conservation	C-	C-	C-	C-	The compact form of the new town enables there to be, on the outskirts of the PUD area, natural areas where fauna and flora will remain intact. Moreover, the vast central park linked to the cultivated areas of the two villages of Daga and Kholpa will allow the wildlife, cleared out by urbanization, to find refuge. However, the spatial organization in an urban form closed to the North, South, and East does not favor the optimal transit of animals on a larger scale.
Access to basic social services (health, education, transport, comm., etc.)	A+	A+	A+	A+	Access to social services, whether education or health, will be improved significantly thanks to the introduction of a hospital and a university. Similarly, at the local level within the residential fabric, the numerous local services provided in neighborhood units (shopping centers, schools, health centers and parks) will allow sufficient access for the population to all elementary social needs.
Level of soil erosion	C+	C+	C+	C+	The area being quite sensitive to washout and soil erosion and good planning of urban space in the upstream and downstream areas of temporary water courses is a prerequisite to avoid the risk of flooding or uncontrolled erosion. The orientation of the urban fabric and its roads following the level contours seems to fulfill this function of channeling rainwater and thus preventing any risk of erosion, even though no storm water drainage plan has been established.
Soil quality and pollution	C-	C-	C-	C-	Potential sources of soil pollution, domestic and industrial waste have not been quantified in the infrastructure development part of the PUD. In spatial terms, there might be a risk that the vast green space, contiguous to residential areas without special controls or maintenance, will become the receptacle of some domestic waste that will pollute the soil. Uncertainty remains, therefore, regarding the degree of the impact of urban development on soil quality.
Landscape quality and quality of life of populations (quietness, space, etc.)	B+	C-	C	B+	In general terms, the mastered urbanization proposed by the PUD will lead to an improvement in living conditions for both new residents but also for the indigenous people who will both be able to enjoy a regular urban fabric and various landscaped spaces. Taking into account the perimeter of flood-prone areas, the spatial organization proposed in Daga Kholpa PUD ensures that residential and activity areas will be not be affected by any floods. Furthermore, parks and green spaces, planned in consequent number and vast surface (228 ha representing 10% of the total area), will provide a greatly improved living environment for future residents coming mostly from urban backgrounds. However, from the short- to medium-term, the native population may not easily accept the significant increase in traffic of the number of construction projects that will have impacts in terms of level of noise and will certainly engender a loss of tranquility and calm. Even though indigenous populations will not be the victim of resettlement as their lives will remain unchanged, the benefits of the major environmental changes (from almost desert farmland to

					densely populated urban core) in their immediate proximity may be accepted only over the long-term.
Land use (agriculture, livestock, housing, etc.)	B+	C-	B+	C	The impact on terms of land use change is extremely important. A sparsely populated environment where the main activity is agriculture will turn into a densely populated urban center in only a few years. The loss of agricultural land may destabilize neighboring markets and disrupt the habits of the indigenous population in the short-term. The spatial organization provides the conservation of some agricultural lands around the villages of Daga and Kholpa, but it will not be enough to keep any rural character in an area traditionally marked by the presence of orchards. In the long-term, it is even possible that these lands only become the receptacle of the urban extension of the two villages and that agriculture will disappear completely from the area. However, urban development will bring many new land uses, such as residential including social services, secondary and tertiary activities, reflecting that the impact of the development will be globally positive.

Source: JICA Study Team based on "SEA Report" of Daga Kholpa PUD

9.8.3 Mitigation and Amplification Measures

The following tables show the results of the mitigation measures for negative impacts and the amplification measures for positive impacts.

Table 9.8.3 Mitigation and Amplification Measures for the Impacts of the Economic Development Strategy

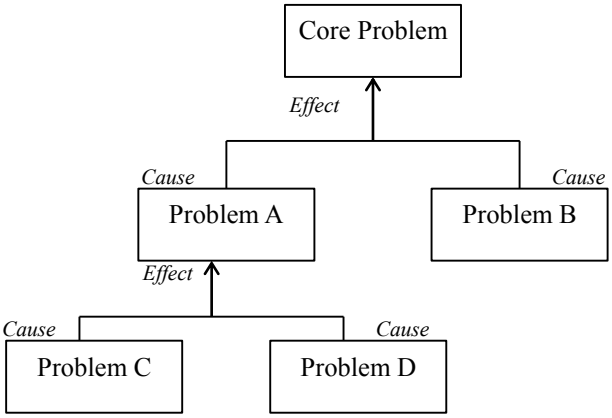
Affected item	Potential impact	Impact level	Mitigation or amplification measures	Predicted efficiency
Quality of surface water and groundwater	Rainwater drainage, which is an important issue in the area of Daga Kholpa, since it is the source of erosion and pollution of the soil, is not correctly studied.	Low (-)	Rainwater drainage should be well studied, in order to achieve the proper sizing of drainage pipes. Furthermore, in the planning regulations to be drafted in future steps, it shall be well considered to control the proportion of built-up surfaces of neighborhood units and to consider infiltration at the plot. A thematic map focused on rainwater drainage may identify strategic places of water table recharge in order to identify percolation trenches in potential construction sites.	No impact
Soil quality and pollution	Domestic and industrial waste management has not been properly studied.	Low (-)	Good domestic and industrial waste management, together with strict application of the environmental management and monitoring laws prior to any investment, will maintain the current high quality of the soil.	No impact

