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JAPAN INTERNATIONAL
COOPERATION AGENCY

MONGOLIAN RAILWAY
MONGOLIA

The Feasibility Study on the Rehabilitation Project of the Mongolian Railway

Final Report

Main Report

January, 1998

Japan Railway Technical Service (JARTS)
Pacific Consultants International (PCI)

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1 US Dollar = 550 Tug. = 110 Yen
(August 1996)

PREFACE

In response to a request from the Government of Mongolia, the Government of Japan decided to conduct a Feasibility Study on the Rehabilitation Project of the Mongolian Railway and entrusted the study to the Japan International Cooperation Agency(JICA).

JICA sent to Mongolia a study team headed by Mr. Naofumi Takashige, Japan Railway Technical Service (JARTS), 4 times between July 1996 and October 1997.

The team held discussions with the officials concerned of the Government of Mongolia, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Mongolia for their close cooperation extended to the team.

January 1998

Kimio Fujita

President

Japan International Cooperation Agency

Letter of Transmittal

January 1998

Mr. Kimio FUJITA
President
Japan International Cooperation Agency

It is my great pleasure to submit herewith our Report for the Feasibility Study on the Rehabilitation Project of the Mongolian Railway. The report is the result of the Study carried out by Japan Railway Technical Service and Pacific Consultants International Co. Ltd. as per the contract with Japan International Cooperation Agency (JICA).

The Study Team conducted field surveys four times during the period between July 1996 and October 1997. The team held sufficient consultations with the Mongolian governmental agencies concerned regarding the results of the field surveys and study activities in Japan, and drew up an adequate master plan of rehabilitation and a rehabilitation plan for the short-term urgent project after implementing comprehensive analysis of the rehabilitation plan of railway structures on the section between Sukhe-baatar and Bayan (about 450km) of the Mongolian Railway. In close cooperation with the Mongolian side, the team thereafter studied the feasibility of the rehabilitation plans from technical, environmental, economic, and financial aspects, and drew up this report.

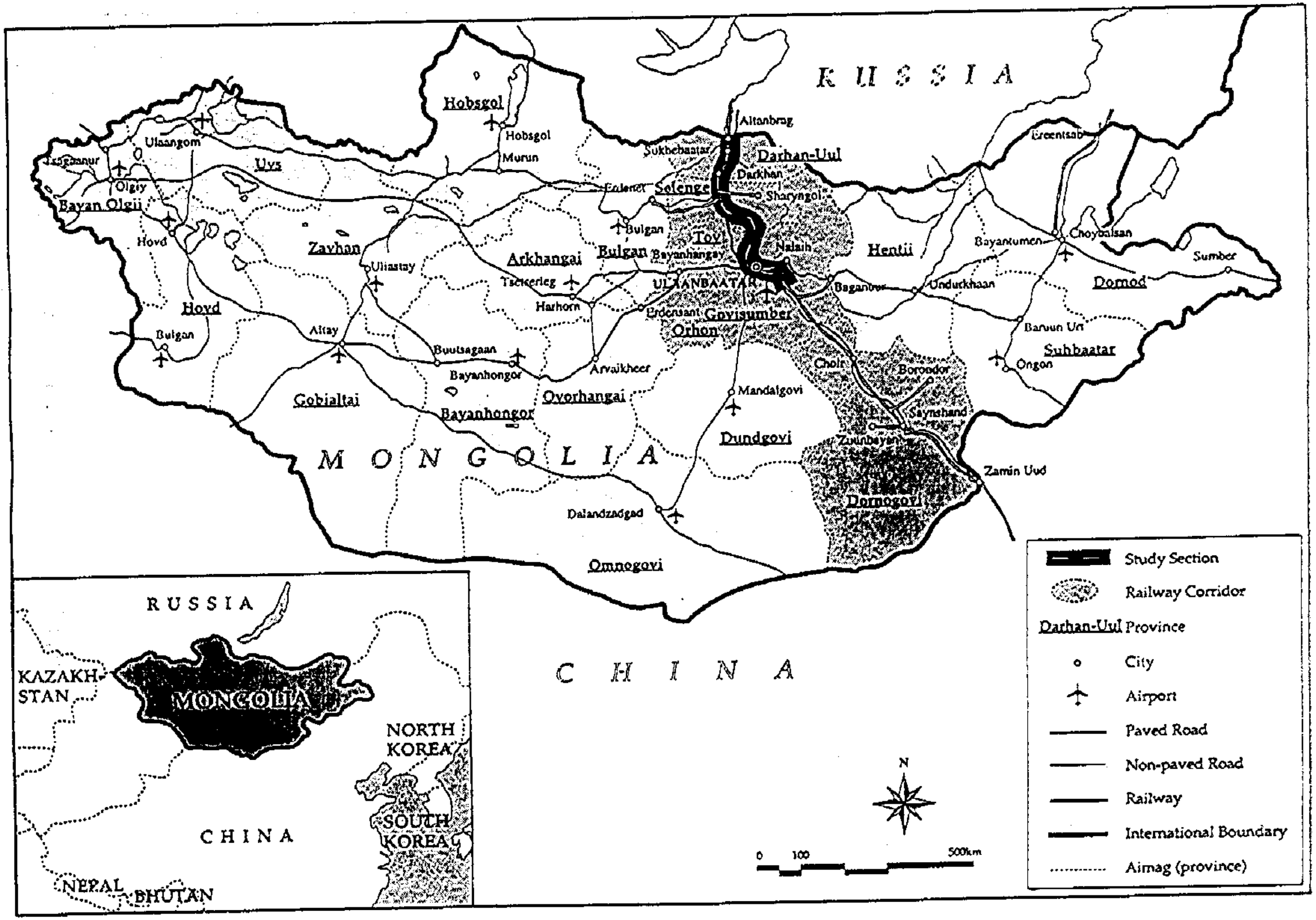
On behalf of the Study Team, let me express my heartfelt thanks to the Mongolian governmental agencies concerned for the generous cooperation, assistance and warm hospitality they extended to us throughout the entire period of the Study.

Our thanks are also due to Japan International Cooperation Agency, the Ministry of Foreign Affairs, the Ministry of Transport, and the Japan Embassy and JICA Office in Mongolia for their valuable advice and support during the Study.

Yours faithfully,

N. Takashige

Naofumi TAKASHIGE
Leader
The Study Team of the Rehabilitation
Project of the Mongolian Railway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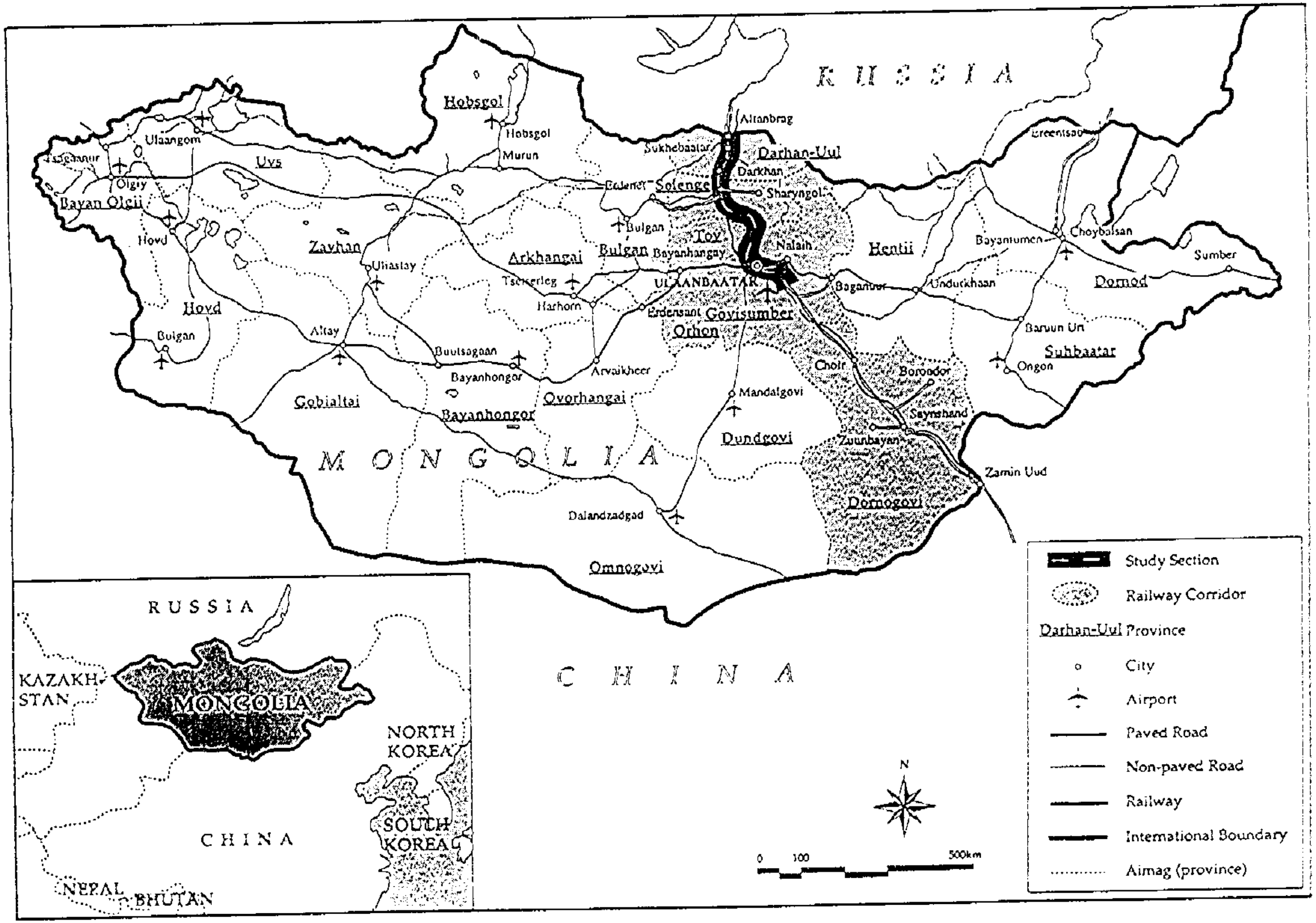
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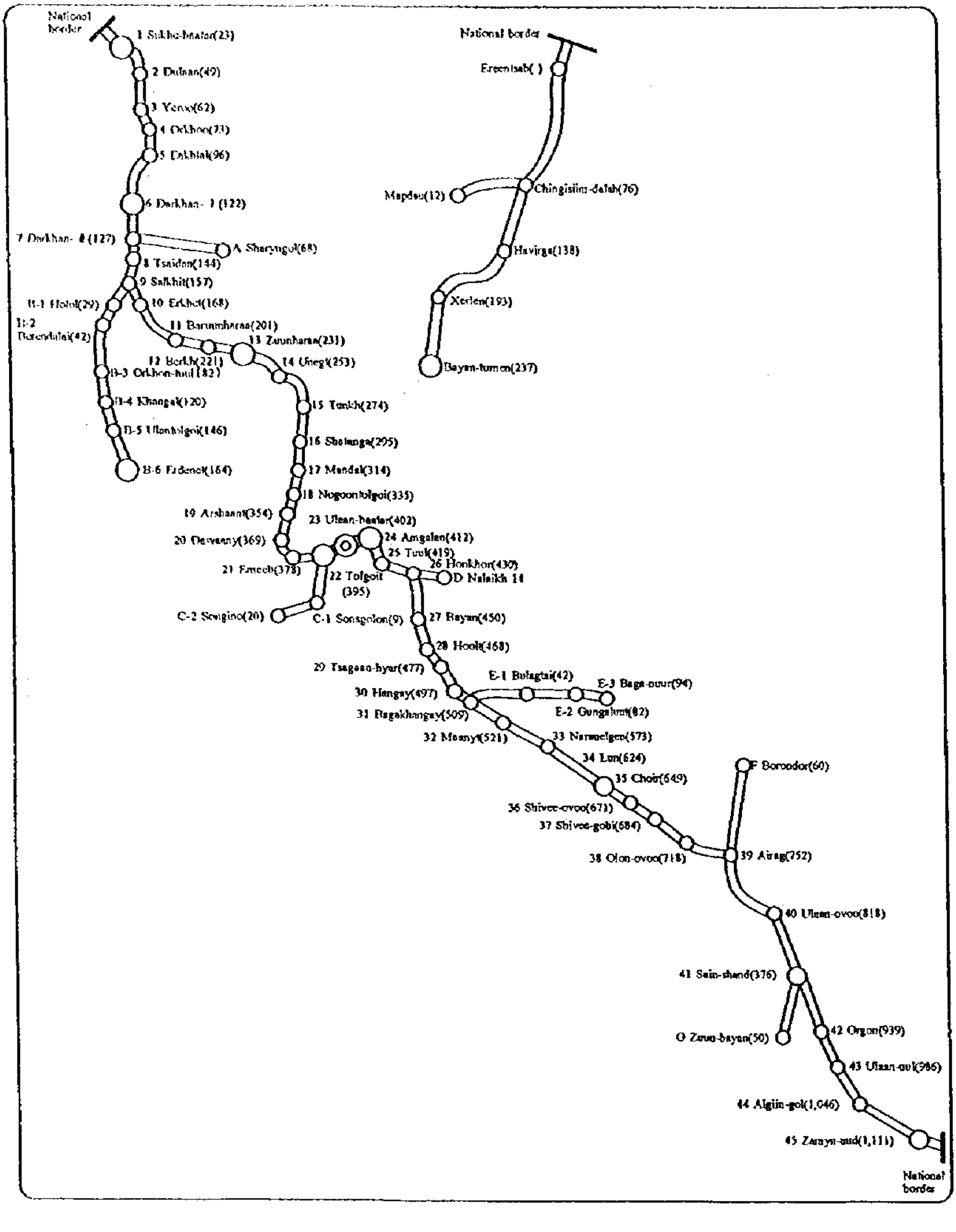
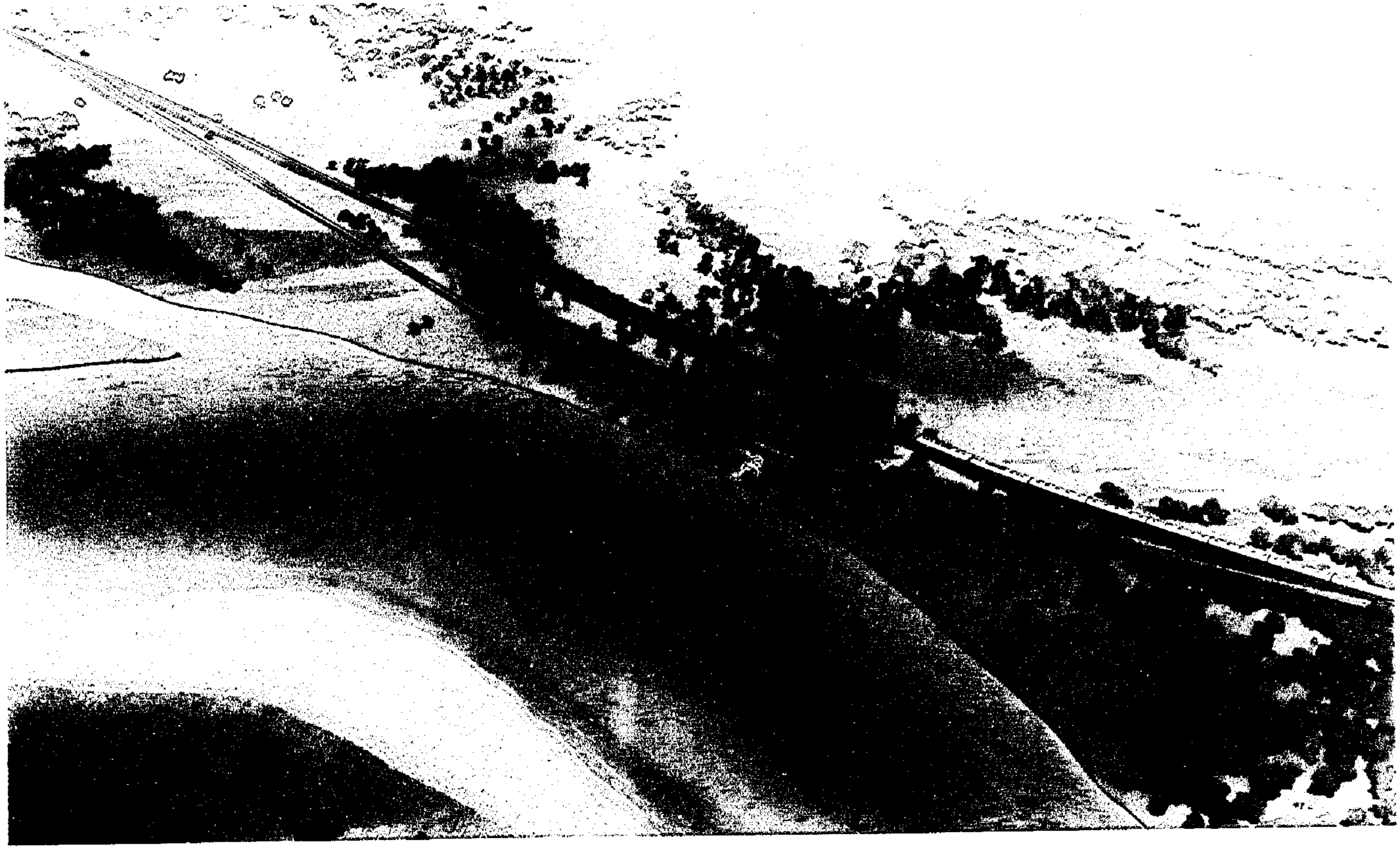
Mongolia



