7. Sediment Analysis

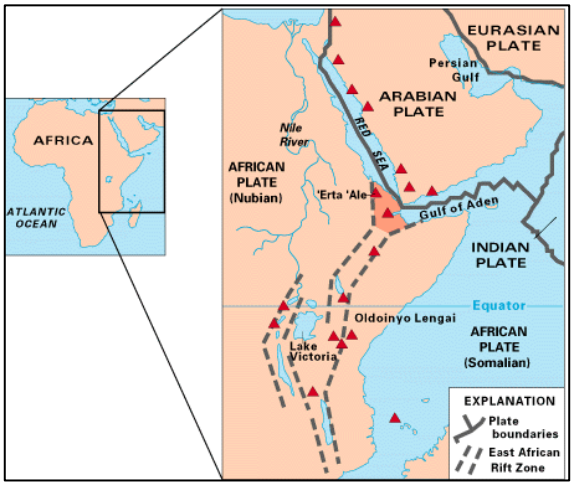
7.1 Natural Conditions

7.1.1 Geology

(1) East African Rift System (EARS)

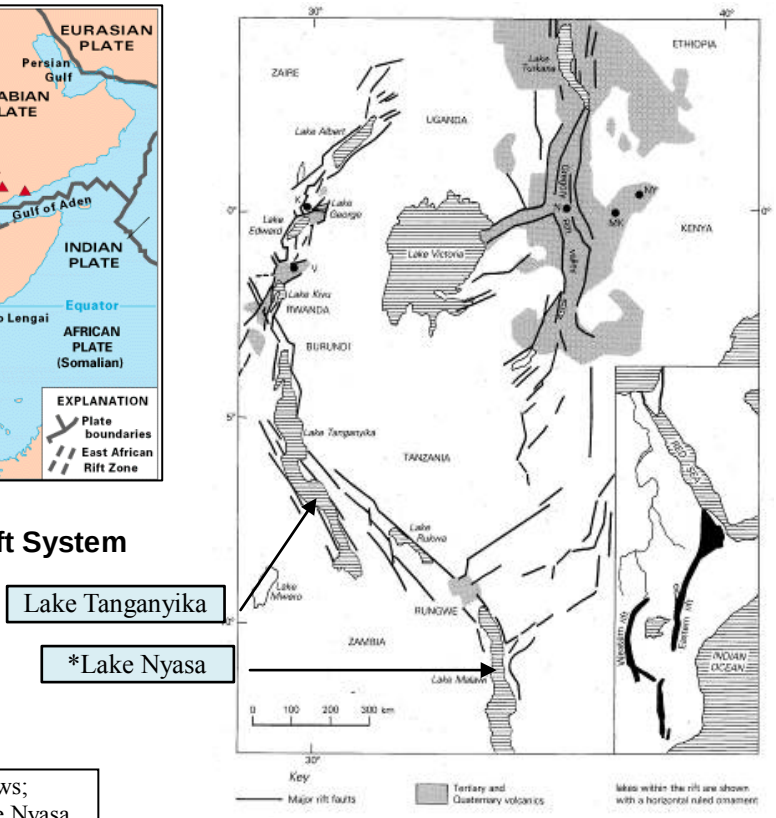
The geological structure of Tanzania is characterized by the Great Rift Valley, of which the African section is known as the East African Rift System (EARS). The East and West Rift Valleys pass across Lake Victoria in the north of Tanzania (Figure 7.1). The East Rift Valley is broken around Lake Turkana in Kenya, which contains an active volcano (Turkana Lake is a crater lake). The East Rift Valley in Tanzania can be clearly recognized on the east side of Lake Victoria, but is less clearly recognized on the south side.

On the other hand, the West Rift Valley can be clearly recognized on the west and south sides of Lake Victoria. Lake Tanganyika and Lake Nyasa are the lakes which are formed in the Rift Valley (Figure 7.2).



Source: USGS

Figure 7.1: East African Rift System



Lake Tanganyika

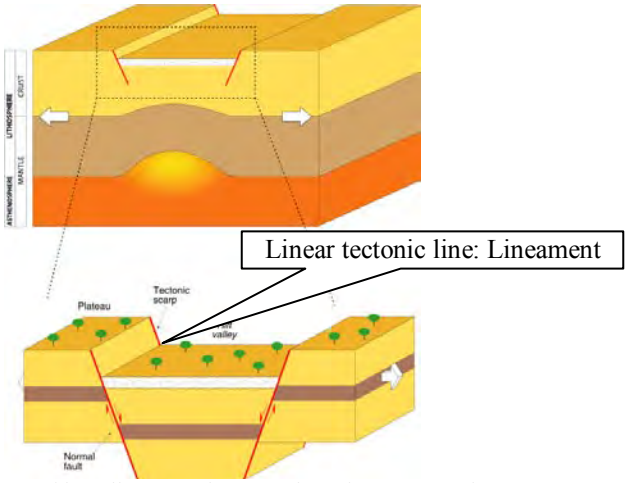
*Lake Nyasa

*Lake Nyasa has two names as follows;
In Tanzania and Mozambique: Lake Nyasa
In Malawi: Lake Malawi