Source: JICA Study Team based on "SEA Report" of Daga Kholpa PUD

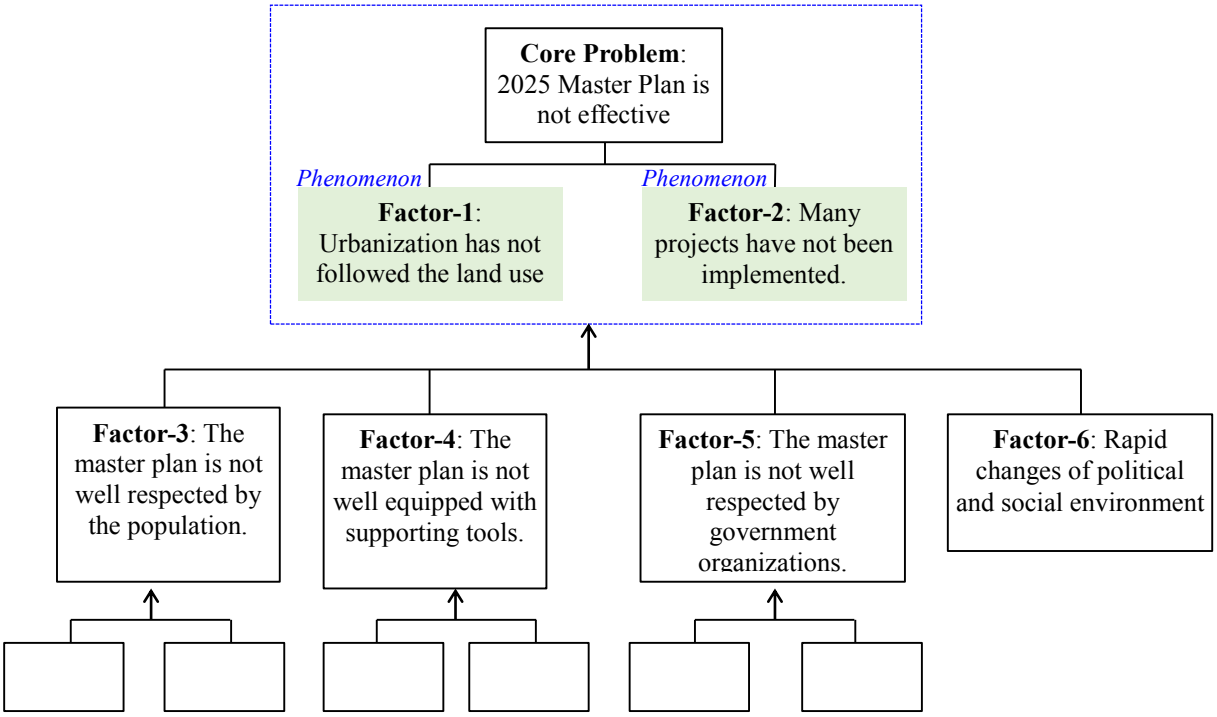
CHAPTER 10 URBAN PLANNING MANAGEMENT

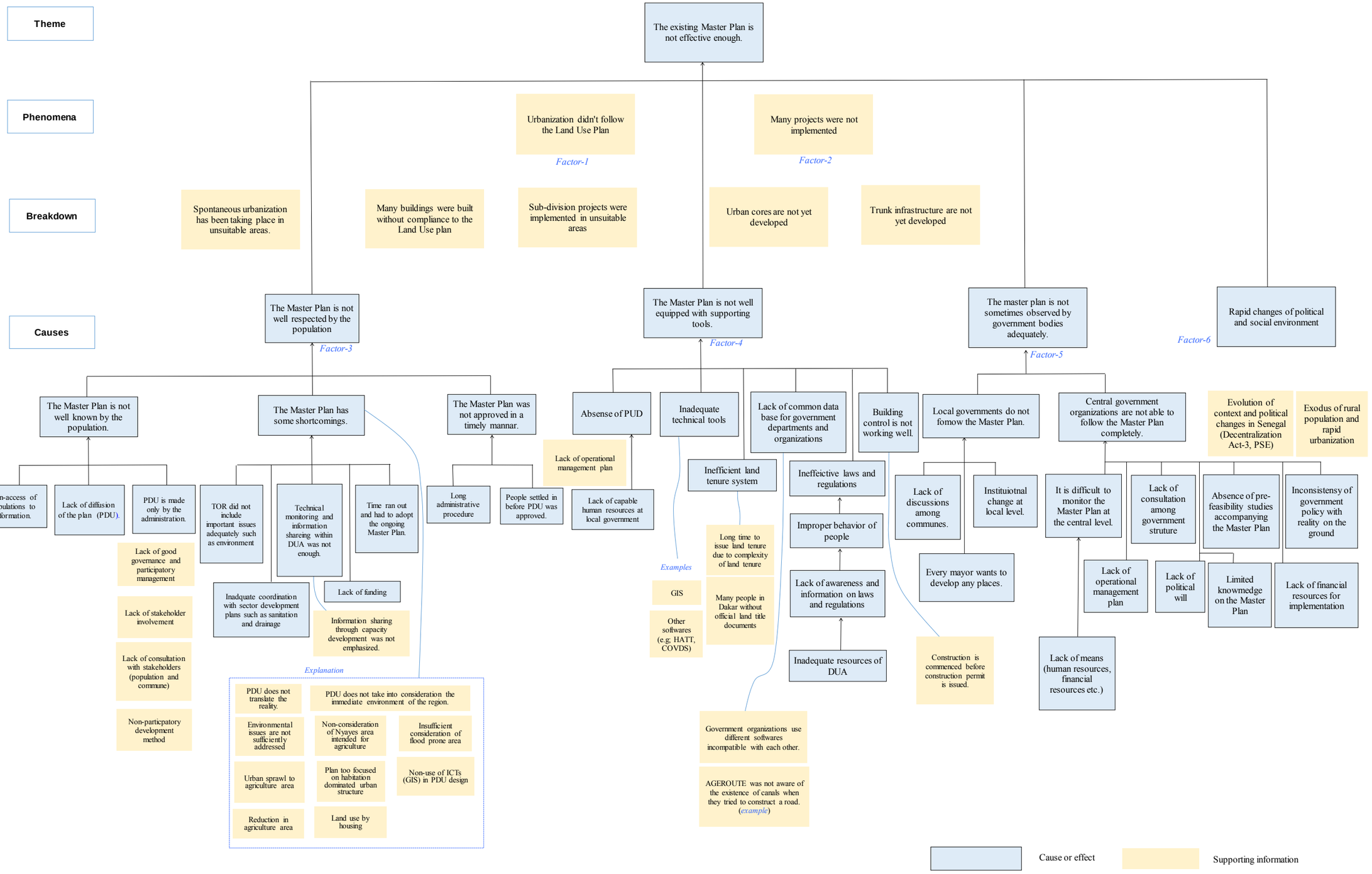
10.1 Present Situation of Urban Planning Management

As a means to clarify the problems in the existing urban planning management system, an analysis called "Problem Analysis" was conducted in April 2015 in the form of a workshop by the JICA Study Team and DUA counterpart team. A problem analysis is a technique to identify the causes and effects of various phenomena taking place in different forms. It is a step in a technique called "Project Cycle Management" (PCM) developed in Japan. A tentative problem tree such as the following is constructed based on an analysis of problems in general.



The core problem is assumed to be that "the existing 2025 Master Plan is not effective enough", which is taken as a hypothesis in the present study. As a result of the workshop and subsequent analysis by the JICA Study Team experts, a tentative problem tree was first constructed. It was finalized in subsequent workshops in July and September 2015 as shown in Figure 10.1.1. The upper level concepts are summarized as follows.


Core Problem: 2025 Master Plan is not effective
Phenomenon
Phenomenon
Factor-1: Urbanization has not followed the land use
Factor-2: Many projects have not been implemented.
Factor-3: The master plan is not well respected by the population.
Factor-4: The master plan is not well equipped with supporting tools.
Factor-5: The master plan is not well respected by government organizations.
Factor-6: Rapid changes of political and social environment



Source: JICA Study Team

Figure 10.1.1 Problem Analysis of Urban Planning Management

An analysis of each of these issues follows.

Core problem: 2025 Master Plan is not effective enough

This core problem is assumed based on a series of discussions with DUA. The biggest reason for the present study to revise the ongoing 2025 Master Plan is that it has some shortcomings, and therefore requires revision. The question is why is it not effective enough and what factors are causing that problem? The solutions could be formulated based on the results of this problem analysis.

Factor-1: Urbanization has not followed the land use plan

Factor-1 is more of a phenomenon explaining the core problem than a cause of it. Three boxes below Factor-1 in Figure 10.1.1 specify the situation. An urbanization pattern inconsistent with the land use plan is observed in such forms as spontaneous urban development in undesirable areas, many structures built without compliance with the land use plan and the implementation of subdivision projects in unsuitable areas.

Factor-2: Many projects have not been implemented

Factor-2 is also a phenomenon that explains the core problem. The two boxes below Factor-2 in Figure 10.1.1 specify the situation. Non-implementation of projects is observed in such issues as the non-development of urban cores and the non-development of trunk infrastructures. For instance, transportation projects including the extension of the VDN from the coast to Diamniadio and the arterial road connecting Lac Rose, Diamniadio and Bargny have not been implemented, although these projects were proposed in the 2025 master plan to realize the envisaged urban structure.

Factor-3: The master plan is not well respected by the population

Factor-3 is a factor causing urbanization that is inconsistent with the master plan. Three factors are listed as reasons that explain why the master plan is not well respected by the people. A social survey in the project reveals 75.6% of respondents in the Project Area do not know about the existence of the 2025 master plan. They do not recognize that their properties must comply with the requirements specified in the 2025 master plan. The supporting causes are also shown.

(a) The master plan is not well known by the population.
- ✓ Because there has been a lack of effort to disseminate information about the master plan and people lack access to information.
- ✓ Because the master plan was prepared by the administration alone and people did not participate in the planning process.

(b) The master plan has some shortcomings.

The shortcomings include non-reflection of the reality on ground, inadequate consideration of environmental aspects, allowing encroachment of the urban area into the agriculture area such as Nyiaye, too much focus on a habitation dominated urban structure, insufficient consideration of flood prone areas and non-use of ICT.

The master plan has its shortcomings.

- ✓ Because TOR did not include important issues adequately such as environment.
- ✓ Because there was no adequate coordination with the sector development plans such as sanitation and drainage.
- ✓ Because technical monitoring and information sharing within DUA was not sufficient.

- ✓ Because there was a lack of funding. Preparation of PDU and PUD requires the database to analyze the existing conditions. An existing budget system does not allocate a sufficient amount to create the database.
- ✓ Because time ran out and DUA had to adopt the master plan.

(c) The master plan was not prepared in a timely manner.

- ✓ Because the administrative procedure was too long.
- ✓ Because people settled in before PDU was prepared.

Factor-4: The master plan is not well equipped with supporting tools

Factor-4 is another factor causing urbanization that is inconsistent with the master plan. There are six reasons and supporting factors for this as shown below.

(a) Absence of PUD

- ✓ Because local government lack technical human resources

(b) Inadequate technical tools

(c) Inefficient land tenure system

(d) Lack of common database for government departments and organizations

(e) Ineffective laws and regulations

- ✓ Because people behave inappropriately due to lack of awareness and information about laws and regulations, as a result of the lack of resources on DUA

(f) Ineffective laws and regulations

Factor-5: The master plan is sometimes not observed by government bodies adequately

The two factors that explain Factor-5 are local governments not following the master plan and central government organizations not able to follow the master plan completely. The supporting factors are as follows:

(a) Local governments do not follow the master plan

- ✓ Because there is a lack of discussion among communes
- ✓ Because there were institutional changes at the local level
- ✓ Because every mayor wants to develop any place

(b) Central government organizations are not able to follow the master plan

- ✓ Because it is difficult to monitor the master plan at the central level due to lack of means.
- ✓ Because there is no operational management plan
- ✓ Because there is a lack of consultation among government structures
- ✓ Because there is no political will
- ✓ Because the master plan is not accompanied by pre-feasibility studies for priority projects
- ✓ Because the ministries and organizations do not know about the master plan
- ✓ Because there is inconsistency between government policy and the reality on the ground
- ✓ Because financial resources for implementation are lacking

Factor-6: Rapid change of political and social environment

The sixth factor causing the core problem is the rapid change of political and social environment such as decentralization act-III, PSE and the exodus of the rural population and migration into Dakar. The decentralization policy has been promoted before the local governments have adequately developed their capacities to carry out the assigned tasks.