Railway Line of Mongolian Railway



The Feasibility Study
on the Rehabilitation Project of the Mongolian Railway
Final Report

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INTRODUCTION

Introduction

1. Background of the Study

The Mongolian Railway operates 1,108 km of main line from Sukhe-baatar, on the Mongolian-Russian border, to Zamyn-uud, on the Mongolian-Chinese border, via Ulaanbaater, the capital. Other rail lines include branches from the main line and other lines in the northeast part of the country. The total length of all railway lines reaches 1,805 km.

The main line between Sukhe-baatar and Zamyn-uud is an important transportation facility for Mongolia. The railway plays an important role as a major artery for freight distribution for long haul and international transportation services in particular, since roads have not been improved as expected. Since initial construction of the existing railway facilities, about 50 years have passed and the facilities are deteriorating due to severe weather conditions. Railway operations are often unavoidably suspended due to natural disasters that occur during the rainy season between June and August. Freight distribution channels were often closed during such periods, seriously affecting economic activities.

In the 450 km section between Sukhe-baatar and Bayan, disastrous incidents including floods of natural streams and rivers, wash-outs of the roadbed due to the inadequacy of bridges and drainage trenches, inundation of railways, and rockslides have occurred frequently, and there has also been deterioration of bridges and earth structures. It has become imperative for the Government of Mongolia to establish plans immediately to make rehabilitation to the existing main railway line of the Mongolian Railway that supports the economy of the country.

With the above as background, the Government of Mongolia requested the Government of Japan to make up a rehabilitation plan for the existing railway structures in the 450 km section between Sukhe-baatar and Bayan.

Upon receipt of this request, the Government of Japan dispatched a Preparatory study team from the Japan International Cooperation Agency (JICA) to Mongolia. An agreement between the two governments on the scope of work (S/W) for the detailed investigation was signed on November 16, 1995, based on the discussions made with the Government of Mongolia on the scope of the detailed investigations to be made.

Based on this S/W agreement, the JICA dispatched the Study team to Mongolia in July 1996. The Study team presented and explained an Inception report that described the scope and methods of the study to be made for the Government of Mongolia. As a result of further discussions, both governments basically agreed on the contents of the Inception report.

Based on this agreement, the Study team stayed in Mongolia and conducted field investigations for approximately two months, starting in July 1996. Both the parties, Japan and Mongolia, diligently worked at carrying out of field investigations, exchanging technical information in a friendly manner, and reached an agreement on the technical criteria to be applied for the rehabilitation, and identifying the facilities to be improved.

After their return to Japan, the JICA Study team made up a master plan for the rehabilitation of specific railway structures scheduled to be completed by the year 2020, and prepared an Interim report on the process of this planning. In the reports, the Study team also proposed a short-term urgent projects extracted from the Master plan, setting a target year of 2005. On March 7, 1997, both parties reached an agreement on the contents of the Interim report.

After conducting supplementary investigations in May and June 1997, we prepared a draft final report which included the feasibility study on the above-mentioned shout-term urgent project, and held discussions with the Mongolian side concerning the report.

Based on the agreement between the Japanese and Mongolian side, this Final Report describes the study results concerning the Master Plan and the short-term urgent projects.

2. Objectives of the Study

This Study will be conducted based on the S/W, agreed to by the Government of Mongolia and the JICA Preparatory Study Team on November 16, 1995. This scope of work requires the development of a master plan for (target year : 2020) rehabilitation of existing railway structures between Sukhe-baatar and Bayan of approximately 450 km, and to make a feasibility study on the short-term urgent project (target year : 2005).

In parallel with this Study, it is also planned to transfer technologies to Mongolian specialists who will participate in the investigation, by holding a workshop and also through field investigation activities.

3. Organization of the Study

The Japanese side is comprised of the JICA, the Advisory Committee, and the Study team. The Mongolian side is comprised of the government representative, the Steering Committee, and the Mongolian Railway counterpart team. The organization chart is shown in figure.

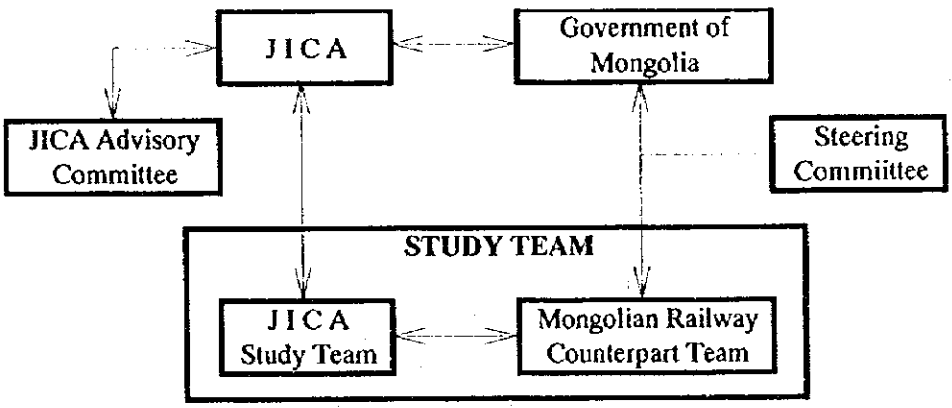


Fig. Study Implementing Organization

The Advisory Committee, the Study team of Japan, the Steering Committee, and the counterpart team of Mongolia are composed of the members listed in the following rosters.

(1) Japanese Members

1) Advisory Committee

Name	Work Assignment	Current Position
Akira YONEZAWA	Chairman	Engineering Planning Division Railway Bureau, Ministry of Transport Deputy Director
Norio ITO	Railway Facilities Planning	Facilities Division Railway Bureau, Ministry of Transport Chief of the Section
Jyunya MATSUMOTO	Transportation Planning	Personal Division Administration Department Kyushu Railway Company Chief

2) JICA

Name	Work Assignment	Current Position
Shouichi TSUGANE	Study Supervision	First Development Study Division Social Development Study Department Japan International Cooperation Agency

3) Study Team

Name	Work Assignment
Naofumi TAKASHIGE	Team Leader
Yoshio SHIBUYA	Deputy Leader/Route Planning
Isamu YOSHITAKE	Transportation and Rolling Stock Planning
Tsuneo HASHIMOTO (1996. 7～1997. 3) Kiyoshi EDO (1997.4～)	Structure and Disaster Prevention Planning
Naonori YAMADA	Track and Station Planning
Masami NAKAJIMA	Electrical Facilities Planning
Taro IWATA	Financial Analysis and Administration Operation
Teruhiko HORIE	Demands Forecast and Economic Analysis
Yoshinori KOTANI	Structural Design and Construction (Bridges)
Kenji MAEDA	Structural Design and Construction (Earth Structures)
Teruo OTSUKI	Track & Station Design and Construction
Shinya NAKAMURA	Natural Conditions
Kazuhiko IKEDA	Environmental Impact Assessment

(2) Mongolian Members

1) Steering Committee

NAME	MINISTRY/OFFICE	POSITION
N.BATMUNKH (1996.7 ~ 1997.2) G.BATKHUU (1997.3 ~)	Mongolian Railway Ministry of Infrastructure Development	Chairman
J.NYAMAA	Mongolian Railway	Member
N.BATMUNKH (1997.3 ~)	Mongolian Railway	Member
R.GANKHUYAG	Ministry of External Relations	Member
D.RENTSENDORJ	Ministry of Finance	Member
S.JAMTS	Ministry of Infrastructure Development	Member
B.JAMTS (1996.7 ~ 1997.2) B.TUMURBAATAR (1997.3 ~)	Ministry of Nature and the Environment Ministry of Nature and the Environment	Member

2) Mongolian Railway Counterpart Team

NAME	POSITION/DEPARTMENT	PROFESSION
J.NYAMAA	Chief Engineer of the Mongolian Railway	Locomotive Engineer
D.DASHZEVEG	Head Engineer in charge of Management and Planning Department	Locomotive Engineer
V.OTGONDEMBEREL	Head of Management and Planning Department	Railway transportation Management Engineer
L.PUREVBAATAR (1997.3 ～)	Senior Engineer of Management and Planning Department	Railway Telecommunication Engineer
G.VANDANDAGVA (1996.7 ～ 1997.2)	Head of Track Facilities Department	Track Engineer
N.BATMUNKH (1997.3 ～)	Head of Track Facilities Department (Deputy Chairman of the Mongolian Railway)	Track Engineer
Z.ZORIG	Chief Engineer of Track Facilities Department	Track Engineer
Z.UURDMANDAKH	Deputy Head of Track Facilities Department	Track Engineer
Ch.ERDENEDALAI	Senior Engineer in charge of artificial structures at Track Facilities Department	Bridgework Engineer
Ch.LKHAGVASUREN	Chief Engineer of Freight Transportation Department	Railway Transportation Management Engineer
T.DASHDEMBEREL	Head of Technical Section of Freight Transportation Department	Rolling Stock Engineer
D.BATBOLD	Chief Engineer of Passenger Transportation Department	Rolling Stock Engineer
L.GANBAATAR	Chief Engineer of Locomotive Facilites Department	Locomotive Engineer
SEREENENDORJ	Senior Engineer of Signalling & Communication Department	Railway Automatics Engineer
B.ARIUNAA	Deputy Head of Financial Department	Economist
L.TUDEV (1996.7 ～ 1997.2)	Head of Statistic and information Center	Railway Economist
T.BATBOLD (1997.3 ～)	Head of Statistic and information Center	Railway Transportation Management Engineer

VOLUME 1 MASTER PLAN

CHAPTER 1

PRESENT SITUATION OF MONNGOLIA

Volume 1 Master Plan

Chapter 1
Present Situation of Mongolia

1-1 The Natural Surroundings

1-1-1 Topography

The overall topography of Mongolia is that mountains are found mainly in the northern and western regions, and plains in the eastern to the south-west regions.

In the west the Altai mountain ranges along the border with China with mountains in the 4,000m class from the north to the south-east region. Khuiten Peak is the highest mountain reaching 4,374m. The Gobi-Altai mountain range, the extension of the Mongolian Altai, is the largest mountain range stretching along the south-east region of the country. To the west the Ih Bogd ridge reaches a height of 4,000m, and gradually becomes lower towards the south-east to the Gobi desert. On the north of the Gobi-Altai is the Hangai ridge which runs parallel to the Mongolian Altai in a north-west to the south-east direction. The highest ridge is the Otgan Tenger mountain which reaches a height of 4,013m. The Henti mountains occupy the north-west of the country running in a north-east to south-west direction.

The capital city of Ulaanbaatar is located between the Altai and the Gobi Altai Ranges. There is a depressed area between the Gobi Altai Range and Hangai which forms the basin for the "Valley of the Lakes". This valley fluctuating between 960m ~ 1,300m contains Uvs Lake at 759m, and Khar Uvs Lake at 1556m. To the east of the Valley of the Lakes is the expanse of the Mongolian Gobi. The Gobi depression (900m ~ 1,000m), has to the north the east Mongolian elevated plains. To the east of the Gobi depression lies the Dornod Plains (1,000 ~ 1,200m). To the north of the Dornod Plains where the lowest elevation is found at the border with Russia the Uvs Lake (560m). The various regions of Mongolia and their ratio of distribution is given in the following Table.

Table 1-1-1 Ratio of Land Distribution by Region

Region	Elevation	Percentage of the country's territory
Mountains	More than 3,000m	2.5%
Mountainous	1,500 ~ 3,000m	40.0%
Hills	1,500 ~ 3,000m	40.0%
Eroded Plains	Less than 1,000m	15.0%

1-1-2 Geology

Mongolia geologically comes under the Ural-Mongolian Palaeozoic fold belt (Mongolian Syncline). The Mongolian Syncline borders with the Siberian tableland, with the north-east semi-tableland, and with the Palaeozoic fold belt in the south-east. The Mongolian fold belt has been described as being added to the Siberian plate by the sinking of the marine plate in the early ages and joining with the Siberian plate on the northern extremity. This is attested by the different kinds of metamorphosed formations of which newer strata can be found from north to south. In addition, it has been described that the Mongolian plate was pushed into contact with the continental plate during sometime during the Palaeozoic to the Meozopic period, and formed the present geological structure.

During the archeozoic to the proterozoic era, the crust of the earth consisted of gneiss, crystalline shale, amphibolite, qyartzite, and granite, and are found widely dispersed throughout the north-west area of the Hangai Mountains. Also in the latter period of the Pre-Cambrian era, there are many metamorphic rocks consisting of large amounts of green schist of the Pheephay system, and in the periphery of the depressed areas of the "Giant Lakes". In the northern parts of the Selenge River near the border with Russia and Mesozoic era, there are large deposit of morass of the land and marine types.