Source: JICA Wami/Ruvu Basin Study Report 2013

Figure 7.2: Great Rift Valley in Tanzania

The Rift Valley has enormous fractures affecting the continental plates that progressively widen over elapsed. The process is related to the divergent movements of lithospheric plates above the underlying asthenosphere, in slow convective motion. Figure 7.3 shows schematic diagrams of the Rift Valley development. The Rift Valley represents the primary and most apparent/ manifested response to this divergence and to the consequent application of tensional forces to the plates, which is manifested through the development of normal faults.



Source: Rift Valley Development by Giacomo Corti; http://ethiopianrift.igg.cnr.it/index.htm

Figure 7.3: Formation of the Rift Valley

(2) Geology

A rift valley has been formed by the divergent (eastward and westward) spreading of two plates, the African Plate and Somalian Plate, by rising magma (Figure 7.3 above). According to a JICA report ("The Study on Water Resources Management and Development in Wami/Ruvu Basin in the United Republic of Tanzania" Final Report November 2013, Chapter 9, page 9-10 to page 9-18), the geology of Tanzania and Wami/Ruvu watershed is described as follows:

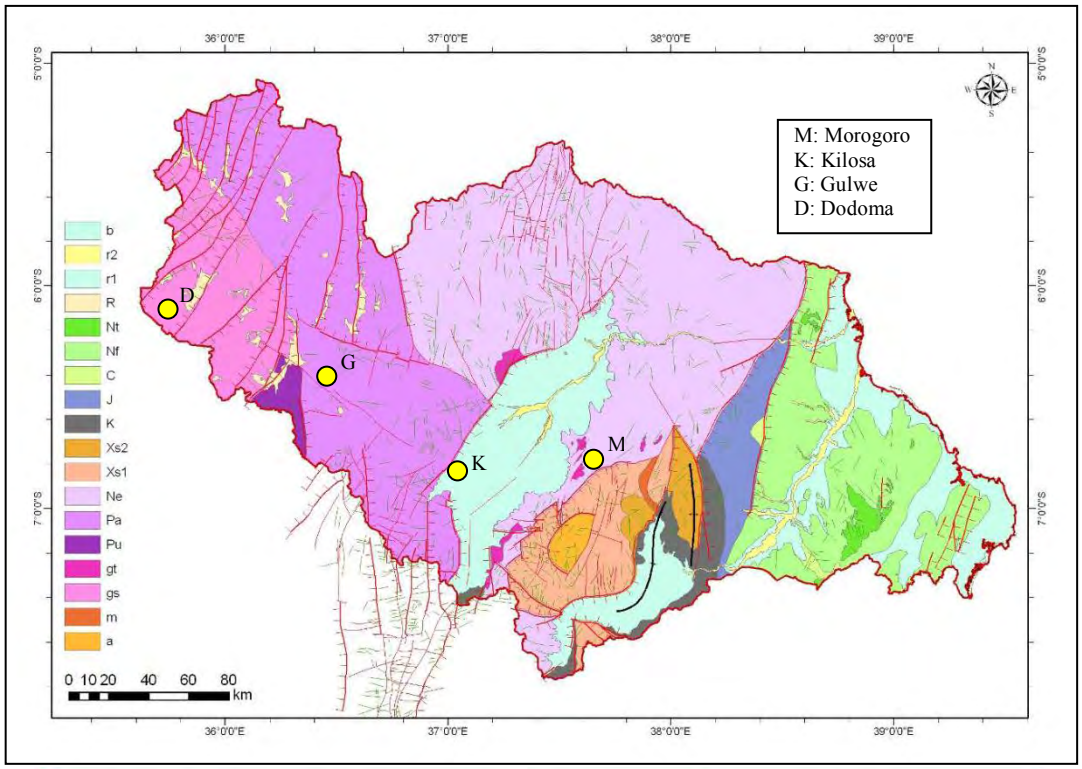
Tanzania is underlain mainly by Archaean and Proterozoic rocks, mostly exhibiting ages of greater than two billion years (>2,000 Ma; 10^6 years). The Archaean rocks date from 2,500 Ma to 2,800 Ma and form the Tanzania Craton, a component of the African Plate, one of the world's largest slabs of continental crust.