10.2 Directions to Improve the Urban Management System

The directions for improving the existing urban management plan are identified in such a way as to address the three causal factors in the problem tree, Factor-3, Factor-4 and Factor-5, which are controllable, and to consider the basic issues underlying all these issues. Factor-6 is an external factor, which cannot be controlled and is therefore excluded. The effectiveness of the present 2035 Master Plan revising the 2025 Master Plan will be enhanced once measures are taken in the directions given below. These directions were reviewed in the workshops in September and October 2015, through an objective analysis, the step following the problem analysis in the PCM technique. The expected situations and the means to realize them are shown below.

(1) Direction 1: Enhancing people's recognition of the master plan (corresponding to Factor-3)

Expected condition: Master Plan is well known by the population.

(a) Promotion of the participatory planning approach to reflect the views of stakeholders in the master plan. Public involvement is legislated in the urban planning law and related regulations. Public consultation meetings should be held at least three times as described below.
- ✓ Analysis works to identify problems, constraints and areas to be protected
- ✓ Planning works to select development alternatives and visions
- ✓ Planning works to discuss draft land use plan

(b) Dissemination of information on the master plan and development controls to the people by various means such as media campaigns (TV, radio), advertisements, website, free delivery of brochure on land use plan with related regulations in the national language, and school education programs.

(c) Accessibility improvement to provide the public with the necessary information on the master plan. A specific section responsible for public relations is to be established in Dakar Department, Pikine Department, Guediawaye Department and municipalities in Rufisque Department in Dakar Region and in Keur Moussa commune and Diass commune in Thies Region.

Expected condition: Master plan is prepared properly

(a) Enhancement of the capacity of the officials in charge by increasing the number of skilled technical staff in Ville de Dakar, Ville de Pikine, Ville de Guediawaye, Ville de Rufisque, Keur Moussa commune and Diass commune. A tutor system is to be enhanced. Guidelines and a manual for analysis and planning are established to formulate a detailed urban plan. After enactment of the decentralization policy, it will take some time to establish the administrative unit with sufficient staffs and budgets in local governments in the departments. Villes will be the focal points for capacity enhancement in the meantime.

(b) Improvement of the information database for a land use map which includes land use, building size, building structure, built year, etc. The information is monitored at regular intervals by the local governments of Ville de Dakar, Ville de Pikine, Ville de Guediawaye, Ville de Rufisque, Keur Moussa commune and Diass commune. An annual budget is allocated for this monitoring and mapping work. Use of appropriate spatial analysis tools such as Google Earth, Quantum GIS, and Manifold are enhanced for these simple works.

Expected condition: Master plan is prepared timely

(a) Securing of the annual budget to prepare the master plan in the timely manner. Criteria for making and revising the master plan are established to ensure the financial resources.
(b) Allocation of an annual budget for the detailed urban plan in local governments. The information database is regularly updated and used to formulate the detailed urban plan. This regular work reduces the large spending at a time.

(2) Direction 2: Enhancing the supporting tools for the master plan (corresponding to Factor-4)

Expected condition: Land administration is working well

(a) Reinforcement of hierarchy of urban plans and urban development projects. The detailed urban plan must be consistent with the urban master plan. The land sub-division must be in compliance with the detailed urban plan.
(b) Encouragement of the population to obtain plots in suitable areas. The grace period for exempting tax payment is returned from the current 4 to 5 years to 10 years as before for people living in suitable locations in line with the master plan.
(c) Strengthening the formalization of the land tenure system by shortening and simplifying the land registration process.

Expected condition: Building control is working well.

(a) Enhancement of monitoring misuses of land and illegal construction
   - ✓ A public suggestion box for illegal construction is established in Dakar Department, Pikine Department, Guediawaye Department, municipalities in Rufisque Department, Keur Moussa commune and Diass commune. DSCOS (Direction de la Surveillance, Contrôle et Occupation des Sols) conducts a regular patrol in areas unsuitable for urbanization, such as parks, airports, forests, and coasts.

(b) Enhancement of the capacity in building permission
   - ✓ Public awareness should be raised of a new online service called "TeleDAK", which was commenced by ADIE (Agence De l'Informatique de l'Etat) for building permission application and issuance in Dakar. This system should be gradually expanded to all areas in Dakar.
   - ✓ A one stop service is established for Keur Moussa commune and Diass commune as a measure until TeleDAK is introduced.

(c) Enhancement of the capacity in land development permission. A planning guideline is established for large-scale land development projects, which, for example, has a land area of more than 1,000 m^2.
(d) Enhancement of penalties. The construction works that are illegal in terms of the form of the building and land use are stopped and seized by DSCOS. Penalties include the suspension of public services such as water supply, electricity supply, and wastewater treatment.

(3) Direction 3: Enhancing recognition of the master plan in central government organizations and local governments (corresponding to Factor-5)

Expected condition: Local government follows the master plan

(a) Enhanced involvement of the local government to prepare the master plan and the detailed urban plan

(b) Reinforcement of the hierarchy of urban plans and urban development projects as specified in the means for Direction 2
(c) Enhanced ownership of population in the master plan

Expected condition: Ministries and agencies follow the master plan

(a) Strengthening of the authority of DUA in enforcing the master plans and revitalization of regional and national planning commissions.
(b) Enhancement of the cooperation between related central government ministries, departments and organizations by information dissemination and sharing. The relevant ministries and agencies will update sector master plans in compliance with the 2035 master plan.
(c) Authentication of the master plan including the legislation of an urban growth boundary and the issuance of the Presidential Decree with regulations to enforce the master plan. The procedure for the authentication will be completed in due time soon after the preparation of the 2035 master plan.
(d) Assignment of an organization that is exclusively responsible for the development and management of urban poles that stretches over more than one administrative unit. The legal basis of APIX in managing the development of Daga Kholpa needs to be established in this sense. DGPU is responsible for the development of Diamniadio.

There are a number of challenges to be addressed, which underline all the issues mentioned above. They can be summarized in terms of the following basic issues.

Basic issues underlying overall urban development management

- Enhancement of the technical capability of DUA planners through periodical training, technical guidance and the application of planning guidelines
- Strengthening of the role of villes in supporting communes in the surrounding areas in planning and service provision through the DUA's technical assistance mechanism
- Gradual shift of the DUA's focus towards urban policy formulation, standard and regulation establishment, and institutional support in parallel with the devolution of responsibilities to local governments

(4) Action Plan for Urban Planning Management

The suggested means for improvement in urban planning management are aligned in a timeframe comprising three periods of short-term (3 years), medium-term (5 years), and long-term (10 years) as shown in Table 10.2.1. This timeframe shows a roadmap of the proposed improvement towards the realization of the 2035 master plan.

The suggested means include activities which were already executed in the Study, such as the stakeholder meetings for promoting public involvement. Some of the suggested means are under the jurisdiction of DUA, such as information dissemination, which is the basis for raising public awareness. The approved PDU will be transmitted to the national archive for security purposes. These means should be implemented in the short-term. On the other hand, the human resource development takes time because skilled technical staff can only be created with the accumulation of a certain amount of experience. Firstly, the planning guidelines with the related training material are prepared in the short-term. The tutors (or trainers) are developed at the same time. Secondly, the skills of the technical staff are developed at the intermediate local level such as in Dakar Department, Pikine Department, Guediawaye Department, municipalities in Rufisque Department, Keur Moussa commune, and Diass commune in the medium-term. These intermediate local governments are the

focal points to supervise and guide communes in the future. Finally, the technical staff at the commune level will develop their skills in the long-term.

Although the financial means of tax exemption is acceptable by the population, this approach should be discussed by the government carefully. This approach may reduce the annual revenue in the government, which is facing increasing expenditures to support the decentralization policy. It is recommended that this approach is established when the government is in a stable financial condition. As the economic development progresses, this financial means becomes an option in the medium-term.