The soils of the Pre-Palaeozoic era are found largely deposited in the Altai Mountain and Tuul River areas and are composed of teyaat, crystalline schist, limestone, shale, and sandstone. The soils of the Mid-Palaeozoic era are found widely dispersed throughout the south side of the Altai Mountains, and the ridges of the Hangai and Hentii Mountains with small deposits in the central parts of the Gobi Desert. These soils contain teyaat, crystalline shale, limestone, shale, and sandstone. In the Hangai and Hentii Mountains intrusives of granite are found. The soils of the Upper Palaeozoic era are found in the middle and lower basins of the Selenge River and the plains at the extremity of the south-east slopes of the Hangai Mountains, also in small blocks on the southern areas in the east west direction, and the Gobi Desert along the border with China. These soils contain land formed deposits of sandstones and conglomerate together with some volcanic rock of basalt and andesite. In general, the soils of the Palaeozoic era are not well metamorphosed. Also, they contain marine polyfacial compressed with remains of different marine fauna and sub-aerial flora.

The soils of the Mesozoic era are mainly found in the eastern areas, and contain terrestrial deposits of sandstone and conglomerates, marine deposits of sandstone and shale, and volcanic rocks of deisite, rhyolite, and andesite. Also, in the center to the eastern areas of Mongolia, there are large deposits of granite which penetrated this area during this era. The loose deposits of the Cretaceous Period containing large deposits of dinasour fossils are found in the Gobi Desert.

The Quaternary formation can be found in the area between the Altai and Hangai Mountain ranges in the region of the depressed area of "Giant Lakes" and the "Valley of the Lakes" and the Gobi Desert. In this area, the unhardened sands and clay of the Cretaceous - old Tertiary - Present can be found throughout Mongolia. The high plains area of Mongolia of the Neo - Tertiary Period basalt rocks formulated by the Mongolian side, and all parts of Central Mongolia, basalt rock can be found in small masses.

From the archaeozoic period to the proterozoic period, there are deposits of gneiss, crystalline shale, amphibolite, marble, quartzite, granite, which are found throughout the north-west areas of the Hangai Ridge. Also, towards the end of the Pre- Cambrian era, there are green schist formations of the leafy system found in the metamorphic rock of the depressed areas of the "Valley of the Lakes", and also are found in the northern areas of the Selenge River near the border with Russia, and on the north-west slopes of the Hentii Mountains. On top of these formations there are large deposits of morass of the Palaeozoic and Mesozoic eras.

The formations of the Pre-Palaeozoic era can be found widely deposited throughout the Altai Mountains and the Tohra River, and compositions of tehyaat, schist, lime rock, shale, and sandstones can be found in this area. There are large deposits of the Mesozoic era are found on the south side of the Altai Mountains, the Hangai Mountains, and the Hentii Ridges, with some found in the central areas of the Gobi Desert. In these deposits are found teyaat, crystalline shales, lime rock, shales, and sandstones. In the Hangai and Hentii Mountains, there are deposits of granite - gneiss.

1-1-3 Hydrology

The north and west regions of Mongolia are heavily forested and because of this fact, there are many rivers are found and large amounts of river water are found. In contrast to this there are very few rivers in the south where it is arid. The river systems can be classified into three district areas.

(1) Rivers of the Pacific Basin

The rivers of the country that flow into the Pacific basin are mostly located in the east, and are divided by the Hentii Mountain watershed which divides from the rivers flowing into the Arctic Ocean basin. The major rivers of the Pacific Ocean basin are the Onon and the Herlen. They flow to the east and along the borders with China and Russia and joins with the Amur River. The total length of the rivers of the river system which flow towards this basin constitutes about 11 %, and its flow accounts for about 15% of the total runoff.

(2) Rivers of the Arctic Basin

The rivers of this system are enclosed on the west by the Henkei and Hangai Mountains, and all generally flow towards the north. The main river Selenge crosses over into Russia near Sukhe-baatar, and then flows to the Arctic ocean. The Selenge has its source on the northern slopes of the Hangai Mountains and flows NEN and joins with the Moron River near Sukhe-baatar. The Moron River has its source also on the northern slopes of the Hangai Mountains, but flows in the NNE direction, after entering Selenge Province it joins with the Tuul River, and again joins with Yoroo River south of Sukhe-baatar. The rivers in this system have a total length of about 50% of all rivers, and consists of about 51% of the total runoff, and is the largest river system in Mongolia.

(3) Rivers of the blind drainage basin

The rivers of this system can be divided into the following two systems:

River Systems that flow into the "Giant Lakes"

These are the river system flows that terminate in the depressed areas of the so-called "Giant Lakes" that are bordered by the Hangai Mountain Ranges on the east, and by the Altai Mountains on the west. The main river of this system is the Zavhan which drains from the western slopes of Hangai and flows into the Hyargas Nuur lake. Further to the north is the Uvs Nuur Lake. Both lakes are blind lakes with no outlet to the sea, and both are salt-water lakes. The rivers that have their source in the Altai mountains all flow into the Har Us Nuur lake and are all fresh water rivers.

River Systems that flow into the "Valley of the Lakes" and the Gobi Desert

These rivers are the ones that flow into the "Valley of the Lakes" in the area between the Hangai Mountains and the Gobi-Altai Mountains. The small rivers that have their source on the slopes of the Hangai Mountains flow into the blind lakes in the "Valley of the Lakes" and eventually drain internally into lakes or are lost in the ground. The blind drainage basin accounts for nearly two-thirds of the total runoff of all rivers in Mongolia, but the actual flow is less than one-third.

1-1-4 Climate

Mongolia is located in the mid-latitudes of the Asian continent inland on a high table-land, and the weather is cool and semi-dry, with extreme continental features. According to Keppenis classification, a greater part of the country is of the weather of the steppes, and is of the sub arctic zone on the northern border. The low lands and ridges are covered with a growth of short grass called the "steppes", and have a monotonous scenery. The mountain areas are covered by forests with coniferous forests, and the northern part continues into Siberia to the Taiga area. The Gobi Desert in the south consist of soils mixed with granite. The wet and dry seasons are clearly defined, and there are two seasons as defined below:

- wet season .... middle of April to middle of September
- dry season .... end of September to first of April..

The average precipitation is 230mm per year, and highest in the north and lowest in the south. The precipitation in the extreme north along the border with Russia receives precipitation of 500mm/yr, and in the extreme south in the Gobi Desert, the precipitation is 50mm/yr. Most of the precipitation takes place during the wet season in June and July.

The mean temperature in the south is 2 ~ 4°C, and in the north -7 ~ -5°C. The mean temperature fluctuates from year to year, and in the winter has recorded -35 ~ -15°C, and in the summer 10 ~ 25°C, and the annual difference can be as much as 50°C. Strong winds blow in the spring throughout the country, and dust storms with loess occur.

1-1-5 Description of the Land Cover Situation

The land cover situation for the whole area of Mongolia is as described in the following table:

Table 1-1-2 Land Cover Status

Classification	Area (mil.ha.)	Percentage of Total Area
Steppe	124	79
Forests	13	8
Lakes, Rivers	1.6	1
Deserts	4.4	3
Living Areas	4.3	2.7
Others (Glaciers, Rock Area)	9.2	6

Most of the grass plains are used for agriculture. Many of the river basins in the northern areas of the country such as the Selenge, Orhon, Herlen, principally are used for agriculture in the order of 1.3 mil. ha, 2.0 mil. ha for hay and fodder, and 122 ha for animal herding.

1-1-6 Natural Calamities

There are some natural calamities peculiar to the geographical natural environment of Mongolia. Some of the natural calamities that the railways experience are :

- blizzards
- heavy snows
- sand storms
- floods
- earthquakes
- forest fires

A description of some of the recent disasters are:

(1) Blizzards (Snow Storms)

One such storm occurred in September and lasted until May of the following year, for a series of 1 ~ 10 day periods. Blizzards occur frequently and differ by areas, and in the investigation conducted for the Ulaan-baatar ~ Sukhe-baatar area they occurred for periods of 2 ~ 8 days, several times during the year. In recent years, on 5 thru 7 May 1993, there was a blizzard that occurred in central Mongolia with snow fall of 20 ~ 60 cm, winds of 24 ~ 34 m/sec, which resulted in 17 people perishing, and 100,000 head of cattle being lost.

(2) Heavy Snow Storm

In the winter months, almost all of Mongolia is covered by snow. According to investigations conducted, the snowfall was on the order of 100 ~ 200 cm. In recent years, in the provinces of Govi-Altay and Ovorhangay (March 1993), and Central Mongol (May 1992), there was a heavy storm of 34 ~ 90 cm in which 850,000 heads of cattle perished, and another snow storm of 70 ~ 80 cm where several thousand heads of cattle were lost.

(3) Sand Storm

Sand storms are caused by the sands of the Gobi Desert coupled with the strong cyclonic winds . Especially, in the lowlands of the east foothills of the Altai Mountains, there are frequent sand storms, and they occur on the order of 7 ~ 120 times a year. In the north-central area of the country where an investigation was conducted sand storms occurred on the order of about 10 times a year. In recent years, there seems to be more sand storms occurring with the result that the desert area are increasing. The cause of the increase of sand storms are being attributed to the excess herding of cattle and other development projects. One such sand storm occurred in the Province of Dornogoví (Central Gobi) in which the wind speeds were 50 m/sec, and 7 persons died, and 800 heads of cattle perished. In 27 ~ 30 November 1991 in some 12 provinces, a sand storm occurred in which there were many *gers*, fencing, and wood houses damaged.

(4) Floods

In spite of the low precipitation in Mongolia, it is subject to damage from spring floods. This can be attributed to the heavy volumes of rain water flowing into the rivers when high mountain thaw waters and untimely heavy rains occur, the low temperatures which tend to delay the radioactive rate, the tundras and little vegetative land cover which tend to prevent the permeation of the surface water into the soil. The cause of floods in Mongolia can be classified into the following 3 types:

a) floods from rainfall during the wet season

b) floods caused by melting snow

c) avalanche of earth and rocks

Items a) and c) differ with the peak of the floods. In a semi-arid area like Mongolia, there is a characteristic of melting snow and heavy rains where sheet water flows there are very heavy rains in the terrain which amplifies the effect of the flood waters. Especially in the northern areas of the Selenge River basin, it is subject to frequent flooding, and it is subject to all three items above.

A recent flood damage is the flood that occurred in 1996 in Ulaan-baatar where the Tuul River overran its banks with 3.12m of water, and more than 100 people died, and damage of more than US$7.5 million was caused. In the flood that occurred in 1983, 12 people died, and damages amounted to more than US$1.1 million.

The avalanche of rock earth and rocks are assumed to have been caused in the Altai and Hangai Mountain ranges, however these areas are far away from areas where there are people living, and the real causes of the avalanche cannot be confirmed. In Ulaan-baatar, there was an avalanche of earth and rock which occurred in 1982, in which 22 people died, and causing damage amounting to US$0.5 million.

Table 1-1-3 Major Floods in Mongolia since 1954

River	Due to Heavy Rain in Summer			Due to Thawing in Spring		
	Year	Velocity (m^3/s)	Incidence (years)	Year	Velocity (m^3/s)	Incidence (years)
Selenge	1986	2,200	50	1975	1,024	100
Dengel	1986	1,900	60	1966	849	50
Orkhon	1965	562	10	1951	678	200
Rearu	1966	1,580	50	1991	424	50
Telerge	1983	564	33	1991	169	100
Haraa	1991	245	20	1991	227	200
Yoroo	1973	1,290	50	1968	466	50
Onon	1990	904	20	1985	218	20
Orutu	1984	196	50	1986	64	50
Helren	1954	1,320	200	1991	214	50
Bokudo	1979	168	20	1991	100	10
Ureasta	1979	157	20	1955	97	50
Borgan	1984	80	10	1988	205	20
Harihira	1989	615	20	1989	28	4
Turgun	1989	38	20	1989	28	4
Baruturun	1987	200	50	1987	23	4
Tes	1973	206	20	1976	156	10

Source: Ministry of Natural and Environment

(5) Earthquakes

Mongolia is a landlocked country with many earthquakes, and in the last 20 years there have been more than 40 earthquakes recorded. Of these, there were 4 instances of magnitude of more than 8 on the Richter Scale. The epicenter of these earthquakes are mostly in the Altai, Gobi-Altai, Hangai Mountain Ranges, and the Huvsgul and Bulnai Ridges. Earthquake damage affects mainly the road network, and in the recent investigations conducted there was no damage reported for the railways. Records of earthquakes in the last 90 years are listed in the following Table.

Table 1-1-4 Main Earthquakes in the Past 90 Years

Epicenter	Year	Magnitude
Unegt	1903	7.5
Tsetreleg	1905	7.6
Bulnai	1905	8.2
Ashani	1931	8.0
Mondin	1950	7.0
Gobi-Altai	1957	8.1

Epicenter	Year	Magnitude
Bayan-Tsagaan	1958	6.9
Burynhyar	1960	6.7
Mogod	1967	7.8
Uragnuur	1970	7.0
Tahi inshar	1974	6.9

(6) Forest and Steppe Fires

In Mongolia the natural disaster of forest and steppe fires occur every year. In the last 5 years 858 forest and steppe fires occured and 38 persons were killed, 610 persons got burned, and 264 moving house , 310 thousand livestock, 660 shed for livestock, 3.3 million ha. of forest, 19.1 million ha. of steppe were burned down. Of this loss, 75% of the areas have been non-restorable.

Especially in last year it was very dry, and forest and steppe fire continued from Febraury 23 until June 4, for 102 days. 17% of livestock and 20% of settlements were burned down, 25 persons were killed, 61 persons got burned, 2.3 million ha. of forest and 7.8 million ha. steppe were burned down.

The causes of the fires have been reported as attributed to accidental fires (ex. throwing cigarette away and children's playing with fire) and natural causes (ex. thunder), and have occured in the spring and autumn in the dry season. Approximately one half of the forest and steppe areas of Mongolia are exposed to dangers from fire, and the railways have been subjected to the dangers of forest and steppe fires.

Table 1-1-5 Fire Record in Mongolia since 1963

Year	Forest Fire		Steppe Fire		Total		Damage (Mill. Tg.)
	Number	Area (Thous. ha.)	Number	Area (Thous. ha.)	Number	Area (Thous. ha.)	
1963		92.1	68	29.6	68	121.7	
1964		0.2	2	0.2	2	0.4	
1965		198.3	141	4.5	141	202.8	
1966		221.9	140	4.9	140	226.8	
1967		42.7	117	3.1	117	45.8	
1968		118.9		1,558.0	0	1,676.9	28.4
1969		144.5	498	6.4	498	150.9	
1970		5.3	676	13.0	676	18.3	
1971	49	15.3	11	11.4	60	26.7	3.4
1972		420.2		314.0	0	734.2	114.4
1973	39	7.4	33	7.2	72	14.6	3.6
1974	48	57.1	50	170.9	98	228.0	3.3
1975	53	21.4	73	831.7	126	853.1	1.3
1976	51	173.9	96	573.4	147	747.3	4.7
1977	116	344.8	173	2,541.4	289	2,886.2	25.4
1978	193	988.0	92	1,648.4	285	2,636.4	82.9
1979	49	66.2	67	666.1	116	732.3	3.3
1980	114	107.2	48	288.6	162	395.8	9.9
1981	52	4.6	42	164.6	94	169.2	0.6
1982	62	153.6	47	777.0	109	930.6	3.8
1983	34	87.4	61	158.0	95	245.4	2.5
1984	60	156.2	56	357.7	116	513.9	1.2
1985	20	3.4	79	1,893.3	99	1,896.7	8.5
1986	58	30.6	146	3,157.4	204	3,188.0	
1987	107	143.3	126	1,084.7	233	1,228.0	
1988	22	2.3	48	240.7	70	243.0	
1989		51.0	18	126.0	18	177.0	
1990	657	55.0			657	55.0	
1991	36	63.9	65		101	63.9	5.4
1992	105	390.7	56		161	390.7	19.9
1993	34	205.2	46		80	205.2	5,200.0
1994	50	120.0	60		110	120.0	63.2
1995	59		61		120	-	
1996	321	2,363.6	96	7,830.8	417	10,194.4	190,747.1

Source: Ministry of Natural and Enviroment
Brank means no record.