The Archaean of Tanzania can be divided into three units: (i) the Dodoman gneisses of central Tanzania, (ii) the Nyanzian granite-greenstone terrain of the north, and (iii) the overlying Kavirondian system of the Lake Victoria region. The Dodoman is regarded by some as equivalent to the Nyanzian, having been subjected to higher degrees of metamorphism, migmatization and digestion. Dodoman gneisses are distributed only in the western part of the Wami/Ruvu basin.

The southeastern part of Tanzania is underlain by the Late Permian to Jurassic Karoo series. This series is prevalent all over southern Africa, reaching its northern-most outcrop in Tanzania. The Upper Mesozoic is represented by limestones, sandstones and shales, with coal, gypsum and salt in the coastal regions, even if in the Wami/Ruvu basin. Cenozoic events saw the incipient dislocation of the African Plate, with rupturing occurring in the West and East African Rift Systems (Figure 7.3).

In Tanzania, the Western Rift is marked by Lakes Nyasa and Tanganyika, while the Eastern, or Gregory Rift, passes through Lake Natron before joining the Western Rift south of Lake Nyasa. Subsidiary rifts are found in the Selous Basin and at Lake Rukwa, where some Karoo rocks are preserved.

The geological interpretation map is shown in Figure 7.4. According to this map, as for the watershed on the upstream side of Kilosa, Meta-igneous and sedimentary (Pa), Meta-sediments, orthogneiss, granulite (Pu), Migmatite, and granite (gs) are distributed.



Age		Name		Lithology	Remarks
Cenozoic	Quaternary	N	b	Beach sand, dune	
			r	Alluvial deposits(r2), Fluvial deposits(r1)	
		R		Lacustrine sediments	
	Tertiary	Nt		Terrace deposits	
		Nf		Fluvial marine sand	
Meso	Creta.	C		Continental and marine sandstone	
	Jura.	J		Mudstone and shale	Karoo series
Palaeozoic		K		Conglomerate and tillite	Karoo series
Proterozoic	Neo-	Xs	Xs2	Marble	Moozambique Belt (upper nappe)
			Xs1	Granulite, gneiss and migmatite	
		Ne		Composite metamorphic crust domain	Mozambique Belt sandstone
	Palaeo-	Pa		Meta-igneous and sedimentary rocks	Mozambique Belt
		Pu		Meta-sediments, orthogneiss, granulite, etc.	Usagaran belt
Archaean Basement		gt		Migmatite, granite and mafic dykes	Dodoman group
		gs		Migmatite and granite	Isangan group
Int.	Neo-P.	m		Meta-anorthosite complex(interlayered)	Plutonic rocks
		a		Meta-anorthosite complex	Plutonic rocks

Geologic boundarie
Clear lineaments (faults)
Unclear lineaments
Anticlinal axis
Synclinal axis

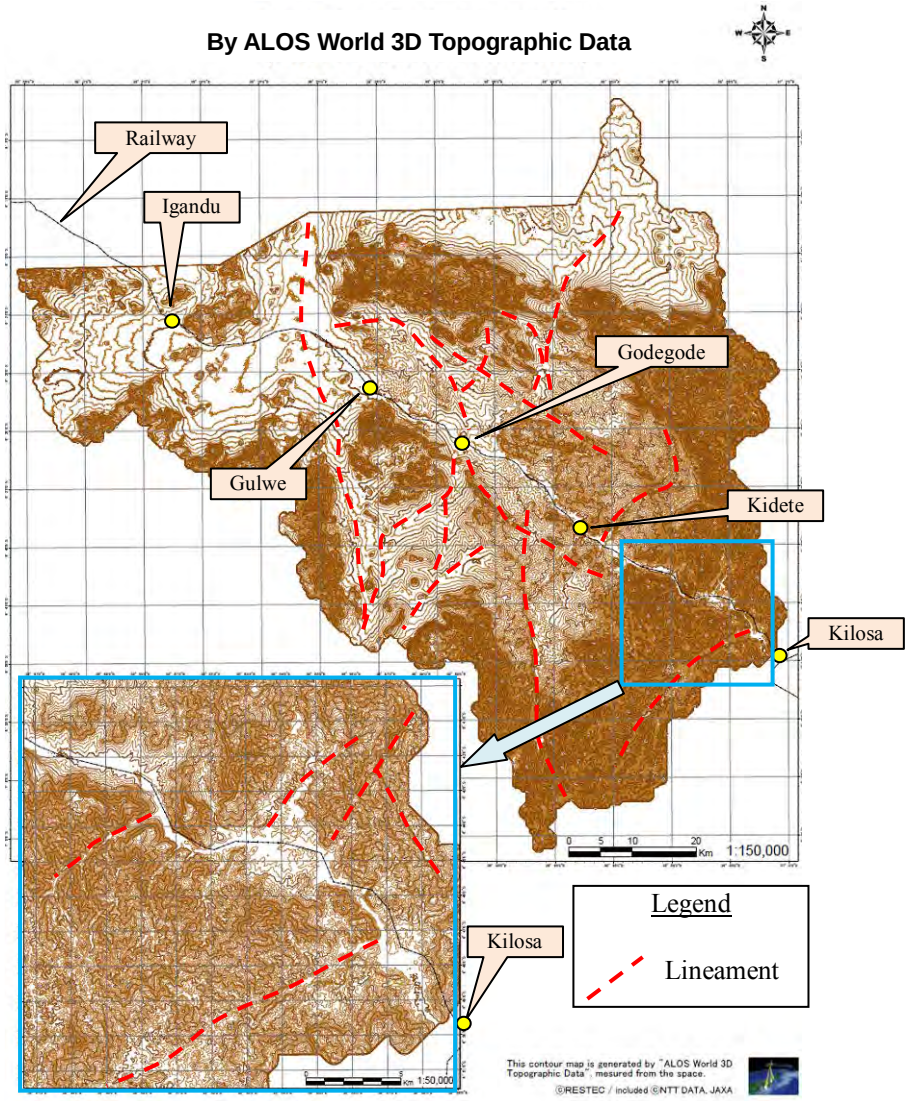
Source: JICA Wami/Ruvu Basin Study Report 2013