Table 10.2.1 Action Plan for Urban Planning Management

Item	Short	Medium	Long
(1) Enhancing people's recognition of the master plan			
(1-1) Master Plan is well known by the population			
(a) Strengthening of public involvement stipulated in urban planning law and regulations	X		
(b) Dissemination of information on the master plan and development controls (media campaigns, advertisements, website, free delivery of brochure, school education programs)	X		
(c) Improvement of accessibility to information at government offices and deployment of adequate personnel for public relation	X		
(1-2) Master plan is planned well			
(a) Enhancement of capacity of the officials in charge			
i) Establishment of guidelines and manual for detailed urban plan	X		
ii) Establishment of tutor system	X		
ii) Increased number of skilled technical staff		X[1)]	X[2)]
(b) Improvement of information database for land use map			
i) Allocation of annual budget for monitoring	X		
ii) Use of reasonable tools	X		
(1-3) Master plan is prepared timely			
(a) Allocation of annual budget for the master plan	X		
(b) Allocation of annual budget for the detailed urban plan	X		
(2) Enhancing the supporting tools for the master plan			
(2-1) Expected condition: Land administration is working well			
(a) Reinforcement of hierarchy of urban plans and urban development projects	X		
(b) Encouragement of population to obtain plots in suitable areas with grace period of tax		X	
(2-2) Expected condition: Building control is working well			
(a) Enhancement of monitoring for misuse of land and illegal construction (public suggestion box and patrol by DSCOS)	X		
(b) Enhancement of capacity of building permission			
i) Awareness raising of TeleDAK	X		
ii) Establishment of one stop service for Keur Moussa commune and Diass commune	X		
(c) Enhancement of capacity of land development permission			
i) Establishment of planning guidelines for large-scale land development projects	X		
ii) Training for skilled technical staff		X[1)]	X[2)]
(d) Enhancement of penalties for illegal construction works	X		
(3) Enhancing recognition of the master plan in central government organizations and local governments			
(3-1) Local government follows the master plan			
(a) Enhanced involvement of local government to prepare the master plan and the detailed urban plan	X		
(b) Reinforcement of hierarchy of urban plans and urban development projects	X		
(c) Enhanced ownership of population of the master plan		X	
(3-2) Ministries and agencies follow the master plan			
(a) Enhanced cooperation between related organizations through information dissemination and sharing	X		
(b) Authorization of the master plan			
i) Issuance of presidential decree with regulations including urban growth boundary and special technical requirements	X		
ii) Authentication of the master plan	X		
(c) Establishment of legal basis to manage the development of Daga Kholpa for APIX	X		

Note: 1) Activities to be targeted for Dakar Department, Pikine Department, Guediawaye Department, municipalities in Rufisque Department, Keur Moussa commune and Diass commune.
2) Activities targeted for communes.

Source: JICA Study Team

10.3 Capacity Development Plan of DUA

10.3.1 Objective and Strategies for Capacity Development

The objective of capacity development is to establish a system and to support human capacities by which desirable urban spaces will be created under the Decentralization Act III context. The following are the strategies for capacity development:

Strategy 1: To clarify the ultimate roles and functions of the relevant organizations such as DUA, local governments and the private sector in urban plans preparation and management in 2035 and to identify transitional steps to reach the ultimate state.

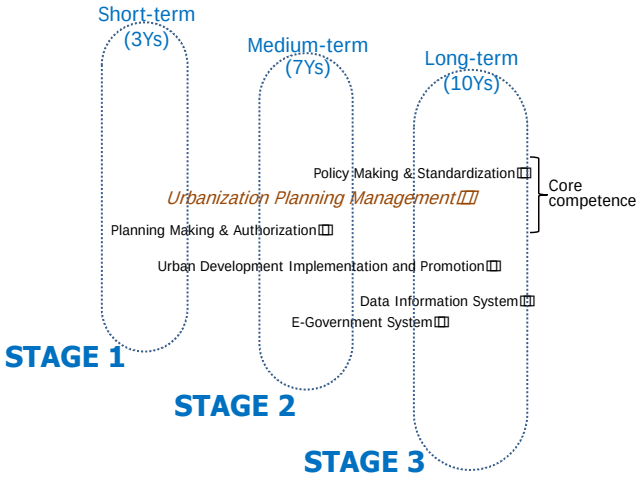
Strategy 2: To strengthen the institutional and organizational capacities of the relevant organizations.

Strategy 3: To strengthen the individual technical and managerial capacities of the officers of the relevant organizations to support the expected roles and functions of each organization.

10.3.2 Capacity Development at Institutional and Organizational Levels

(1) Transformation of DUA's role

The DUA's roles and functions will gradually be shifted from direct involvement in plan preparation, management and development control towards policy and strategy preparation and support of local governments. Figure 10.3.1 presents a process in which the DUA's functions will be transformed until 2035.



Source: JICA Study Team

Figure 10.3.1 Conceptual Diagram for DUA Organization Development Roadmap

This process is characterized as follows:

- Urban planning and management is the core competence DUA always has to be equipped with and therefore requires continuous upgrading. Its application, however, has different focuses depending on the situation. DUA has been directly engaged in preparing urban plans such as PDU and PUD as well as its management including the issuance of development permits and building construction. These functions will be gradually devolved to local governments, while DUA will become engaged more with the preparation of policies and strategies, the provision of guidance, activities related to standardization and promoting the capacity development of local governments.
- Planning works related to implementation such as Cooperative Development Zones (ZAC), Urban Renewal (RU), Land Consolidation (RE), and Restructuring (R) will remain the tasks of DUA until 2035, since devolution of the planning functions to local government will be limited to PDUs and PUDs in consideration of the long period of time required for the capacity of local governments to grow.
- The implementation of plans in a proper way is secured by development control and public investment in infrastructures and public facilities. Two bodies have been playing this role in Senegal: DUA for control planning and permits and DSCOS for enforcement and the monitoring of controls and regulations. Part of the DUA's control and permit works will be devolved to local governments except for large-scale or multi-jurisdictional cases and the planning and introduction of innovative control measures such as a measure to obligate private developers to secure part of the land for parking spaces.
- Information management has become an indispensable tool in the government of Senegal, as seen in the case of introducing a new system of ADIE as part of the government effort to create an e-government system. In line with this government policy, DUA is expected to play a more positive role in establishing an efficient information management system within its own organization to share information internally and with relevant government organizations to share and exchange information externally. Urban planning also requires effective support through a spatial data information system (GIS). The provision of GIS equipment and software accompanied by the training of DUA officers on GIS in the Study can be an initial step to strengthen this policy. A shift towards policy making and standardization cannot be realized without the strengthening of the information management system.
- The ultimate role of DUA in individual capacity development will be to support local governments in expanding their technical base. It is proposed that an urban planning training center will be established to bear this function as a long-term approach (2026-2035) after DUA developed its capability in the initial stage (2016-2018) and the upgrading of local governments officers is realized in the medium-term (2019-2025). The DUA's role in encouraging the capacity development of local governments will expand as time goes on.

(2) Measures to Strengthen Organizational Capability of DUA and Local Governments

A number of issues need to be addressed to upgrade the organizational capacity of DUA as follows:

Short-term (2016-2018)

- There is a need to develop a middle level stratum of staff. The present staff structure of DUA is skewed and polarized into a group of experienced elder officers and another group of young officers which lacks the mid-level staff to link them. More than half of the young officers have a master's degree. The young officers should be strengthened in their technical and administrative skills through on the job training, and it is the middle level staff who can be instrumental in this aspect.
- The job descriptions of each DUA officer should be prepared based on responsible services of the division in order to clarify the responsibilities of each officer. Types of knowledge and skills that need to be developed can be more easily identified with clear-cut job descriptions.
- A system to support self-learning by DUA officers should be established by creating a mini library offering various technical books and strengthening the existing DUA archive.
- MRUHCV should secure a budget for scholarships for DUA officers to study at schools offering urban planning.
- DUA will cooperate with educational institutions in developing a school curriculum to address current urban issues and to reduce the gap between the school curriculum and the practical need for urban planning.
- A strategic internship program should be established to replace the existing informal arrangement. Such components as the setting of clear objectives, the preparation of terms of reference and evaluation would make the internship system strategic. Graduates of graduate schools could be mobilized as interns for longer periods, thus contributing to the DUA's work. Some kind of compensation arrangement would be necessary in this case. Even in the event that the interns are not employed by DUA after graduation, their experience as interns would contribute to making the cooperation and communication between DUA and the relevant organizations where the ex-interns began to work easier.

Medium-term (2019-2025)

- Providing opportunities to some DUA officers to experience the works of other government organizations related to urban development and planning, for example water supply, sewerage or solid waste management, would give them a good chance to develop their knowledge and skills in relevant fields.
- An inter-organizational personnel transfer mechanism between the central level and local level will also be established, in which DUA as the national organization and DRUH/SDU as field offices close to the population exchange personnel to enrich their experiences.
- A group of officers should be nominated to specialize in specific subjects such as GIS database creation and analysis and economics, for example. The skills for these specialized subjects can be concentrated in certain sections and do not have to be shared by all the staff.
- Securing a proper number of officers with the stable status would be an important factor to assure efficient and stable works by the officers. The current situation where there are not adequate permanent officers and there are many project-based officers (contract officers) is not desirable and therefore should gradually be improved.

Long-term (2026-2035)

It is proposed that an urban planning training center should be established as a long-term approach (2026-2035) after DUA developed its capability in the initial stage (2016-2018) and the upgrading of local government officers is initiated in the medium-term (2019-2025). The officers of DUA including

DRUH/SDU will be instructors and will coordinate the curriculum, materials etc. The following needs to be considered:

- Inviting experienced local government officers who underwent training as instructors in the medium-term
- Cooperating with related organizations such as ENEA and other agencies
- Including the subjects of devolution of responsibilities to local governments from DUA
- Establishing an e-learning system for self-study and to support officers in remote areas

(3) DUA's Expected Function in the Long-run (2026-2035)

The key subjects and tasks of DUA in the long-run are identified as shown in Table 10.3.1. An appropriate organizational structure needs to be established so that DUA will be able to properly undertake these tasks.