1-2 Socio-Economic Situation

1-2-1 Population

The country has a land of 1,570,000 km^2 surrounded by Russia and China, a land-rocked country, being shown in Fig. 1-2-1. Population was 1.8 million in 1985, which increased to 2.3 million in 1995, an increase of about 0.5 million persons in ten years with which the average rate of increase is calculated at 2.3 % per annum. But it registered a lower rate of growth of about 1.5 % per annum in the recent five years, 1991-96. The age composition shows those less than 14 years are 39 %, the ages from 15 to 65 are 57 %, which differs from developed countries, for example, the current Japanese pattern is 16 % for those less than 14 years and 70 % for 15 to 65 years in 1994. Majority of the work force in Mongolia has been engaged in traditional livestock raising utilizing the vast grassland.

1-2-2 GDP

(1) GDP

Gross Domestic Product (GDP) in constant prices of 1993 is shown for 1985 - 95 in Table 1-2-1. In those years the country encountered economic restructuring from the planned production quota system under the socialist government rules to private ownership system with market mechanism. It started in 1990 simultaneously with the collapse of Soviet and COMECON. GDP had reduced by 22 % in four years up-to 1993, a rate of -7 % per annum in real terms. However, it turned to increase in 1994 and 95 with an annual rate of 4 % per annum. There is no dependable COMECON system any more in the former socialist countries. Although the market mechanism of supply and demand under the private ownership has not been prevailed common in the country, it is the only way the economy should pursue to develop. Economic development may require much more association and competition with not only Russia and China but also Asian and European countries through trade and communications.

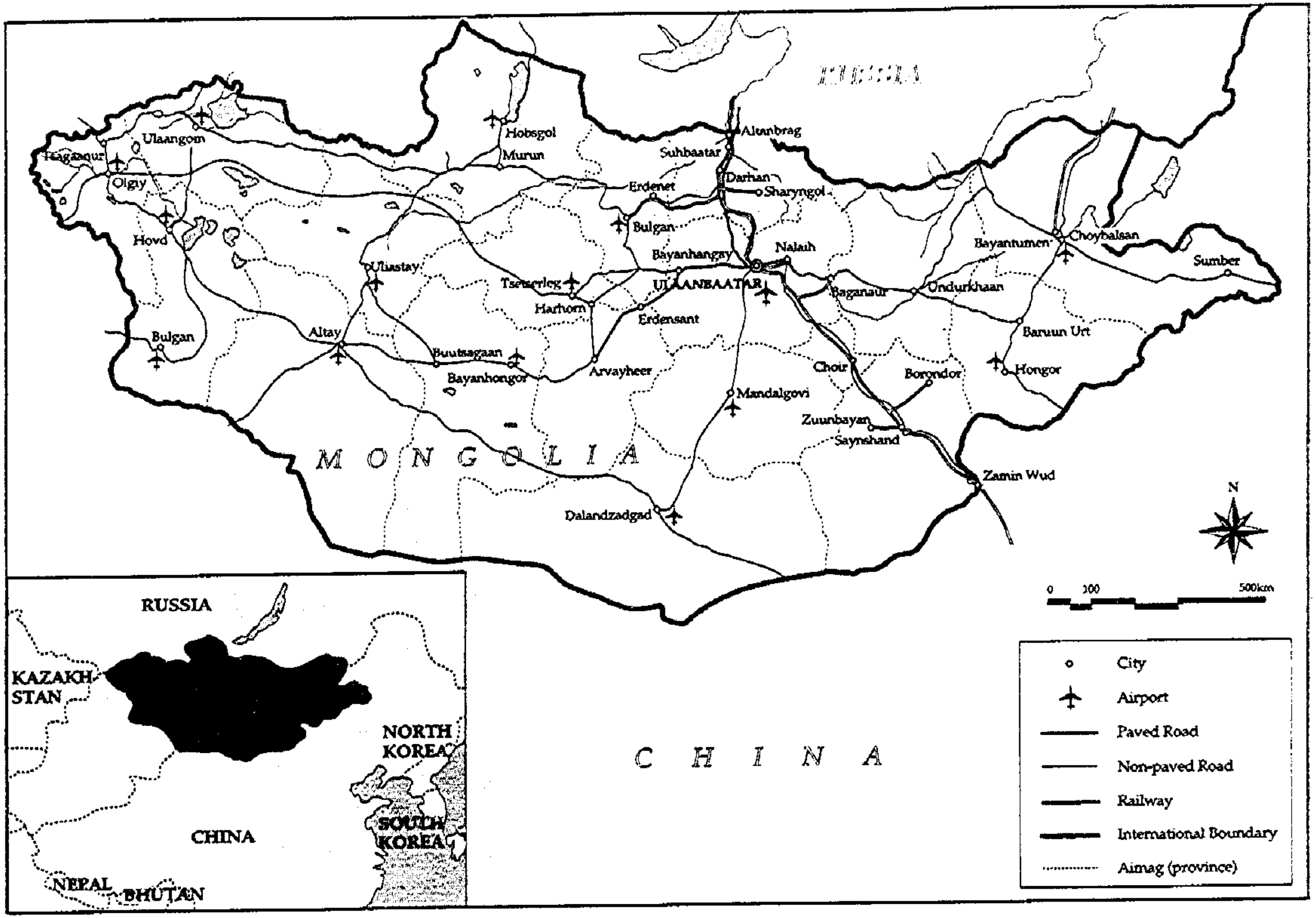


Fig. 1-2-1 Mongolia: Roads, Railways and Airports, 1996

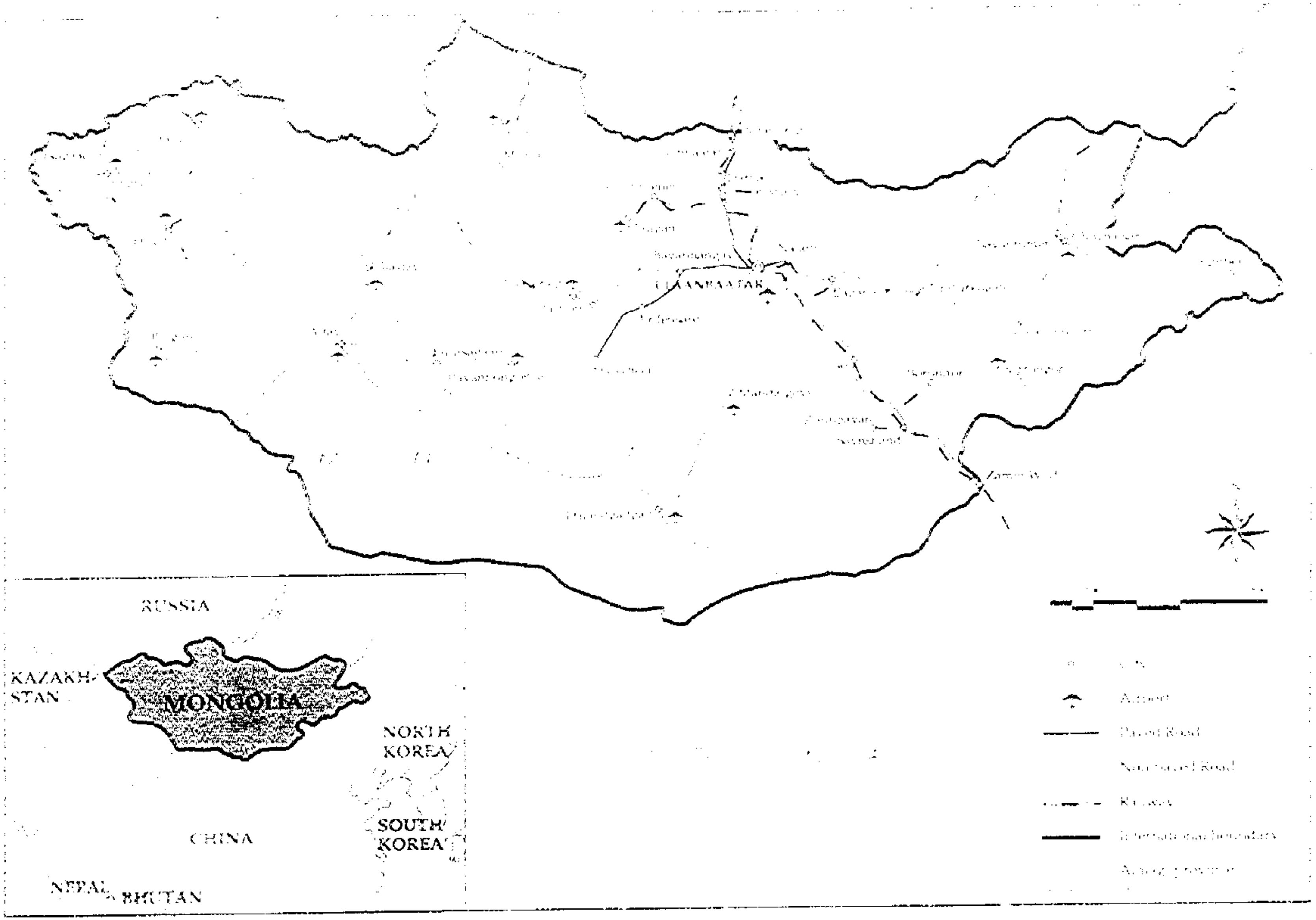


Fig. 1-2-1 Mongolia: Roads, Railways and Airports, 1996

Table 1-2-1 Population, GDP and GDP per Capita,1985-95

Year	Population in '000		GDP in mn 1993 Price		GDP per Capita in Tug	
		Av. rate.p.a.		Av. rate.p.a.	1993 pr.	Av. rate.p.a.
1985	1822.6	2.30%	172737.3		94.78	
1986	1872.6		188929.2	9.37%	100.89	6.45%
1987	1920.3		195461.5	3.46%	101.79	0.89%
1988	1966.9		205439.7	5.10%	104.45	2.61%
1989	2018.8		214027.7	4.18%	106.02	1.50%
1990	2075.5		208641.9	-2.52%	100.53	-5.18%
1991	2129.0		189349.2	-9.25%	88.94	-11.53%
1992	2177.1		171365.4	-9.50%	78.71	-11.50%
1993	2221.3		166219.1	-3.00%	74.83	-4.93%
1994	2259.0		170042.3	2.30%	75.27	0.59%
1995	2293.9		180775.4	6.31%	78.81	4.69%
1996	2329.9		185547.9	2.64%	79.61	1.02%

Source: Mongolian economy and Society in1996 (SOM,1997), and data in STOM
* -6.5 and -8.0 are the average figure of 4 years past respectively.

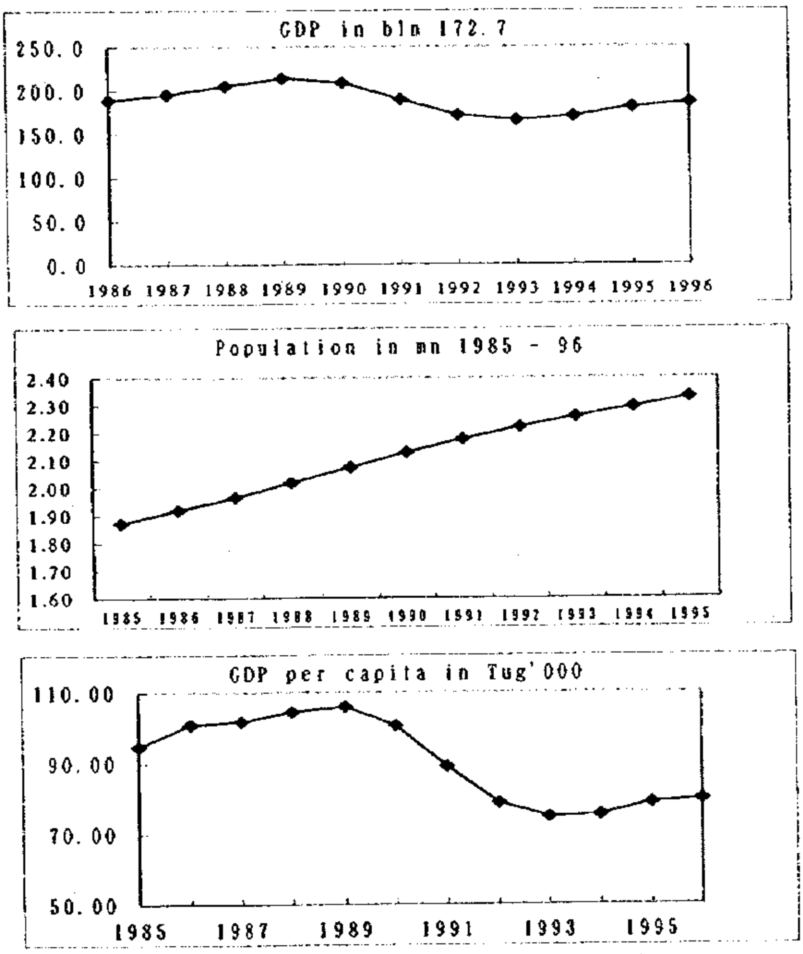


Fig. 1-2-2 GDP, Population, in 1985-96

The sectional composition of the economy in 1995 is shown in Table 1-2-2 which shows that industry sector produces the share of (33 %) and the agriculture/livestock sector of 34 %. The total animals kept in the country in 1995 was 28.6 million, 12 heads per person. The employment status shows a different pattern, being shown in Table 1-2-3. The employed persons in the industry sector was 108,000 (14 %) while the agri-livestock sector enrolled 354,000 as the largest share of 45 % in the employment total of 795,000 in 1995. Unemployment registered 45,000 persons in that year, which means a 5 % unemployment in the economically active population. Due to the economic reduction in the transition years, the agri-livestock sector has played a buffering role in the market by maintaining excessive workers in industrial and other sectors.

(2) Prices

The economic restructure of the country has caused heavy inflation which is not calm down in 1995 and 1996. Statistical index of consumer prices indicate price level increases as under:

Year	Month	Overall (1991-1 = 100)	Previous year
1991	9	134.9	-
1992	9	409.7	-
1993	9	1610.0	1.00
1994	9	2703.0	1.68
1995	9	4506.3	1.67
1996	9	6758.0	1.50

Prices have increased annually 68% in the recent few years up to 1995 according to the general consumers price index of the Statistical Year Book, 1996. Efforts to reduce the inflation rate are required in years ahead. since it is an indispensable condition to have stable development of the economy.