Table 10.3.1 Desirable Technical Functions of DUA Headquarters in 2035

Category	Key Theme	Key Tasks
1. Policy & Strategy	Policy Integration (cross cutting issues)	• Sustainable city environment formulation
		• Climate change adaptation to urbanization
		• Public transportation and urban development integration
		• Economy encouragement through urban management
		• Decentralization and de-concentration adaptation
		• Sector coordination and integration
	Urban Policy Making	• Urban growth management and control improvement
		• Urban development and revitalization promotion
		• Urban settlement and housing environment
		• Urban design and landscape management
	Institutional & Legislative Arrangement	• Institutional arrangement for urban planning system
		• Institutional development for redevelopment promotion mechanism
		• Institutional arrangement for urban growth control measures
	Technical Standards & Guidelines & Research	• Urban planning standard and guideline development
		• Subdivision guidelines and planning standard development
		• Living environment development standard and guidelines
		• Impacts assessment and evaluation (traffic impact, environment impact)
2. Planning & Authorization	Planning Management	• Planning management & coordination (SDAU/PDU/PUD/PL)
	Planning Authorization	• Urbanization plans appraisal and inspection for authorization
		• Authorization system improvement and management (e-government)
3. Urban Development Implementation & Promotion	Project Formulation & Coordination	• Urban development implementation programming (ZAC, R, RE, RU, etc.)
		• Urban development funding and institutional arrangement
		• Technical coordination and integration
	Urban Community Management	• Participatory planning project formulation with local community
		• Public hearing coordination and management
		• Dissemination and enlightenment of urban development promotion
4.Urban Growth Management	Control & Regulation	• Zoning administration system development and planning
		• Zoning code system enforcement and improvement
		• Evaluation, improvement through monitoring and inspection by DSCOS
	Permit Guide & Consultation	• Dissemination and enlightenment of zoning regulation promotion
5.Urban Data & Information Management	Planning Information Management	• Project documentation and archive digital deposit system development
		• On-going project database management system operation
		• Planning support spatial analysis and management (GIS)
	e-DUA System Management	• Online zoning information system management
		• Planning certification online management (Tele-DAC integration)
		• Building permit online management (Tele-DAC integration)
6. Personnel Capacity Development & Training	Urban Planning Technique Training	• Urban planning theory and techniques training
		• Urban control management theory and techniques training
		• External organization personnel training development
	Operation Management Training	• Project management and operation skill development
		• Innovative skill and knowledge development

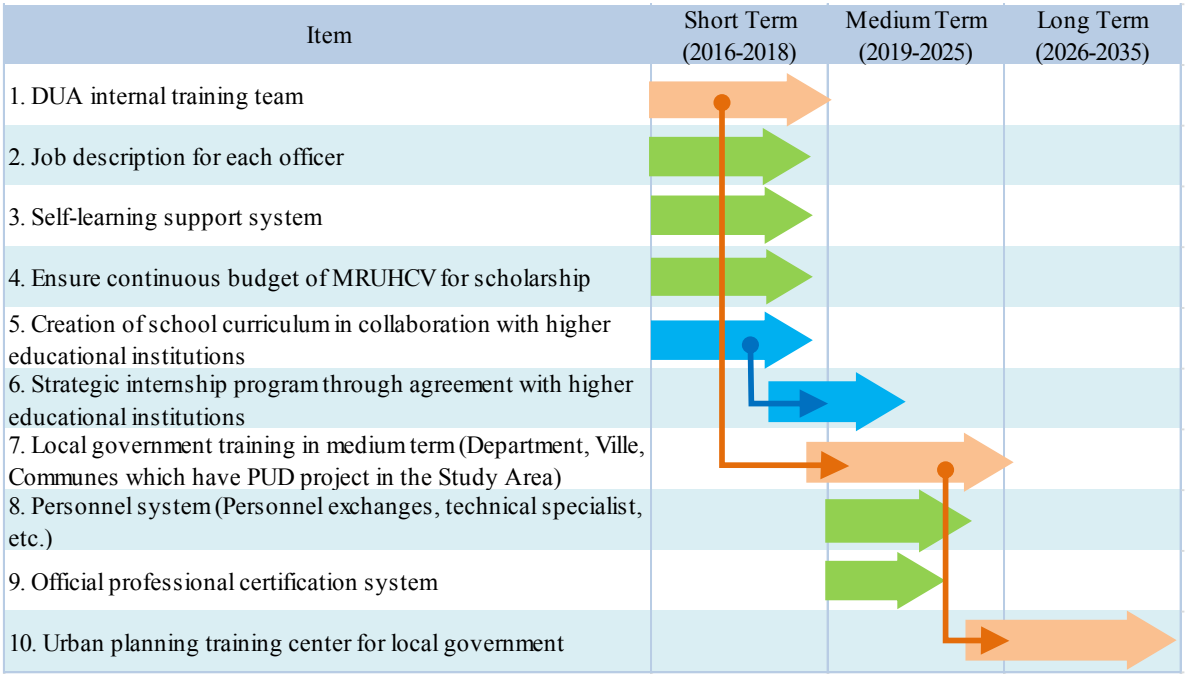
Note: Tele-DAC; *Tele-Demand d Autorisatian de Construire*
Sources: JICA Study Team

(4) Systems and Regulations related to Urban Plan Preparation and Management

A professional certification system will be established through the cooperation of DUA and the urban planning professional association to determine the definition of a planner in Senegal. Once introduced, the certificate will serve as a measure to assess the qualification, not only for DUA but also for other government organizations and the private sector. The level of urban planning is expected to be upgraded.

10.3.3 Capacity Development at Individual Level

A plan for capacity development for DUA and local governments is prepared for three stages: short-term (2016-2018), medium-term (2019-2025) and long-term (2026-2035) as shown in Figure 10.3.2 below.



Source: JICA Study Team

Figure 10.3.2 Proposed Capacity Development Plan

The activities in each of the three stages are explained below.

Short-term activities (2016-2018)

A DUA internal training team will be established with retired DUA officers with adequate experience of serving as instructors. The retired officers have a good understanding of the DUA work and capabilities of DUA officers. The key activities are as follows:

- The instructors will receive training in teaching methods in cooperation with educational institutions.
- The instructors undertake practical training programs applying a PDCA (Plan-Do-Check-Act) method.
- They will utilize the PUD guideline, which will be updated through the training. A procedure manual of DUA works and other training materials will be prepared.
- Workshops for DUA officers will be held on basic skills and advanced skills related to urban planning.
- Instructors will also assist young officers in developing their skills as tutors.
- The number of middle level officers will be increased and they will be trained in management and leadership so that they will be able to lead and manage working teams comprising younger staff of DUA. They will be future chiefs and instructors.
- Instructors are also invited from educational institutions, other sector organizations and professional associations for various training.
- Such practical and useful yet no-cost tools as Quantum GIS and Google Earth will be used by a wide range of officers.

- A number of measures taken to strengthen the organizational capacity of DUA such as the preparation of job descriptions and the establishment of a system to support self-learning and scholarship by MURHCV would contribute to upgrading the individual capabilities of the DUA staff.

Medium-term activities (2019-2025)

Local government training in the medium-term will be undertaken as follows:

- The targets of training for local governments in the medium-term are departments, villes and communes, which are preparing PUDs in the Study Area. Priority is given to them in consideration of the urgency of those local governments and efficient use of DUA's limited resources. Large local governments are considered as the targets because human resources and budgets for preparing PUDs are more available.
- Training programs and materials will be prepared based on the experiences of DUA's internal training team.
- Cooperation will be pursued with related organizations such as ENEA.
- An inter-local government cooperation system will be established in which departments and villes will support communes in their jurisdictions and in their vicinity in preparing PDU/PUD.

A number of measures to strengthen the DUA's organizational capacity such as promoting inter-governmental personnel exchanges and ensuring a sufficient number of permanent staff would contribute to upgrading the individual capacity of DUA staff in the mid-term.

The introduction of a certificate system for urban planners at this stage would also upgrade the skill level of urban planners including those of DUA.

Long-term activities (2026-2035)

The urban planning center to be established at this stage would contribute not only to upgrading the planning capabilities of local government officers, but also those of DUA officers.

CHAPTER 11 PRIORITY PROJECTS IDENTIFIED IN 2035 MASTER PLAN

11.1 Selection of Priority Projects

A project list is formulated in each sector development plan. Among the proposed projects and programs, those that meet the following criteria are selected as the priority projects.

(a) Consistency with national policy
(b) Contribution to the realization of the vision, objectives and strategies of the 2035 Master Plan
(c) Effects to achieve the sustainable development, which contribute to the improvement of the living environment in existing urban areas, preparation of new urban areas for population increase, mitigation of heavy environmental deterioration, and enhancement of disaster prevention
(d) Urgency
(e) Absence of commitment by international partners

A set of projects with high priority are prepared to realize the 2035 Master Plan with their details and locations shown in Table 11.1.1.

Table 11.1.1 List of Priority Projects for Realization of the 2035 Master Plan

Priority Projects	Description
(a) Road and Transportation	
(a)-1 Improvement of Cité Keur Gorgui Intersection, SDE Intersection, and Aimé Césaire Intersection on VDN	VDN was originally planned as a regional arterial road serving traffic to and from Dakar via the northern part of the peninsula. At present, section 1 (6 km) in the city of Dakar is in service, and work is in progress on section 2 (9 km) and part of section 3 (17 km). On section 1, there are three bottleneck intersections (Station SDE, Cité Keur Gorgui and Aimé Césaire, from north to south). This project particularly aims to improve the Station IDE intersection, the Cité Keur Gorgui intersection and the Aimé Césaire intersection by constructing a grade separation for the purpose of recovering the traffic function of the regional arterial road, dealing with future growth of traffic demands, and contributing to the development of the overall economic and logistic activities of the country.
(a)-2 Improvement of Bourguiba Intersection and Khar Yalla Intersection on Front de Terre Road	Front de Terre Road is a major arterial road in the city of Dakar, connecting east-west with VDN, Routes des Niayes, the toll motorway, and national route 1. At present, there are three bottleneck intersections (Liberte 6, Khar Yalla and Bourguiba, from west to east) on this road. This project particularly aims to improve the Khar Yalla intersection and the T-shaped intersection of Bourguiba Road by constructing a grade separation for the purpose of realizing smoother traffic inside the city, dealing with future growth of traffic demands, and contributing to the development of the economic activities in the Dakar metropolitan area.
(a)-3 Improvement of Kapa Intersection, Hann Intersection, Pont d'Amitier and Thiaroye Intersection	As part of PATMUR, improvement projects at intersections of Kapa (railway crossing), Hann, Pont d'Amitier (reconstruction) and Thiaroye (roundabout) are underway through grade separation; whereas there are some other bottleneck intersections that have not yet been implemented, namely, Liberte 6 (six-leg intersection) and Keur Massar (roundabout).
(a)-4 Access Road Improvement around Baux Maraîchers Bus Terminal	Baux Maraîchers is the main intercity bus terminal that has been relocated from Pompiers bus terminal in the center of Dakar. It has been developed at an ideal location, just beside the national road (RN1), the toll motorway and a commuter rail (PTB) station. However, since no traffic circulation plan has been developed, there is chronically heavy traffic congestion on the access road to the terminal, which seriously jeopardizes not only the punctuality of the intercity buses but also accessibility to the terminal by public and private feeder transport. Thus, through physical improvements such as widening of the access road and the construction of grade separation or a direct access ramp to RN1 or the motorway, as well as improvement measures in traffic management such as one-way circulation and traffic regulation, the terminal is expected to recover its original function as one of the

	most successful multi-modal terminals in Africa. This project also matches one of the sustainable strategies of the Urban Master Plan, that is, the enhancement of the intermodality between different modes of transport.
(a)-5 Extension of VDN/Development of "La Cotière"	Ongoing new road developments after VDN section 3, namely the extension of the VDN off the coast towards Diamniadio and the development of a branch road from VDN that will continue along the coast (La Cotière) linking to the regional Niayes Road toward Saint-Louis are planned, but there is no funding yet. The former is expected to serve in part as an important north-south axis across the Study Area, while the latter is expected to contribute to the development of the northern coastal region with Lac Rose as a sub-center.
(a)-6 Development of Niayes Road	Niayes Road, in the peninsular area of Dakar stretching from the roundabout of Liberté VI up to Keur Massar, is an important trunk road that connects the major suburban development areas and hence is expected to serve the traffic supporting commercial and social activities along this road. Apart from national route 1 and the planned section of VDN, it is the only prospective trunk road running east-west through the peninsula with a relatively large ROW available. As such, the Senegalese government has requested the upgrading of this road by widening the two existing lanes into four lanes. Meanwhile, the BRT pilot project has also been planned on this road, and this road development may contribute to the BRT development as well. Furthermore, the development of this road is expected to improve access to Thiaroye railway station, which is a major station with many passengers in the current PTB operation. However, some road sections between Liberté 6 and Croisement Béthio Thioune intersections have a limited existing façade-to-façade width that may only be able to accommodate four lanes, causing a conflict between this road development and the BRT project. Thus, AGEROUTE and CETUD need to coordinate to come up with a solution. If the traffic on Niayes Road mainly consists of through traffic, VDN may be proposed as an alternative road for the through traffic in order to utilize one lane in each direction of Niayes Road for the operation of BRT.
(a)-7 BRT Development	A pilot project of BRT has officially been determined and the corridor has been selected from the three planned routes (VDN route, Rue 10 route and Keur Massar route) by the Ministry of Transport. The project runs along BRT-1 from Guédiawaye to Pl. Cabral via Niayes Road and Rue 10. About four million US$ will be allocated from the World Bank to assist with conducting the study of the pilot phase of BRT as part of the PATMUR project. However, the remaining funds for the implementation have not yet been determined. Even for the funding of the pilot BRT project there is no firm commitment from the Bank; they are only supporting studies. In case the Bank should become involved, there will still be some financial gaps which could be filled by JICA. They also hope that JICA will support the Study and the implementation of the second or third BRT lines.
(a)-8 Rail-based Mass Transit Development	A tramway or a light rail transit (LRT) line is planned to connect the existing city center (i.e., Plateau) and the new city center that is to be developed at the current airport site along the west coast of the peninsula. Connectivity between these two centers is valued and thus a rail-based mass transit system is preferred by the Senegalese side. In relation to a tramway project, many international partners are showing an interest. The chances are that it will be conducted in the form of a PPP. No feasibility studies have been conducted for this project. However, a recent study created for CETUD has shown that a BRT option is superior to the tramway option in terms of cost.
(b) Logistics Infrastructures	
(b)-1 Improvement of Inland Cargo Transportation Infrastructure (Road)	Various problems have been identified in road conditions including heavy congestion and poor maintenance, and damage caused by heavy vehicles. Many countermeasures such as rehabilitation of road pavements are badly needed. In addition, the sustainability of maintenance must be secured; therefore, asset management of the road pavements needs to be introduced so that the road conditions can be monitored continuously and the maintenance works can be done properly and efficiently.
(b)-2 Improvement of Inland Cargo Transportation Infrastructure (Railway)	In consideration of reducing travel time as well as enhancing security and safety, the railway is the most suitable transportation mode for longer distances. In order to promote Dakar Port for Malian transit cargo, it is essential to improve efficiency and increase the capacity for cargo transport between Dakar and Bamako. Although the World Bank is financing a preliminary examination for the reform of the organizational structure, a feasibility study can be done separately from any other schemes.
(b)-3 Development of Logistic Infrastructure	One of the reasons for the congestion in the vicinity of Dakar Port is that the industrial zone is located in the city center. In order to avoid the congestion around the port, the existing industrial zone may be relocated to the suburbs or a new logistic infrastructure shall be developed outside the city center, and the supporting infrastructures such as road and railway shall be established between the port and the relocated industrial zone or new logistic infrastructure. The strategic location of the logistic center should be examined in consideration of the future industrial structure and location as well as the future transport infrastructure development.