Table 1-2-2 GDP by Sector, 1989 - 96

(In prices of 1993, mn Tug. and share in ratio)

	Year	1989	1990	1991	1992	1993	1994	1995	1996
1	Industry	69111.4	69336.5	60701.1	54812.1	51307.8	52174.9	59913.8	60212.5
	Share	0.323	0.332	0.321	0.320	0.309	0.307	0.331	0.325
2	Agriculture	64908.9	64045.4	61235.4	59958.1	58335	59910.9	62453.5	64800
	Share	0.303	0.307	0.323	0.350	0.351	0.352	0.345	0.349
3	Construction	9476	7144.3	5967	3250.9	2724.6	3010.9	3329.3	3507.7
	Share	0.044	0.034	0.032	0.019	0.016	0.018	0.018	0.019
4	Transport	13769.9	12596.3	7158.5	5955.2	5391.4	5398.4	5283.9	5854
	Share	0.064	0.060	0.038	0.035	0.032	0.032	0.029	0.032
5	Comm,Trade & m	3267.7	3494.9	2693.4	2139.2	2322.3	2140.7	2165.5	2396.2
	Share	0.015	0.017	0.014	0.012	0.014	0.013	0.012	0.013
6	Technical Provisio	37651.3	37134.4	32594.3	25205.1	26536.6	26532.8	26564.4	27313.4
	Share	0.176	0.178	0.172	0.147	0.160	0.156	0.147	0.147
7	Services	12820.5	12113.4	15985.6	16498.9	15799.2	16484.4	16573.1	17229.4
	Share	0.060	0.058	0.084	0.096	0.095	0.097	0.092	0.093
8	Others	3022.0	2776.7	3013.9	3545.9	3802.2	4389.3	4491.9	4230.8
		0.014	0.013	0.016	0.021	0.023	0.026	0.025	0.023
	Total	214027.7	208641.9	189349.2	171365.4	166219.1	170042.3	180775.4	185544.0
	Share	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Source: Statistical Yearbook 1996 (Statistical Office, 1997)

The share is the ratio of the total in each year.

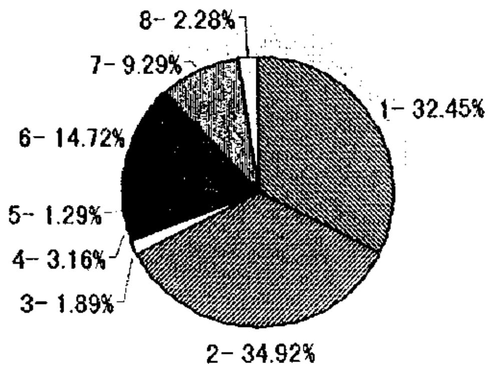


Fig. 1-2-2 GDP by Sector 1996

Table 1-2-3 Number of Employees by Sector, 1991 - 96

	Year	1991	1992	1993	1994	1995	1996
1	Industry	132.2	133.9	124.1	100.9	108.1	104.6
	share	*0.166*	*0.166*	*0.161*	*0.128*	*0.136*	*0.132*
2	Agriculture	274.9	294.2	302.2	336.6	354.3	358.1
	share	*0.345*	*0.365*	*0.391*	*0.428*	*0.446*	*0.452*
3	Construction	49.4	41.4	33.0	27.3	29.5	29.7
	share	*0.062*	*0.051*	*0.043*	*0.035*	*0.037*	*0.038*
4	Transport & comm.	52.2	50.2	46.0	31.5	31.6	31.6
	share	*0.066*	*0.062*	*0.060*	*0.040*	*0.040*	*0.040*
5	Trade & technical provision	51.9	53.8	50.5	67.4	64.8	68.5
	share	*0.065*	*0.067*	*0.065*	*0.086*	*0.082*	*0.087*
6	Others	235.1	232.5	217.0	222.8	206.4	199.3
		0.295	*0.288*	*0.281*	*0.283*	*0.260*	*0.252*
	Total of employees	795.7	806.0	772.8	786.5	794.7	791.8
	share	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*

Source: Statistical Yearbook 1996 (Statistical Office, 1996)
Unit: Persons in '000, and the share in ratio

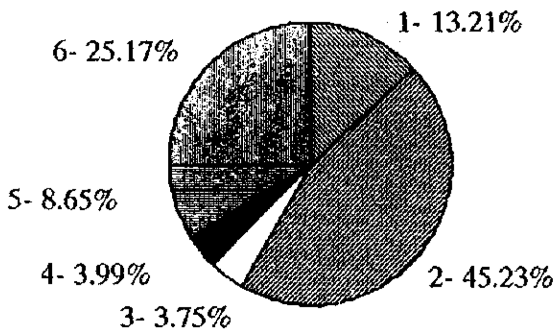


Fig. 1-2-3 Employment by Sector, 1996

1-2-3 Other Characteristics

(1) Petrol fuel

All petrol fuels are imported, mostly from Russia since there is no production sites nor refinery in the country. They are used not only by vehicles on roads but also other manufacturing activities, except power plants which depend on coal produced domestically.

(2) Coal

Abundant coal mine resources are identified in the country which can produce most of the necessary amount for power plants, heating and other consummations. But, it has difficulty in finding markets in neighbouring countries because of quality, cost, transport, and so on. A master plan study of the coal industry development was conducted in 1995 by JICA in which main development target mines are designated at Baganour and Shevee-ovoo, both use the railways for transport to major urban centers. It is agreed by OECF Japan to loan a fund to rehabilitate the Baganour Mine in 1997. In other parts of the country away from the railway corridor, a number of small scale coal mines supply coal to the consumption centers using truck vehicles and animal carts for transport. The total production was 4.9 million tons in 1995. The production forecast of the master plan together with the estimated increasing volume of transport by railways are discussed in Chapter 5.

(3) Export

Major export items are copper from Erdenet, fluorite mine from Bolondor and product of livestock such as hide skin, wool, meet, etc. Traditional market was in Russia and East Europe. The mineral products cannot expect larger demand increases in those countries since no long term planning of those development are found in Russia and CIS (Commonwealth of independent states), traditional customers in the export market. The international market of copper is well known of its fluctuation of prices and demand, resulting in difficulty in having a development strategy for the mine, which is in joint ownership of Russia and Mongolia. Other mineral products including gold and molybudenite are in Mongolia, but less influential in export and GDP composition..

(4) Development Plan

The government is said to show a new economic development plan some time in 1996, but no publication of numerical target figures are made during the year. It is said the government have stressed among others qualitatively the need of development of new manufacturing sub-sectors for export and innovate tourism facilities. Expected sub-sectors to be developed newly are electronics related manufacturings as can be seen in Asean countries and tourism to attract foreign visitors. Emphasis are seen in garment and wool-textile industries, meat processing and others having local facilities and competitive potential in international market.

1-2-4 Data Handling

In this report discussions of statistical data in the Master Plan Study are presented as they were in Interim Report of March 1997. Newly collected data for1996 in the Feasibility Study stage after March 1997 are added to the tables and figures edited in the master plan study stage. But, comments on those added data are discussed in Chapter 20 since general trend of recovery after 1993/94 continues again in 1996 and found not necessary to revise the content of the Master Plan.

CHAPTER 2

TRANSPORT SECTOR

Chapter 2
Transport Sector

2-1 Transport System

2-1-1 Main Modes

(1) Modes

The nation-wide transport modes are composed of railways, roads and airlines. The networks are in Fig. 2-1-1, where the main railway line is located in the corridor north to south in the central part of the country with several minor branch lines. International movements of trains are made in north through Sukhe-baatar- to Russia and in south through Zamym-uud to China. The eastern line of the railway system between Ereentsab and Bayan-tumen is separated from the main line, while occasional train movements to/from the main line are realized through railways within Russia. Roads are located to reach every part of the country with earth/gravel roads, in which no railway services are extended. Civil aviation network covers key local cities to Ulaan-baatar with modest frequency by small planes. Regular international flights are operated through Byant Ukhaa airport in Ulaan-baatar.

(2) Administration

1) Mongolian Railways

The Mongolian Railways (MR) is the national corporation under the administration of Ministry of Infrastructure Development (MID). It is owned jointly with Russia. The Mongolian Railways' organization, staff, operation, etc. are described in Chapter 6, while financial matters are discussed in Chapter 13.

2) Roads

Roads are classified into a. national roads which are in the jurisdiction of Department of Roads, MID, and b. provincial roads which are under Aimag (Province) organization. Periodic traffic counting system has not yet developed in the country. Traffic rules, mechanical safety check of vehicles and vehicle registration are by Aimag Traffic Police. Main national roads are in Fig. 1-2-1.

3) Airlines

Civil Aviation Authority (CAA) is in charge of airports, flight operation and safety regulations. Recently small privatized airline companies have entered in domestic services, although service volumes are modest. MIAT is the national flag carrier owned by the government. Beside its domestic service between Ulaan-baatar and local airports, MIAT has regular international routes extending to Moscow, Beijing, Seoul, Kansai, Irkutsk, etc. Main local airports, which have no hard surfaced runway yet, are linked to Ulaan-baatar by small plane flight in regular schedule. These airports are marked in Fig. 1-2-1.

2-2 Transport Demand

2-2-1 Changes in Demand by Mode

The economy has suffered chaos and reduction in activities through restructuring from the socialist planning method to a liberalized market mechanism during the early part of the 1990s together simultaneous encouragement of privatization. Substantial reduction of the economic production were seen in those years as presented in Chapter 1. Generated by the reduction of economic activities, transport demand had decreased simultaneously. The summary of those changes are in Table 2-2-1.

Passenger turn over volumes were 2.1 bln pass-km in 1989 which came down at 1.4 bln in 1995. Domestic passengers alone had a tendency of small increase in this period from 0.58 bln pass-km to 0.68 in 1995. Cargo volumes in ton-km was high at 8.1 bln in 1989 but dropped to 2.4 bln ton-km in 1995. In general, there were small increases in volumes in 1993 thru 1995 which can be expectable to be an indication of continued recovery under the economy of market mechanism.

(1) Mongolian Railways

1) Lines

Operation lines of the railways has not expanded nor reduced in those years.

East line with branches	249 km
Main line with branches	1566 km
Total	1815 km

Fares are revised a few times in the past in order to respond price escalation. The latest revision was September,1996.

2) Trains

Train operations are studied in Chapter 6. Passenger trains have a time schedule and operation is punctual in general, while cargo trains have no determined time schedule of operation. They move in response to the transport demands. Majority of cargo trains are engaged in coal transport to Ulaan-baatar, Darken and Erdenet.

Table 2-2-1 Changes in Transport Demand by Mode, 1985 – 96

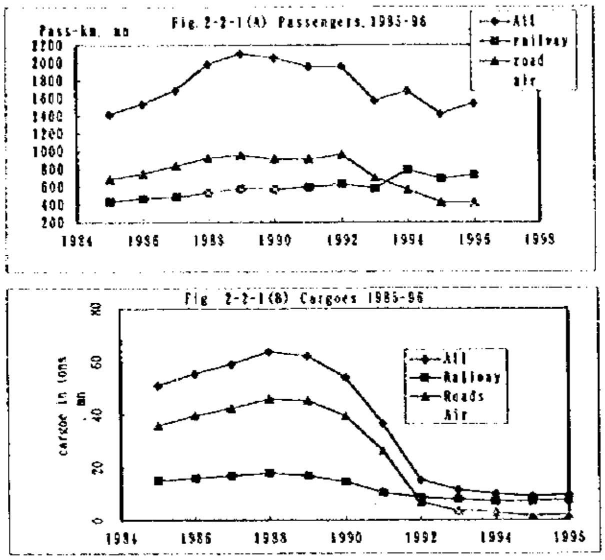
A. passenger-km and ton -km

Year	Pass turnover, mn pass-km								Freight turnover, mn ton-km							
	All	(%)	Railway	(%)	Road	(%)	Air	(%)	All	(%)	Railway	(%)	Roads	(%)	Air	(%)
1985	1418.5	(100%)	435.8	(30.7%)	688.2	(48.5%)	294.5	(20.8%)	7905.4	(100%)	5959.6	(75.4%)	1934.3	(24.5%)	6.5	(0.1%)
1986	1536.5	(100%)	467.1	(30.4%)	747.1	(48.6%)	322.3	(21.0%)	8390.9	(100%)	6333.4	(75.5%)	2046.1	(24.4%)	7.1	(0.1%)
1987	1692.8	(100%)	486.5	(28.7%)	838.6	(49.5%)	367.7	(21.7%)	8292.3	(100%)	6179.9	(74.5%)	2099.1	(25.3%)	8.1	(0.1%)
1988	1986.8	(100%)	531.0	(26.7%)	923.4	(46.5%)	532.4	(26.8%)	8418.8	(100%)	6241.1	(74.1%)	2162.2	(25.7%)	10.6	(0.1%)
1989	2102.9	(100%)	578.6	(27.5%)	957.0	(45.5%)	567.3	(27.0%)	8068.9	(100%)	5956.1	(73.8%)	2097.9	(26.0%)	9.9	(0.1%)
1990	2056.1	(100%)	570.1	(27.7%)	914.6	(44.5%)	571.4	(27.8%)	6971.6	(100%)	5087.8	(73.0%)	1870.9	(26.8%)	8.0	(0.1%)
1991	1958.1	(100%)	596.3	(30.5%)	913.4	(46.6%)	448.4	(22.9%)	4380.9	(100%)	3012.6	(68.8%)	1362.5	(31.1%)	4.1	(0.1%)
1992	1956.5	(100%)	629.5	(32.2%)	963.0	(49.2%)	364.0	(18.6%)	3320.9	(100%)	2756.4	(83.0%)	559.1	(16.8%)	5.4	(0.2%)
1993	1572.7	(100%)	582.5	(37.0%)	700.6	(44.5%)	289.6	(18.4%)	2805.2	(100%)	2531.0	(90.2%)	268.4	(9.6%)	5.8	(0.2%)
1994	1676.8	(100%)	789.6	(47.1%)	567.7	(33.9%)	319.5	(19.1%)	2283.3	(100%)	2131.7	(93.4%)	146.7	(6.4%)	4.9	(0.2%)
1995	1424.2	(100%)	689.7	(48.4%)	424.3	(29.8%)	320.2	(22.5%)	2444.4	(100%)	2281.0	(93.3%)	152.9	(6.3%)	4.5	(0.2%)
1996 *	1552.2	(100%)	744.5	(48.0%)	425.1	(27.4%)	382.6	(24.6%)	2696.7	(100%)	2540.0	(94.2%)	152.4	(5.7%)	4.3	(0.2%)