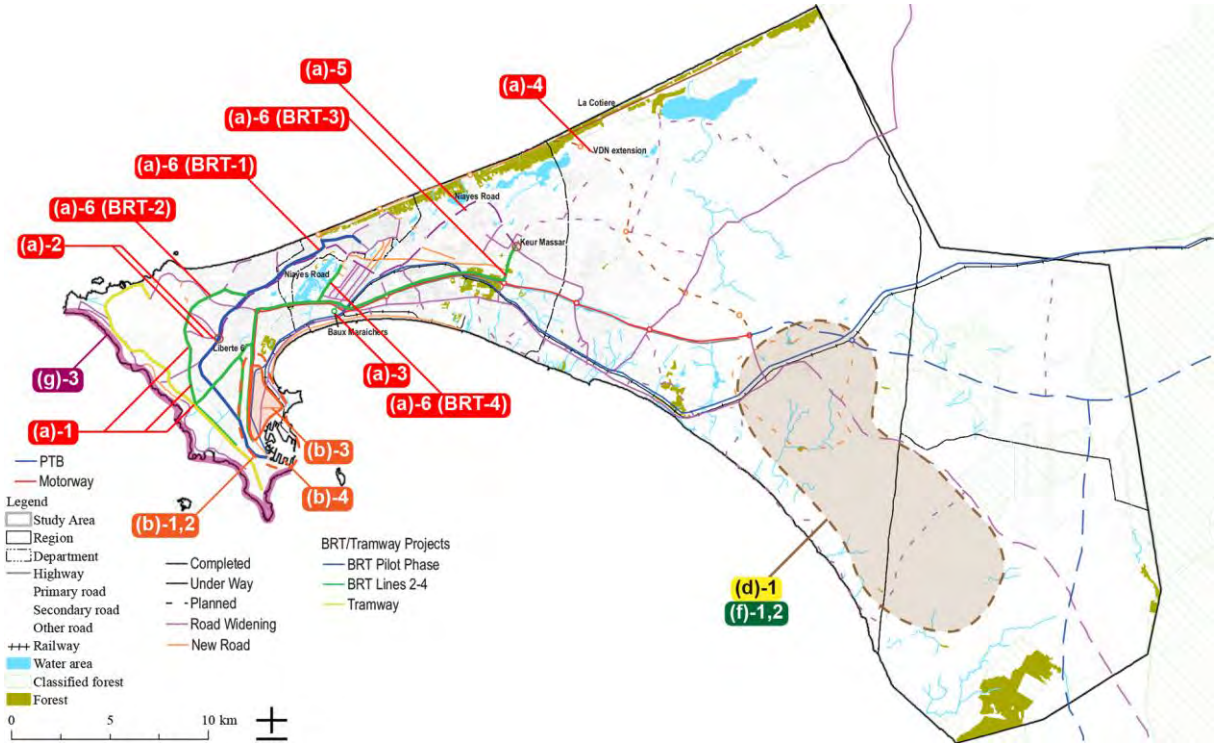
(b)-4 Strengthening of Competitive Advantage of Dakar Port	In order to strengthen the competitiveness of Dakar Port against other ports in neighboring countries, it is essential to improve the port's efficiency and reduce the port charge. In addition, in order to anticipate economy of scale, Dakar Port needs to accommodate bigger vessels; however, the port does not have enough depth to do so at this moment. Therefore, not only the depth in front of the berths but also the depth of the access channel shall be increased so that bigger vessels, which can be accommodated at the neighboring ports such as Lome Port and Lagos Port, can be accommodated at Dakar Port as well. In addition, as mentioned above, the hinterland connection to/from the port must be improved together with the improvement of the port itself.
(c) Water Resources and Water Supply	
(c)-1 Technical Assistance for Preparation of Integrated Water Resources Management Plan for the Study Area	The proposed technical assistance project would support the preparation of the GIRE plan in the Study Area. The project would include the following activities: • Basic study of water sources and their uses in terms of both water quantity and quality • Water cycle modeling and analysis • Identification of problems and issues from the point of view of the water resource management concept • Formulation of integrated water resources management plan • Stakeholder meetings In the pre-F/S, a preliminary study will be conducted to clarify its validity as a technical assistance project.
(c)-2 Treatment of Non-standard Quality Groundwater to Counter Scarcity of Water Resources	Treatment stations to remove the detrimental elements contained in groundwater should be constructed at points where groundwater from groups of low-quality boreholes is received, such as storage tanks and pumping stations. The treated water can be pumped into the existing supply system as a supplement supply for distribution to cover the increasing water demands.
(c)-3 Awareness Campaign on Water Conservation to Restrain Water Demands	To resolve the imbalance between high demands and scarce water sources, an awareness campaign for water consumers about water conservation is essential. The subjects for sensitization can include correction of daily habits such as turning off the tap while brushing teeth, washing dishes using a bucket filled with water instead of running water, and using leakage preventive taps or water saving taps. Other practices for water conservation can include using collected rainwater for watering gardens and livestock as well as washing vehicles. For industries and farmers, instead of using domestic water from the supply system, they can use other sources suitable for their needs such as treated wastewater or low-quality groundwater. Concurrently, a pilot project on the installation and use of rainwater harvesters is recommended. Rainwater harvesters can be easily installed on the roofs of houses and buildings to collect rainwater during the rainy season. As a pilot project, some houses and buildings can be selected for the actual installation of harvesters and practical applications can be demonstrated to prove their effectiveness in water conservation.
(c)-4 Reduction of Non-Revenue Water (NRW) to Improve Water Supply Efficiency	Training will involve subjects such as leakage detection and prevention, as well as proper accountability and billing. The training should include OJT at the existing facilities of the Dakar water supply system and field trips to water supply facilities in other municipalities where reduction of NRW is being practiced.
(c)-5 Use of Treated Wastewater for Non-domestic Purposes	The planned total average capacity for treating sewage water from the Study Area in 2035 is about 165,000 m^3/day which is expected to produce about 132,000 m^3/day of treated wastewater. Using this amount for non-domestic purposes can greatly reduce the amount needed for distribution to the Dakar water supply system and can conserve precious water resources.
(d) Sewage and Sanitation	
(d)-1 Project on Installation of Sewage System in Strategic Urban Expansion Area	In the strategic urban expansion area in Diamniadio and Daga-Kholpa, appropriate urban infrastructure should be installed from the initial development stage so that the area becomes attractive. This project covers priority components of the strategic development of the sewerage system in Diamniadio and Daga-Kholpa's planned sewer area. The project components would include the following activities: • Formulation of sewerage master plan in Diamniadio and Daga-Kholpa sewered area towards 2035, with coordination among the relevant agencies • Ensuring sewage treatment site and necessary land area correspond to 100% of the required capacity • Preparation of implementation arrangements such as the demarcation of public and private components: for example, sewage treatment plan and trunk sewer by the public sector, and branch sewer together with other urban infrastructure development and land development by the private sector • Implementation of priority components, such as construction of sewage treatment plan and trunk sewer to achieve a 40% coverage ratio by 2025 •

(d)-2 Project on Installation and Appropriate Management of Septage Treatment Facility in Est and Rufisque North Planned Sewered Area	In order to improve groundwater contamination, it is necessary not only to install septic tanks, but also to treat septage appropriately. In some urban areas such as Est and Rufisque North sewered area, since the spread of septic tanks is expected to continue until the area receives connected sewerage, it is necessary to install a septage treatment facility. The project component would include the following activities in Est and Rufisque North planned sewered area: • Feasibility study on installation of septage treatment plant • Preparation of septage collection and management system • Preparation of definitive plan • Implementation of construction of septage treatment plant
(e) Solid Waste Management	
(e)-1 Comparative Analysis of Proper Waste Treatment Alternatives	The following items on waste treatment methods will be examined and evaluated comprehensively, and the proper method will then be selected: • Environmental conservation: a) Waste reduction, b) Greenhouse gas reduction, c) Pollution prevention for surrounding environment, d) Recovery of resources and energy • Stabilization and safety: a) Operation and maintenance, b) Waste composition, c) Waste treatment capacity, d) Previous performances • Economic efficiency: a) Construction cost, b) Operation and maintenance cost, c) Recovery cost of resources and energy
(e)-2 Identification and Construction of Sanitary Landfills	Since the lifespan of the Sindia landfill is relatively short and it still faces serious opposition from neighboring residents, it is crucial to secure additional sanitary landfill areas in a reasonable location in the future. Hence, the identification and construction of a post-Sindia landfill site should be an urgent and practical project (on the condition that CADAK-CAR is in charge of construction and operation, instead of applying a PPP scheme).
(e)-3 Promotion of 3R	Owing to the limited lifespan of existing landfill sites, technical cooperation to encourage the 3R concepts is useful in the long-term perspective. More specifically, the improvement of waste discharge and collection needs to be supported, including awareness raising among the public and capacity development among local officials.
(e)-4 Introduction of Waste-to- Energy System	Waste-to-energy is the process of generating energy in the form of electricity and/or heat from the incineration of waste. From the long-term point of view, the introduction of this technology can be one of the options to ensure an efficient use of resources. It can also contribute to the extension of the lifespan of the landfill site by reducing waste volume.
(f) Power and renewable energy	
(f)-1 Installation of New Substations and Distribution Systems in the New Development Area	Though electricity demand is expected to increase remarkably in the new development area in the Study Area in the near future, the installation density of SENELEC transmission and distribution lines is low in this area at present. Thus, this situation will pose a serious problem for the stable supply of electricity. For a sufficient electricity supply to this area, new substations, which will reduce the voltage from the transmission voltage (90 kV or 226 kV) to the distribution voltage (30 kV and/or 6.6 kV) and related distribution systems, are needed in or adjacent to this area soon. These subordinate infrastructures will be most effective after the completion of the rehabilitation project of the SOCOCIM trunk substation in the future.
(f)-2 Modernization of Distribution Management Systems (DMSs) for the New Development Area	The National Power Dispatch Management System of SENELEC was modernized seven years ago but the Regional Dispatch Management Systems (distribution management systems, or DMSs), the subsystems, are old-fashioned. Thus, modernized DMSs should be installed at new DMS offices in the new development area. The DMSs are recommended to be installed in tandem with the systems of (g)-1, which would be most effective. Moreover, not only in the new development area but also in the greater Dakar area, there are some places with DMS offices, and the modernization of DMS for those offices would be expected in the future.
(f)-3 Technical Aid Project for the Detailed Study on the Transmission and Distribution Systems in Existing City Areas of Dakar	Existing transmission and distribution systems in the Dakar city area are aging and have low capacities. Thus, cable fire disasters caused by extreme heat generation and equipment trouble frequently occur due to large electricity loads on the system. To cope with the increase in electricity demands, replacement of electric lines and rehabilitation of related equipment is needed. On the other hand, as the electrical systems are very complicated in the city area, detailed studies are required to find out where and how to improve the system. For this objective, a special electrical engineer experienced in a developed country like Japan should be dispatched to SENELEC as an expert to assist with technical aid.
(f)-4 Installation of a "Waste-to-Energy" Power Plant	The current situation of municipal waste disposal at waste dump facilities in the Study Area is considered to be terrible by the parties concerned, and the government needs fundamental solutions. Additionally, finding and securing new waste dump sites is difficult under the current social situation. Reducing the volume of waste and improving sanitary conditions, installing a "waste-to-energy" plant in the Study Area for that purpose, and producing electricity using combustible waste (biomass, one of the renewable energy resources) should be planned soon.

(f)-5 Installation of "Mega-Solar-Electricity" Facilities at a Communal Public Facility	The promotion of RE use is extremely important to Senegal, and the target of 25% of energy production coming from RE is sought by the year 2025. To achieve the target, DUA, a government organization, should take the initiative to introduce RE utilization. It would be best to install PV at the public facilities of communities in the new development areas.
(f)-6 Installation of Wind Power Facilities	Wind power is one possible RE resource that should be used for generation. The coastal area has especially good conditions. From the point of view of the "self-consuming" national policy, the wind power facilities should be installed at public facilities and/or neighboring land in the vicinity (within approx. 50 km) of the Study Area. Part of the generated electricity is to be used in those facilities and the excess electricity is to be sent to SENELEC transmission/distribution lines to sell.
(f)-7 Installation of Low-head Hydropower Plants in Gambia River Basin	The Gambia River is a big river in Senegal, and has large hydropower potential. The area near the Guinea boundary has great potential to be used as one of the renewable energy resources. A big dam type hydropower development is difficult to plan because of the topographical conditions. Thus, the low-head type hydropower development is most promising for the Senegalese electricity sector, and the low-head is environmentally friendly. Some low-head hydropower plants have the capacity of 5-10 MW class, and many small and mini hydropower plants would be planned in the Gambia River basin downstream of Sambangalou hydropower plant (128 MW).
(g) Disaster Risk Management	
(g)-1 Technical Assistance Project for Capacity Development on Land Use Management Emphasizing the Flood Management Area Concept	In the 2035 Master Plan, the concept of the Flood Management Area is proposed to control flood risk in the urban area. Since there is no legislative background at the moment, the Flood Management Area and Controlled Area for Flood Management could only be effective under the framework of the 2035 Master Plan. It is necessary for relevant agencies to enhance their capacity for dealing with a Flood Management Area: how to designate it scientifically, how to regulate the development activities in it, how to review applications for permission for construction, etc. The project could include the following activities: • Preparation of guidelines on how to designate a Flood Management Area and related training • Preparation of guidelines on how to reflect the Flood Management Area in PUD and related training • Preparation of guidelines on how to regulate development activities in the Flood Management Area and related training • Awareness campaign about the importance of setting a Flood Management Area
(g)-2 Formulation of Urban Drainage Master Plans in Emergent Urbanization Areas in Rufisque and Thiès	There will be rapid expansion of the urban area in Rufisque and Thiès, including the new urban cores such as Diamniadio and Daga-Kholpa. It is necessary to formulate a master plan for urban drainage in these areas before the urbanization really proceeds, in order to avoid creating flood-prone areas by urbanization, as happened in Pikine and Guédiawaye departments. The formulation of master plans would include the following activities: • Basic studies including the existing situation of the area, the effect of future urbanization on the area and downstream reach • Identification of necessary structural measures and setting of the overall layout of drainage facilities such as drainage channels and detention ponds • Setting of Flood Management Area as a regulated area for urban development • Identification of possible measures to mitigate flood disaster risk in Controlled Area for Flood Management Discussion of other necessary non-structural measures such as flood hazard mapping and early warning scheme.
(g)-3 Comprehensive Coastal Management Project in Corniche Area of Dakar	In view point of conservation of land, all three coastal areas (Grande-Côte, Corniche, Petite-Côte) should be properly conserved. In addition to this, the Corniche area of Dakar is one of the important areas to be conserved as a symbolic place in Dakar. This area has been threatened by coastal erosion for a long time. There are also uncontrolled developments along the shoreline. Comprehensive management and development plans should be prepared urgently. The project aims to properly manage the Corniche area of Dakar by pursuing regulation of uncontrolled development along the shoreline, and by applying optimum countermeasures against coastal hazards considering environmental conservation. The project would include the following activities: • Preparation of a comprehensive coastal management plan, including a basic study on coastal erosion, identification of necessary countermeasures and their priority, guidelines for the regulation of coastal development and institutional arrangements for management • Implementation of the priority components of structural/non-structural measures.

Source: JICA Study Team

The locations of the projects are shown in Figure 11.1.1 except those projects for technical cooperation, and those for which locations are not yet specified.



Source: JICA Study Team
Note: Only those projects with locations specified are shown.

Figure 11.1.1 Location of Priority Projects for Realization of the 2035 Master Plan

11.2 Selection of Priority Projects for Pre-Feasibility Study

The candidate projects for the pre-feasibility study are selected from the priority projects listed in Table 11.1.1 focusing on the infrastructure projects:

- No overlap with donors or government agencies for implementation
- No serious environmental and social impact

The project (e)-1 "Comparative Analysis of Proper Waste Treatment Alternatives" and (e)-4 "Introduction of Waste-to-Energy System" in Table 11.1.1 are integrated into one project, since they address the same issue of improving the waste treatment system: (e)-1 in a general manner and (e)-4 focusing on the waste-to-energy system. The (e)-4 project could be a potential solution to the (e)-1 project. The title of the project is set as "Comparative Analysis of Proper Waste Treatment Alternatives Focusing on Waste-to-Energy System".

The selected candidate projects are evaluated with a set of criteria that cover the following five aspects:

(a) Consistency with national policy and the 2035 Master Plan
(b) Urgent need: Severity of the problems is assessed. A higher score is given to a project that will solve problems apparently observed in existing conditions, while a lower score is given for a project that corresponds to emerging problems.
(c) Maturity: A project is clearly recognized by the related agencies and prioritized in a sector development plan
(d) Suitability for Japan's cooperation

(e) Possibility of social problems

The highest score of 13 points is given to Comparative Analysis of Proper Waste Treatment Alternatives (e-1). The second highest score of 12 points is given to the improvement of the three intersections on VDN ((a)-1), the improvement of two intersections on Front de Terre Road ((a)-2) and the improvement of Baux Maraîchers ((a)-4).

The comparative analysis of proper waste treatment alternatives is a preliminarily study to identify the best solution for improving solid waste management in the Study Area. The other three projects of the transportation improvement are selected as the priority projects for a pre-feasibility study in order to assess the viability of these projects from technical, environmental, economic and financial perspectives.

Table 11.2.1 Selection of Projects for Pre-Feasibility Study

Candidate Projects	Selection Criteria					Total Score
	Consistency	Urgent Need	Maturity	Suitability for Japan's Cooperation	Possibility of Social Problem	
Scoring criteria	3= high 2=medium 1=low				1=No problem 0= Problem may occur	
(a)-1 Improvement of Cité Keur Gorgui intersection, SDE intersection, and Aimé Césaire intersection on VDN	3	3	3	2	1	12
(a)-2 Improvement of Bourguiba intersection and Khar Yalla intersection on Front de Terre Road	3	3	3	2	1	12
(a)-4 Traffic improvement at Baux Maraîchers	3	3	3	2	1	12
(a)-7 BRT-2/BRT-3	3	3	3	1	1	11
(b)-4 Access improvement project around Dakar Port[1]	3	2	2	3	1	10
(d)-1 Sewerage system in Diamniadio and Daga-Kholpa areas	3	2	2	1	1	9
(d)-2 Sewerage system in Rufisque north area	3	2	2	1	1	9
(e)-1 Comparative Analysis of Solid Waste Treatment Alternatives Focusing on Waste-to-Energy System	3	3	2	3	1	13

Source: JICA Study Team

Note: The plans and programs related to the priority projects listed above are the following:
(a-1), (a-2): Programme of Grand Road Projects by AGEROUTE 2014-2018
(a-4), (a)7): Transport Master Plan 2025
(b)4): PSE Flagship Project 18 Integrated Logistic Hub, PSE Pillar 1: Economic and Growth Structural Transformation
(d-1), (d-2): Sewerage Master Plan for 2025
(e-1): National Program on Waste Management, Strategic Plan 2013-2020, Dakar Solid Waste Management Master Plan

[1] *This project is not listed in the project list in the Priority Action Plan (PAP), however, it can be considered as levers (item no. 5 and item no. 6) described in levers for "Pillar 1: Economy and growth structural transformation" of PSE.*