B. passengers and tons

Year	Passenger turnover, mn passengers								Freight turnover, mn tons							
	All	(%)	Railway	(%)	Road	(%)	Air	(%)	All	(%)	Railway	(%)	Roads	(%)	Air	(%)
1985	171.2	(100%)	2.1	(1.2%)	168.5	(98.4%)	0.6	(0.4%)	51.0	(100%)	15.0	(29.4%)	35.9	(70.4%)	0.0	(0.0%)
1986	187.6	(100%)	2.4	(1.3%)	184.5	(98.3%)	0.7	(0.4%)	55.4	(100%)	15.9	(28.7%)	39.5	(71.3%)	0.0	(0.0%)
1987	211.5	(100%)	2.5	(1.2%)	208.3	(98.5%)	0.7	(0.3%)	59.1	(100%)	16.8	(28.4%)	42.3	(71.6%)	0.0	(0.0%)
1988	234.5	(100%)	2.6	(1.1%)	231.1	(98.6%)	0.8	(0.3%)	63.7	(100%)	17.9	(28.1%)	45.8	(71.9%)	0.0	(0.0%)
1989	242.2	(100%)	2.7	(1.1%)	238.7	(98.6%)	0.8	(0.3%)	62.0	(100%)	16.8	(27.1%)	45.1	(72.7%)	0.0	(0.0%)
1990	232.2	(100%)	2.6	(1.1%)	228.8	(98.5%)	0.8	(0.3%)	54.0	(100%)	14.5	(26.9%)	39.4	(73.0%)	0.0	(0.0%)
1991	234.4	(100%)	2.5	(1.1%)	231.3	(98.7%)	0.6	(0.3%)	36.5	(100%)	10.3	(28.2%)	26.2	(71.8%)	0.0	(0.0%)
1992	252.2	(100%)	2.6	(1.0%)	249.3	(98.9%)	0.3	(0.1%)	15.2	(100%)	8.5	(55.9%)	6.7	(44.1%)	0.0	(0.0%)
1993	191.8	(100%)	2.3	(1.2%)	189.3	(98.7%)	0.2	(0.1%)	11.4	(100%)	7.9	(69.3%)	3.5	(30.7%)	0.0	(0.0%)
1994	146.8	(100%)	2.9	(2.0%)	143.7	(97.9%)	0.2	(0.1%)	9.9	(100%)	7.1	(71.7%)	2.8	(28.3%)	0.0	(0.0%)
1995	110.3	(100%)	2.9	(2.6%)	107.2	(97.2%)	0.2	(0.2%)	8.9	(100%)	7.3	(82.0%)	1.6	(18.0%)	0.0	(0.0%)
1996	109.1	(100%)	3.0	(2.7%)	105.9	(97.1%)	0.2	(0.2%)	9.5	(100%)	7.5	(79.0%)	2.0	(21.0%)	0.0	(0.0%)

Source: Statistical Yearbook, 1996 (SOM, 1997) *By statistical data of MR, 1997



Cargo ton-km (%)

Passenger-km (%)

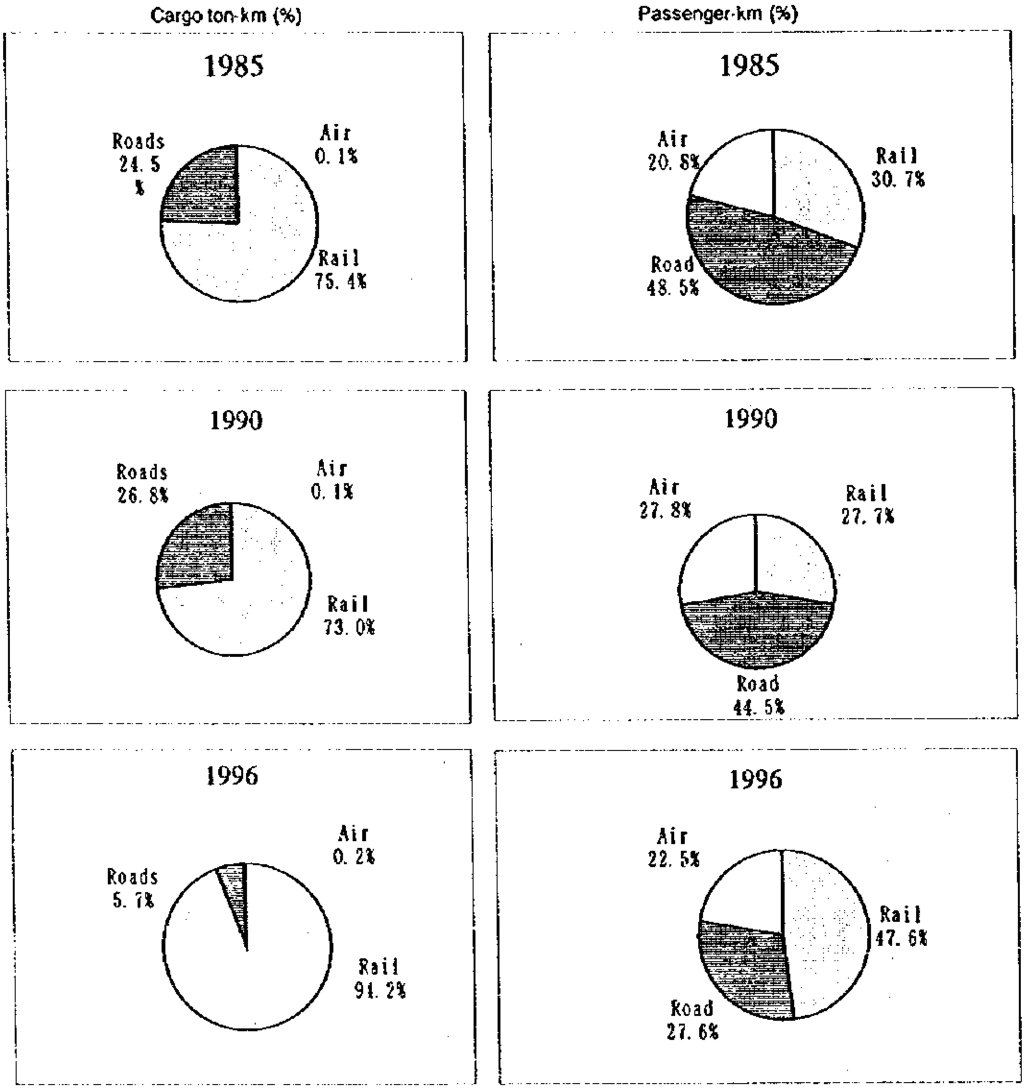


Fig. 2-2-1 Demand of Transport by Main Mode, 1985-96

3) Demand

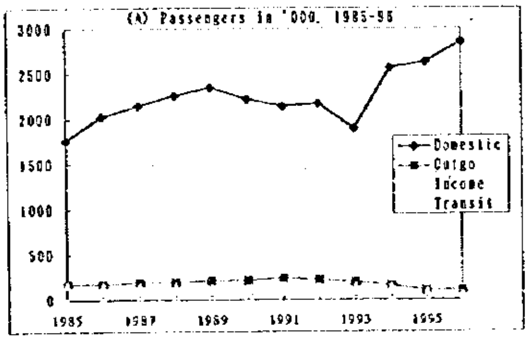
-1.Passengers

International movements decreased by 50 % from 1990 to 1995, while domestic movements increased by 47 % in the same period in terms of pass-km. It is said the main reason was the deterioration of bus service by public corporation; while there were commencement of private operators, collection of statistical data of services performed by them was not organized well. Table 2-2-2 shows those changes. Domestic movements of passengers became 88 % approximately in 1995 of the total pass-km on railways, while they were 70% in 1985.

Table 2-2-2 Passengers on Railways, 1985-96

	Passengers in 1,000 persons						Passengers in mn pas-km					
Year	Domestic	Outgo	Income	Transit	Tot Int.	Total	Domestic	Outgo	Income	Transit	Tot Int.	Total
1985	1762.7	171.8	160.6	9.2	341.6	2104.3	304.8	62.5	58.3	10.2	131.0	435.8
1986	2027.0	176.0	146.7	12.3	335.0	2362.0	337.7	63.8	51.9	13.7	129.4	467.1
1987	2144.2	192.9	148.3	16.9	358.1	2502.3	345.2	73.7	52.1	15.5	141.3	486.5
1988	2262.2	190.6	144.9	20.9	356.4	2618.6	379.5	70.7	54.2	26.6	151.5	531.0
1989	2349.0	207.7	138.5	21.3	367.5	2716.5	422.9	78.7	51.7	24.3	154.7	577.6
1990	2219.8	211.7	132.1	26.6	370.4	2590.2	407.9	83.5	49.1	29.5	162.1	570.0
1991	2141.3	237.0	116.9	41.1	395.0	2536.3	409.1	96.4	45.3	45.5	187.2	596.3
1992	2170.0	217.9	147.3	35.8	401.0	2571.0	447.0	94.2	55.1	39.9	189.2	636.2
1993	1893.4	195.1	139.8	20.7	355.6	2249.0	427.6	85.3	46.8	23.0	155.1	582.7
1994	2567.7	156.5	145.0	15.7	317.2	2884.9	659.1	58.5	53.8	17.4	129.7	788.8
1995	2634.3	100.5	84.2	8.5	193.2	2827.5	601.4	46.0	24.2	9.4	79.6	681.0
1996	2852.6	105.1	47.5	5.8	158.4	3011.0	665.3	52.3	20.5	6.4	79.2	744.5

source: Mongolian Railway, 1997



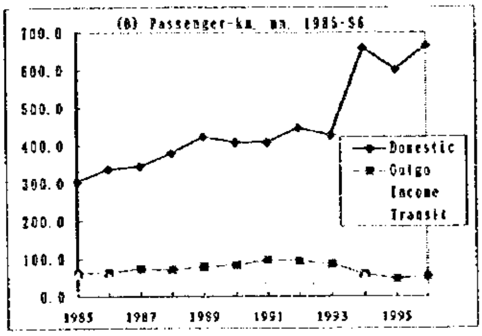


Fig. 2-2-2 Passengers on Railways, 1985-96

-2.Cargoes

Cargo movement in ton-km and tons on railways 1985 - 1995 are shown in Table 2-2-3 where transport volumes are found decreased from 1990 to 1993 or 1994, and a recovery in 1995. Transit cargo showed the largest reduction and no recovery in 1995. One reason is train operation policies of China and Russia which encourage to run on their own rail sections as much, resulting in the savings in foreign currency payment for the use of railways to Mongolia. However, their savings mean the revenue reduction of foreign currency in MR. It is hard to confirm a stable tendency in the future since the decision is not in MR, but in those two foreign railway operators. Changes of transport of particular cargo items are in Table 2-2-3 in which domestic coal movement had modest changes in the years 1990- 95, a fact of stable consumption in urban energies. The similar stable tendency is found in copper export caused by a constant demand of factories in Russia.

Table 2-2-3 Main Cargo Movement on Railways, 1985-96

Year	Copper ton-km	Export ~Min. mn tkm	Import Fuel mn tkm	Dom Coal mn tkm (mn ton-km)	Others mn tkm	Total mn tkm	Copper t000	Export ~Min. t000	Import Fuel t000	Dom Coal t000 (10^3 tons)	Others t000	Total in tons '000
1985	129	637	422	870	4,540	5,960	408	1,192	1,161	4,047	9, 121	15, 929
1986	125	481	395	914	4,900	6,333	398	969	1,081	4,533	9, 771	16, 752
1987	126	457	410	1,005	4,640	6,180	399	936	1,149	5,023	10, 343	17, 850
1988	128	566	426	1,073	4,614	6,241	407	1,061	1,174	5,342	9, 916	17, 900
1989	136	612	357	1,138	4,325	5,956	432	1,118	1,034	5,074	9, 202	16, 860
1990	148	593	270	1,132	3,539	5,088	465	1,097	817	4,830	7, 308	14, 517
1991	125	369	222	1,195	1,471	3,013	344	701	634	4,910	3, 681	10, 270
1992	162	379	154	1,100	1,341	2,756	380	660	428	4,698	2, 352	8. 518
1993	172	286	179	1,107	1,073	2,531	452	622	461	4,541	1, 806	7, 882
1994	223	303	111	1,000	798	2,132	459	561	320	4,330	1, 398	7, 068
1995	229	312	144	1,011	588	2,284	455	584	393	4,351	1, 542	7, 325
1996	254	350	141	980	815	2,540	466	466	371	4,366	1, 789	7, 458

Source Mongorian Railway, 1997

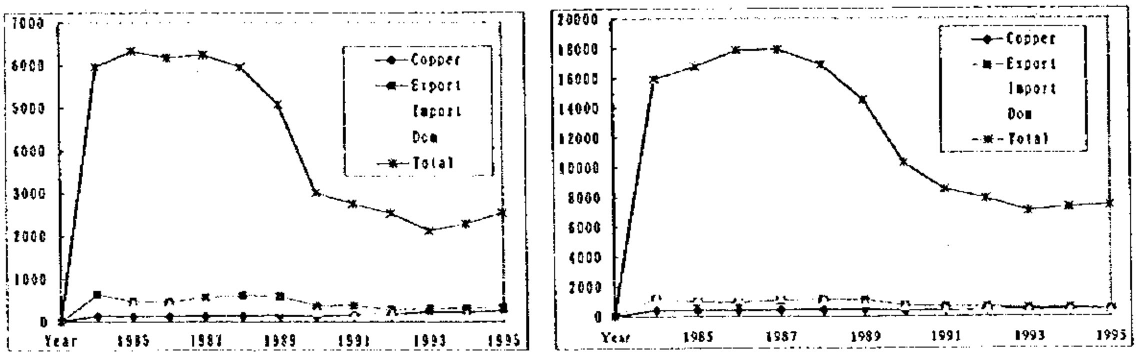


Fig. 2-2-3 Main Cargo Movement on Railways, 1985-96

AP. Table 2-2-4 shows the volumes of categorized cargo service in 1995. Of the total mn ton-km of 2,284 on railways, domestic movements shared 56 % in which coal transport was in majority of 80 %. The coal is the energy source of power plant and hot water all through the year, and heating in winter season and the priority has been given in production and transport.

-3.Modal Service and Competition

Table 2-2-1 shows percent shares among the modes. The percent share of the railways have increased in the data of passenger-km and cargo ton-km in the past 10 years. Percentages of the modes in selected years are again shown below:

	Passenger-km (%)				**Cargo ton-km (%)**			
	All	**Rail**	**Rd**	**Air**	**All**	**Rail**	**Rd**	**Air**
1985	100	31	49	20	100	75	25	0
1989	100	28	46	26	100	74	26	0
1995	100	48	30	22	100	94	6	0

In the case of changes in passenger-km two factors have influenced: one is the reduced demand caused by decreased economic activities under the restructured economy and the other is the leakage in data filing caused by private vehicle operation in road transport. In the case of cargo ton-km, transport of coal product to major urban areas and export/import beyond the border shows the strong dependency on railways. Thus percentages of MR increased during those years. Reduction of percentage in transport of cargo on roads would be mostly caused by the same reasons mentioned in the case of passengers. Data in terms of passengers in number and cargo in tons showed the same tendency as stated above, although percent share were different.

Spatial distribution of transport network is shown in Fig. 2-2-4, where air service network can be excluded for the discussion of modal competition since the service volume is modest and has no modal competition with the railways. An overall relationship between roads and railways can be identified in the following classifications.

Land Transport Network

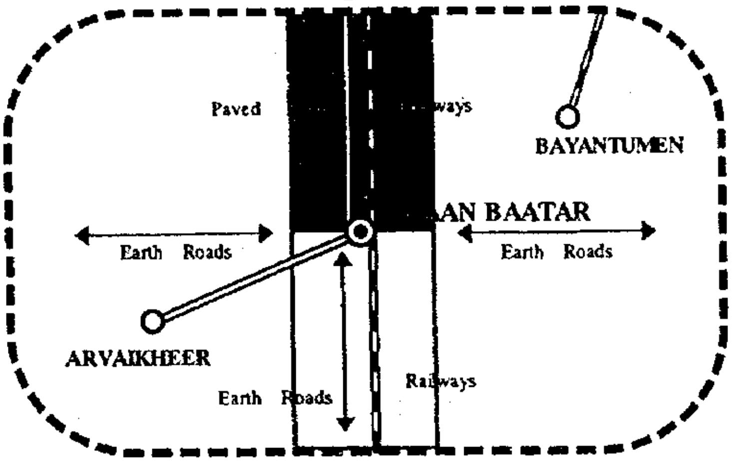


Fig. 2-2-4 Spatial Distribution of Modal Service

1.Railways: Services are in the limited corridors (not covering the whole country) and engaged in monopolistic service of international service for passengers and cargoes. See AP Table 2-2-4 for classified volumes in 1995. In the total of the country, railways carried 62% of pass-km of the land transport and 94% of ton-km of cargo.

2.Roads: The network covers the whole country

3.Notes:

- The influence area of railways is named the railway corridor which can be divided into two parts: the south and the north. In the southern part only the railways provide services punctually from Ulaan-baatar to Zamyn-uud (China border) of 600 km without competing roads since roads are earth surfaced in rough conditions and hard to travel through the whole sections throughout the year. Vehicles run only for short distances on earth roads.

-The northern corridor 350 km by roads from Ulaan-baatar to Altanbrag (the Russian border) has railways and paved roads in parallel. They can compete in services for cargoes and passengers, respectively. But, it is noted there had been competition-constraint-policies of the government resulting in the use of railways advantageous. The policies were:

  -Lower fares of cargo transport of railways than roads. Discussions of the comparison are in Chapter 5.

  Buses are running only between Darkhan and Ulaan-baatar two round trips per day. Traveling to Russian border have to be by train. Three passenger trains are in operation per day from Ulaan-baatar to Sukhe-baatar. Those rules are to give MR advantages of operation. But the situation is changing now; private buses are increasing on roads.

-Use of private vehicles including trucks in the future can be expected to grow since increases in the vehicle ownership by private sector is a world-wide trend. Already Mongolia has shown an increasing tendency through years 1987 to 1996, being shown in AP Table 2-2-1. Use of private buses are eventually seen often in mixed loading with cargo. No regulation nor control by MID and traffic police are seen for this matter. Partly it will open the way toward service competition with the railways though difficulty remains in gathering data of operation.

- In summary it can be said the network pattern in Mongolia indicates rather supplemental relationship among the modes and competitive aspects among the modes are quite modest.

(2) Roads

1) Roads

Roads are classified in Table 2-2-4. DOR is in charge of maintenance and improvements of 11,000 km of designated national roads. The paved sections are 11 % of the total 11,000 km; They are from Ulaan-baatar to Altanbrag (Russian Border, 350 km) and Ulaan-baatar to Arvayheer (400 km) and others in short distance sections.

Table 2-2-4 Road Classification and Length in km, 1996

(km)

	Paved	Gravel	Unsurfaced	Total
National Roads	1,351 (92%)	1,621 (49%)	8,510 (19%)	11,482 (23%)
Local Roads	120 (8%)	1,704 (51%)	36,360 (81%)	38,184 (77%)
Total	1,471 (100%)	3,325 (100%)	44,870 (100%)	49,666 (100%)

Source: Road Master Plan (ICT & SWK, 1993)
Updated to 1996 by using Statistical Yearbook, 1997

2) Demand

No annual regular traffic counts have been conducted on those national roads in the past. Once in 1993, Road Master Plan Study was conducted by ICT and Scott WK in which vehicle traffic per day of most sections in 1993 are presented. The overall weighted averaged volume per km is calculated as under in vpd of 1993.

	Truck	Others	Total
Average Vehicles per day (1993) over 11,400 km	65	24	89

Registered vehicles in Traffic Police showed a steady increase from 41,400 in 1987 to 101,400 in 1996, the annual rate of increase at 10 %. They are in AP Table 2-2-1.

In this study, road traffic counting was conducted in August 1996 on the five locations on the paved road between Ulaan-baatar and Altanbrag of 350 km. After monthly adjustment in 1996, the traffic volume is compared as under, which would have an annual rate of increase at 8 % per annum in 3 years, a larger rate than railway transport volumes. The road traffic counting data in this study are summarized in AP Table 2-2-3.

	vpd 93	vpd 96
Ulaan-baatar - Altanbrag	417	528

3) Changes in Traffic on Roads

Table 2-2-5 shows changes of transport volumes on roads of the country 1985 - 1995. The volume decreased from 2,098 (1989) to 147 (1994) in ton-km and 957 (1989) to 424 (1995) in pass-km, which are caused by the destruction of the economy being stated in Chapter 1.

Table 2-2-5 Transport Volumes on Road, 1985-96

Year	Cargoe		Passengers	
	mn ton-km	mn tons	mn pas-km	mn passengers
1985	1934.3	35.9	688.2	168.5
1986	2046.1	39.5	747.1	184.5
1987	2099.1	42.3	838.6	208.3
1988	2162.2	45.8	923.4	231.1
1989	2097.9	45.1	957.0	238.7
1990	1870.9	39.4	914.6	228.8
1991	1362.5	26.2	913.4	231.3
1992	559.1	6.7	963.0	249.3
1993	268.4	3.5	700.6	189.3
1994	146.7	2.8	567.7	143.7
1995	152.9	1.6	424.3	107.2
1996	152.4	2.0	425.1	105.9

Source: Statistical Yearbook 1996 (SOM, 1997)

(3) Civil Aviation

1) Airports

Civil Aviation Authority (CAA) is in charge of airports in the country, supervising the safety of planes, management of safety flights in the air. Local airports are marked in Fig. 1-2-1. Only the runway at Ulaan-baatar is surfaced. Ap. Table 2-2-2 shows local airports each with length of runway and trips per week.

2) Carriers

Airlines are partly privatized. MIAT is the national flag carrier of the Mongolian government and has participated in the regular domestic flight schedule. Minor new private companies have their flights mostly in chartered and non-regular. Names of the company and planes owned are also in Ap. Table 2-2-2.

3) Changes in Demand, 1985 - 1996

Traffic on the civil airlines are quite modest. They are in Table 2-2-6. Cargoes and passengers decreased in to 1995. Post material are 1.3 % alone in tons of cargo, and international passengers shared 35 % of passengers in 1995, being shown in Tables 2-2-1 and 2-2-2.

Table 2-2-6 Transport Volumes on Air Lines, 1985-96

Year	Cargoe		Passengers	
	mn ton-km	in tons	mn pas-km	in '000 pass
1985	6.5		294.5	
1986	7.1		322.3	
1987	8.1		367.7	
1988	10.6		532.4	
1989	9.9	13,119	567.3	817.7
1990	8	10,913	571.4	825.7
1991	4.1	4,399	448.4	615.7
1992	5.4	3,123	364	329.4
1993	5.8	2,854	289.6	202.9
1994	4.9	2,794	319.5	228.2
1995	4.5	2,676	320.2	225.2
1996	4.3	2,700	382.6	222.0

Source: State Statistical Yearbook 1966 (SOM, 1997)

The volumes carried by civil airlines are modest since there are constraint factors as under:

- Demand is small because of dispersed local economic activities and population
- Demand by tourism and others may have potential to grow in the future. However, they have constraint as stated in the followings
- Wind, and cold weather in winter are not favorable for safely flight by small planes used in domestic lines. Flights are often canceled/postponed because of those unfavorable natural reasons. Tourists come mostly in summer months of June - August.
- Airports, roads, hotels, restaurants, and other facilities including transport systems need be improved to accept international visitors in local cities.

2-2-2 Recent Improvement Projects of Transport Sector

Improvement projects in the transport sector are in Table 2-2-7. All projects have utilized foreign assistance funds. However, five or ten year programs are yet consolidated since the overall national development plan is not announced.

Table 2-2-7 Recent Improvement Projects in Transport Sector

Road Projects

	Tittle	Component	Cost	Funds	Status	Finish Yr.
1	RoadMaster Plan & Feasibikity Study	Study	$0.625 mn	ADB	Completed	1994
2	Detailed Engineering Nalaih - Mannit	Study	↑	ADB	Ongoing	1996
3	Rehabilitation & Repair Ulan Baatar (km19) - Altanbulag	Works	$25 mn	ADB	Soon	1999
4	Construction of 2 Bridges on Dalkhan - Eldenet Rd	Works	↓	ADB	Soon	1999
5	Road Improvement Using Rock Asphalt Nalaih - Baganour Road					
	* Rehabilitation 17.8km, Pilot work 13.3 km		Grant	JICA	Ongoing	1997
	* Remaining 56 km		-	Dept. Rd.	Own fund	-
6	Dalkhan - Eldenet, 180km	D.D & Works	$24.2 mn	Kuwait F.	In negotiation	-
7	Maintenance System of Paved Road	System	$2.7 mn	IDA	Ongoing	1997

Souce: Road Department, August, 1997

Railways

	Tittle	Component	Cost	Funds	Status	Finish Yr.
1	Railway Rehabilitation (METS) loco overhaul, etc	Works	$5.00 mn	IDA	Completed	1994
2	Zaminwud Transfer facility Construction	works	Grant	JICA	Completed	1995
3	Transport Capacity Reinforcement (new rails, Tel exchange, loco & rolling stock,workshop Eqip.	works	Yen 8074 mn	OECFj	Ongoing	1998
4	Rehabilitation (loco-overhaul,spairparts)	works	$10.20	IDA	Ongoing	1997

Source: Mongolian Railway, 1997

Civil Aviation

	Tittle	Component	Cost	Funds	Status	Finish Yr.
1	Safety Master Plan Tech. assist. and Inst. Stlengthen		$0.85 mn	ADB	Finished	1995
2	Airport Upgrading: UB Buyant Ukhaa Airport	Works	$36.0 mn	ADB	Ongoing	1996
3	NavigationDevelopment Strthen Navi. system, etc.	Works	$32.5 mn	ADB	Start soon	1999

Source: civil Aviation Authority, 1997

CHAPTER 3

EXISTING CONDITION OF RAILWAY NATURAL DISASTER AND RAILWAY STRUCTURE

Chapter 3
Existing Conditions of Railway Natural Disaster and Railway Structure

3 - 1 Railway Natural Disaster

Past railway natural disasters at project site are shown in Table 3-1-1. Railway natural disasters in Mongolia are flood disaster, falling rocks from natural slope, and track bump by freezing of embankment. However most of natural disasters listed in Table 3-1-1 are flood disasters. Because no big trouble has been occurred by falling rocks from natural slope and track bumpy by freezing of foundation with routine careful inspection.

(1) Flood disaster

A lot of railway bridges and embankment are washed away by flood. There are 3 patterns of flood disaster on railway in Mongolia.

a) Embankment on back of abut, piers, and bridges are washed out by large river flooding.

b) Small river is flooded at waterway of embankment and the embankment is washed away.

c) The embankment is eroded by large river's meander.

(2) Falling rocks

Railway operation is sometimes obstructed by falling rocks because the railway is constructed as threading its way through mountains and some rock slope is hanging over the railway. There are some possibility of derailment by train running on the rocks which diameter is about 1m.

(3) Track bump by freezing of embankment

Track bump is occurred by freezing of embankment on the damp ground in the winter. At the result 10mm/day dump and 40 - 50 dump/year are occurred and it urges train to drive slowly.

Table 3-1-1 Large Railway Natural Disasters in the Past

No.	Location			Year/Month	Train Stop Period	Rehbilitation Cost (Mil. Tg.)	Outline of the Disaster
	Section	Kilom.	Picket				
1	UB - Choir	413	1	1971.6	51.5 hours	200	Piers at east side of Ulaanbaatar were washed out.
2	Eroo - Orkhon	64	1 - 6	1973.1	11 days	500	Embankment (460m length) at Reoo station was washed out.
3	Sainshand - Zamynuud	915	4	1977.7	2 days	300	Passenger train was crushed due to washing out of embankment at south side of Sainshand by heavy rain.
4	Choir - Sainshand	564 - 587		1978.7	10 days	120	Embankment at 564-587, 4 bridges and curbart were washed out by flood.
5	Emeelt - Tolgoit	384	1	1978.7		2	Piers were washed out by flood.
6	Salhit - Erdenet	130	1	1979.6	15 hours	0.7	Piers were washed out by flood.
7	Salhit - Erdenet	67	3	1979.7	10 hours	1	70m length ballast was washed out by flood.
8	Salhit - Erdenet	98	4 - 6	1980.6	20 hours	2	Ballast was washed out by flood.
9	Salhit - Erdenet	861 - 889		1980.8		20	20 km length embankment was washed out by flood.
10	Sainshand - Zuunbayan		5 - 7	1987.7		0.5	Piers were washed out by flood.
11	Emeelt - Tolgoit	383 - 385		1987.7	15 hours	1.5	Piers were washed out by flood.
12	SB - Baruunharaa	31	6	1987.7	20 hours	2	Railway was submerged by flood.
13	Salhit - Erdenet	32 - 34		1987.7	13 hours	1.5	Piers were washed out by flood.
14	Salhit - Baruunharaa	170		1987.8	15 hours	1.5	Embankment and ballast were washed out by flood.
15	Sainshand - Zuunhara	30	10	1987.8	22 hours	3	Embankment on the back of abut was washed out by flood.
16	Salhit - Erdenet	112 - 115, 123 - 125		1988.7	10 hours	1	Embankment and ballast were washed out by flood.
17	Rashaant - Emeelt	360 - 365		1991.6	15 hours	0.5	
18	Sainshand - Zamynuud	1,014 - 1,015		1992.7	24 hours	2	Railway was submerged by flood and embankment was washed out.
19	Salhit Station			1992.7		0.2	Railway was washed out by flood.
20	Honkhor - Bayan	422, 425, 429, 434, 438		1993.7	20 hours	250	Embankment and curbart were washed out by flood.
21	Choir - Sainshand	865	4	1993.7	14 hours	2	Embankment on the back of abut was washed out by flood.
22	Airag - Bor Undur	52, 57		1994.7	4 days	6.3	Embankment was washed out by flood of Urtyngol.
23	Darkhan - Baruunharaa	195	2	1994.7	1 days	3	Embankment (230m length) was washed out by flood.
24	Salhit - Tsaidam	150	1	1994.8	1 days	60	Embankment was washed out by flood and the train derailed.
25	Salhit - Erdenet	59 - 60		1994.6	22 hours	1	Ballast was washed out by flood.
26	Salhit - Erdenet	114	4	1994.7	19 hours	20	Embankment was washed out by flood of Orkhon.
27	Airag - Borondor	43	4	1995.7	5 hours	0.7	The small river ran over the railway embankment because the capacity of curbart of embankment was not enough.
28	Choir - Sain Shand	675	3	1995.7	5 hours	1.7	The bridge was washed out by heavy rain.
29	Tolgoit Iwilifi			1995.8	-	12	The branch line was washed out.
30	Amgalan - Tuul - Honkhor			1996.6	5 hours	10	The railway facilities at 419km, 431km were washed out by momentaly heavy rain and the flood ran over the railway.
31	Serendalai - Orkhon tuul			1996.6	12 hours	15	The embankment at 57km, 62km, 63km and railway facilities at 57km, 60km were washed out.

3-2 Railway Structure of Each Section

(1) Section Between Northern Border and Zuunharaa (231 km)

The kilometer railway distances of the MR starts counting at a starting point located in Russian territory. The Mongolian-Russian boundary is located at a point 6 km 500 m from the starting point. Between the northern boundary with Russia and Zuunharaa, the Haraa river that flows north and joins with the Ohhon river at the 95 km point. The river joins with the Selenge river west of Sukhe-baatar near point 19 km, increasing the flow of water. Along the right bank of the river, the railway is laid out ascending south. Therefore, the railway line has been affected with erosion caused by the meandering river stream in this section, and with falling rocks from weathered rocky cut slops.

In cut sections at 8pk10, 9pk5, 13pk4, 14pk8, and 17pk6, weathered pieces of rock washed down by rain had been deposited along the sides of the track.

In section 11pk1 to 4, the river curves and comes within only 7 to 20 m of the railway. Since it was feared that train operations could be affected, rocks were cast for the last three years to prevent further erosion. The erosion appears to have been controlled at the present time. (Photo 3-2-1)

In section 16pk1 to 4, the embankment constructed over the valley between rocky mountains is being eroded at a rate of one to two meters a year, but the railway has not been directly affected.

At 18pk1, a large angular rock mass causes ponding along the side of the railway.

In section 18pk10 to 19pk1, where the Selenge and Orhon rivers join, river banks are being eroded by floodwaters, and weathered rocks affect the tracks. (Photo 3-2-2)

In Sukhe-baatar Station, rainwater runoff flowed down adjacent hills into urban areas, and the entire town was affected by the floodwater. All station facilities and employees' quarters were also damaged. An attempt was made to divert the floodwater outside the urban area with flood control embankment constructed at the periphery of the area, but this attempt has not been successful because the embankment were not adequate to control the volume of floodwater.

In section 31pk2 to 4, river banks have been eroding at a rate of 5 to 6 meters a year since the 1970's, and 4,000 m^3 of large stone blocks have been cast . However, the tracks can still be overtopped at times of flooding. The ground is sandy and can be easily eroded. This area is comparatively flat, different from other areas close to the rocky mountains, but it can be expected that erosion will develop further in this area.

In section 36pk1 to 10, river banks had been eroding 2 to 4 meters a year. Because the Russian Army changed the river channel, oxbow lake was formed along the railway. There are little fear of erosion but this lake may become flooded.

In section 51pk9 to 52pk3, approximately 500 m^3 of rock blocks were cast in 1987 but 2 to 4 meters of erosion still occurs every year.

In cut sections of 52pk9, 54pk2, and 61pk9, rock surfaces are being weathered and rainwater washes debris down to the track. (Photo 3-2-3)

In section 54pk4 to 5, river banks are being eroded at a rate of 3 meters a year, and no protection work has been done.

At 55pk9, erosion has been completely controlled by levees that were constructed during the period from 1989 to 1991.

In section 57pk9 to 10, river banks are eroding at a rate of 3 meters a year, and no protection work has been provided.

The Yeroo Bridge, crossing over the Yeroo river in an area close to point 64pk1, was replaced with a new PC beam bridge, 23 m x 10 spans, constructed on a new railway line. A steel beam bridge, 23 m x 6 spans, on the old line has been abandoned in the river area.

In section 67pk4 to 7, the Orhon river meanders sharply, making a hairpin curve and hitting the railway. River banks are being eroded 3 to 5 meters a year. Approximately 500 m^3 of rock blocks were cast , but erosion continues. (Fig.3-2-1)

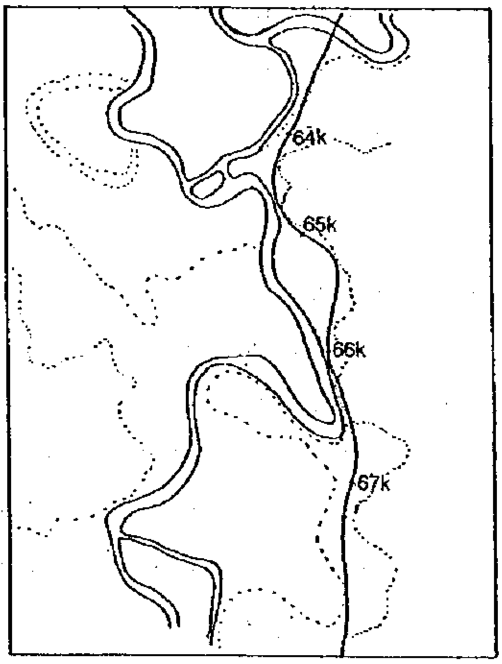


Fig.3-2-1 Meander of Orhon River

In section 88pk4 to 10, river banks have been eroded by the flow of a tributary stream of the Orhon river, and no protection work has been done.

In areas close to the drainage facility at 89pk7, water is retained behind the embankment because the drainage piping is undersized for the amount of runoff flowing from adjacent mountains.

The Haraa river meets the Orhon rivers in the vicinity of point 102 km, but becoming narrow at 85 km, the railway has been affected frequently after heavy rains in section 92 to 96 km, and areas around the railway have been flooded. The underside of the bridge at 93pk1 has been often immersed in floodwaters and trains have been forced to slow down in this area.

In section 170pk1 to 3 and at 195pk1, floodwaters from the mountainside become ponded behind the embankment, and the embankment has been overtopped frequently.

Areas around section 197 km to 199 km have cut slopes on both sides, and ditches have become filled with weathered debris.

In the vicinity of section 208pk1 to 2, the Haraa river curves toward the tracks and river banks are being eroded 2 to 3 meters a year. Nearly 1,000 m^3 of rock blocks were cast prevent the banks from collapsing.

In the vicinity of points 210 km, 218 km and 223pk7, runoff discharged from hillsides became ponded behind the embankment for nearly one month, and road bed ballast washed away.

(2) Section Between Zuunharaa and Ulaan-baatar (402 km)

The railway between Zuunharaa and Ulaan-baatar runs south along the Haraa river. Upstream on the Haraa river, the water flow decreases and damage to river banks by erosion decreases. Since the railway stretches over the watershed, there are stretches with grades of from 12 ‰ to 17 ‰ within the 7 km long section from point 379 km to 386 km, approximately 20 km north of Ulaan-baatar. The hauling capacity of northward trains in this section is reduced to half that of other sections.

On bridges at 235pk3 and 255pk3, cracks were appearing in the slab deck of concrete beams, allowing entry of rainwater into concrete. In addition, the flow capacity of river channel under the bridge appeared to be inadequate.

Bridges at points 245pk5, 285pk1, 289pk1, and 326pk9 received damage to the ends of concrete beams, or in some cases main reinforcing bars have been exposed on lower portions of structural members. (Photo 3-2-4)

Minor cracks were occurring also in the abutments at 255pk8, but it was determined that these might not affect the structural functions of the bridge.

In cut sections at 250pk7 or 251pk10 and of section 282 km to 283 km, rocks fell down from weathered slopes, and at 267pk2 a rock mass projects from the slope surface. It can be presumed that rocks will fall down the slope as weathering develops.

In the vicinity of section 299 km to 300 km, the railway passes, drawing an S-shaped curve between a bridge and the foot of a rocky mountain. In such topography, an S-shaped curve cannot be avoided and it is not considered urgent to modify such curves.

Drainage culverts installed at 313pk10 and 391pk2 have a diameter apparently undersized for the estimated necessary volume of drainage. Floodwater can pond behind the embankment, or can infiltrate into the body of embankment, which tends to wash away fill materials. The river bed downstream from the culvert has been scoured by the flow of water.

The drainage culverts at 314pk10 within the compound of Mandal Station traverse five lines. Therefore, the flow velocity is extremely low and mud is deposited inside the culvert, which clogs the inside. Water can pond behind the embankment at times of flooding.

On the reinforced concrete bridges at 334pk3 and 356pk3, rainwater has penetrated through the waterproof membrane to the concrete beams, dissolving lime compounds. The ends of concrete beams were also damaged and drainage channels were small for necessary estimated volume of drainage. (Photo 3-2-5)

On the reinforced concrete bridge at 338pk10, cracks were occurring because of rusting of main reinforcement bar due to insufficient compaction of concrete during fabrication, and because of voids produced in the body of beams. (Photo 3-2-6)

On the abutments at 342pk2, it was seen that lime compounds were dissolved by water infiltrating through cracks, but the bodies of beams appeared to be sound.

On the concrete bridges at 344pk1 and 356pk2, it was seen that the undersides of beams had been scraped off by vehicles passing through the underside of bridge, exposing the reinforcing bars. It appeared that the concrete surfaces were getting to deteriorate.

Since steam pipes for heating are laid out through the drainage culverts at 394pk4, the culverts appeared to be undersized for the discharge of water. For this reason, this bridge often causes flooding after heavy rains in Ulaan-baatar city. It appears that train traffic is not seriously affected by such flooding, but the flooding causes significant problems for the public.

The bridge at 399pk1 was constructed as the single track new line with a larger bridge, 6.0 m + 16.5 m + 11.5 m. At present only the new line is being used. The river flowing vicinity of the bridge was also widened, except for the portion around the railway, but the old one-span bridge structure is abandoned in the river obstructing the smooth flow of water. This old structure is a bottleneck, and blocks the smooth flow of water at times of flooding. The city of Ulaan-baatar has been flooded because of this obstruction. Since train operations are not directly affected by this obstruction and the railway authority intends to reuse the old bridge as a part of a double track line to be completed in the future, a project for removal of the old bridge and widening of the river has not been planned. (Photo 3-2-7)

In Mongolia, the MR is also responsible for tracks of sidings to the outside exterior walls of industrial factories, and for maintenance of such track. A number of siding tracks are laid out for industrial use in the city of Ulaan-baatar. These railway facilities often become damaged, and cause security problems in various locations. The siding track for delivering coal to the Third Power Generation Plant of Ulaan-baatar is supported by a temporary bridge. This temporary bridge, constructed after the former bridge was swept away during a flood, is made of steel beams on sleeper saddles on the ground, protected by steel sheets. (Photo 3-2-8)

This construction constricts the river channel and blocks the flow of water; besides presenting the possibility of the bridge wash out. It can be presumed that this situation raises various problems for protection of the city of Ulaan-baatar from flooding and for providing electricity.

The side track for the brick masonry factory in the northeast of Tolgoit is out of service at present because the first abutment of the 3 span bridge settled drastically after river bed had been severely scoured by floodwaters in August 1996. (Photo 3-2-9)

The side track located in area downstream from 399pk1 bridge can become a new bottleneck after bridge banks are modified, because the bridge is shorter than the width of river.

(3) Section Between Ulaan-baatar and Bayan (450 km)

The railway south of Ulaan-baatar, constructed after 1952, is newer than that to the north. The highest point of the main line is located at a point 471 km, south of Bayan. As trains are forced to climb steep grades with large differences in elevation, hairpin curves or S-shaped curves are provided. These curves raise operational and maintenance problems. The branch line from Honkhor to Nalaih, where there are coal mines, had been operating with a

750 mm narrow gauge track to Ulaan-baatar until 1956. This line now has a 1,520 mm gauge track, but trains are not being operated because the coal mines in Nalaih are temporarily closed. However, the MR intends to operate this line again in the future.

The bridge at 413pk1 was replaced with the largest steel bridge in Mongolia, 8 x 27 m, after the old bridge was washed away in the flood of 1971.

Since the underground drainage piping within the compound of Tuul Station at 420pk1 has an insufficient water conveyance capacity, water ponds behind the embankment after heavy rains, and soil has been washed away because of infiltration through the embankment. As the flow velocity of water increases, ground surfaces adjacent to the outlet of the drainage has been severely scoured.

On the bridge at 422pk3, the embankment back of the first abutment was washed away but trains are now being operated after the affected area was temporarily backfilled. Vehicles passing under the bridge have scraped off concrete from the underside of beams and reinforcing bars have become exposed.

The railline between Amgalan Station (1,310 m in elevation at point 412 km) to Bayan Station (1,560 m in elevation at point 450 km), constructed on slopes, with continuous curves, and with a grade of nearly 9‰ is a bottleneck, raising operational and maintenance problems. In the section between point 426 km (1,404 m in elevation) and point 436 km (1,468 m in elevation) with Honkhor Station (430 km) on center, there is a difference in elevation of 64 m for 3.4 km in straight distance. Therefore, S-shaped or hairpin curves with grades of nearly 9 ‰ are provided, raising railway maintenance problems. In this section the railway embankment has washed away in heavy rains and trains have often been derailed.


Photo 3-2-1


Photo 3-2-2


Photo 3-2-3


Photo 3-2-4


Photo 3-2-5


Photo 3-2-6


Photo 3-2-7


Photo 3-2-8


Photo 3-2-9

CHAPTER 4

BASIC POLICY OF THE STUDY

Chapter 4
Basic Policy of the Study

The railway between Sukhe-baatar and Bayan, comprising a part of the main line of the Mongolian Railway, the major transportation artery in Mongolia, has often been damaged by natural disasters including floods and collapse of embankments during the rainy season, in addition to incurring structural deterioration. Train operations are often interrupted, and the economy of Mongolia has been greatly affected by such interruptions. Taking into consideration such conditions, this rehabilitation plan is to provide properly improved railway structures to secure a year-around stable railway transportation system for this section of track, and to improve the reliability of the Mongolian Railway.

The basic policy of the study for the rehabilitation of existing railway structures is as stated below.

(1) Harmonized Planning

1) Ensure harmony with the superior plans of Mongolia (national development plan, land utilization plan, etc.).

2) Ensure harmony with the projects the Mongolian Railway is now carrying out (with OECF loan, etc.) or is planning.

(2) Basic Policy in the Technical Aspect

1) For the Master Plan for rehabilitating the entire track structures between Sukhe-baatar and Bayan, set the target year at 2020. As for the Short-term Urgent Project, set the target at 2005.

2) The rehabilitation planning will be developed in a manner to provide durable structures that can withstand the damaging affects of heavy rains during the rainy season, or structures that can be quickly and easily restored if they become damaged.

3) In the planning, put higher priority on measures for ensures for ensuring safe and reliable transport, rather than those for increasing train speed and strengthening transport capacity.

4) The rehabilitation planning will be developed in a manner to assure a step-by-step feasible system at an appropriate investment, taking into consideration the economic strength of Mongolia and the financial condition of the Mongolian Railway. For the

investment, the amount directly necessary for the rehabilitation plan will be earmarked.

5) The rehabilitation planning will be developed in a manner to reduce construction costs, taking into account the improvement of investment efficiency.

6) The rehabilitation planning will be developed in a manner to provide facilities that can be easily maintained in the future, taking into account the skills of workers and technical level of the Mongolian Railway.

7) For all aspects of planning of railway structures, including preliminary design and construction planning, natural conditions and environmental impact will be fully considered.