Figure 7.4: Geological Interpretation Map of the Wami/Ruvu Watershed

(3) Distribution of Lineament

Generally, a fault is recognized on the ground as a “lineament”, which is a visible linear pattern (refer to Figure 7.3). These lineaments can be observed by remote sensing images or topographical map made from those images. Figure 7.5 is the topographical map made by ALOS (Advanced Land Observing Satellite) showing the main lineaments in the target area. A

great deal of lineaments are observed along the Rift Valley. Small lineaments can be observed near the large lineament. In the target area especially, a multitude of small lineaments are distributed throughout.



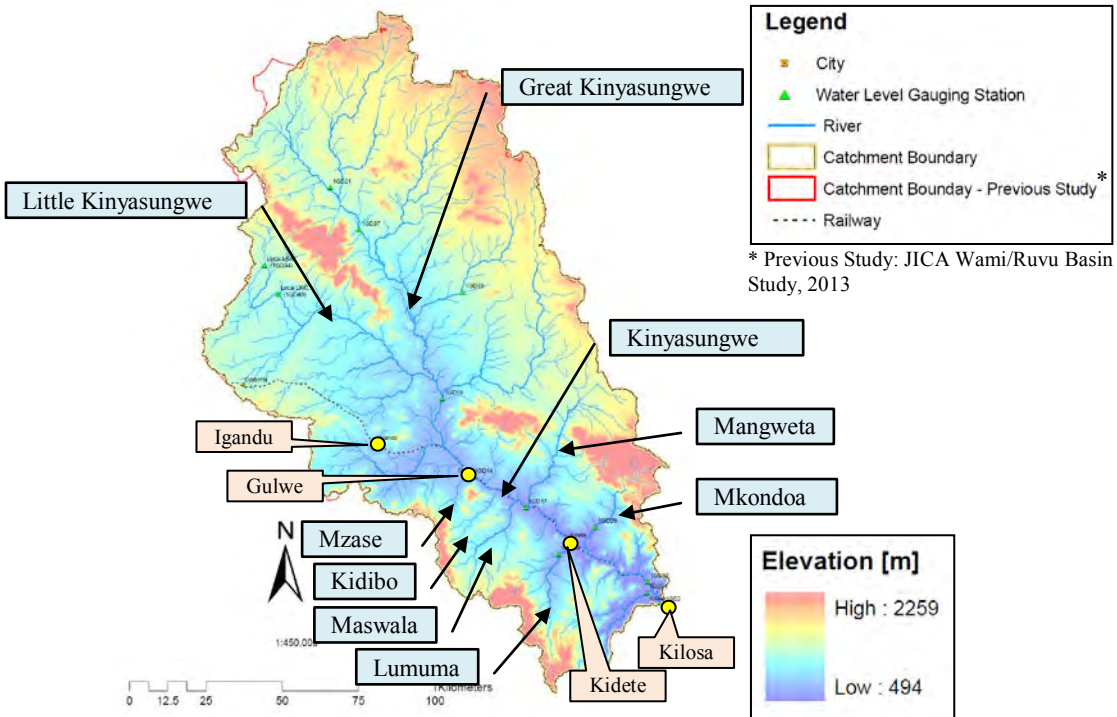
Source: JICA Study Team

Figure 7.5: Distribution of Lineaments in the Target Area

7.1.2 Topography

(1) Outline of General Topography

The watershed spreads out from the southeast to the northwest direction. Mountains over 2,000 m above sea level are distributed throughout the watershed (Figure 7.6). However, aside from this, most of this watershed consists of vast plains.

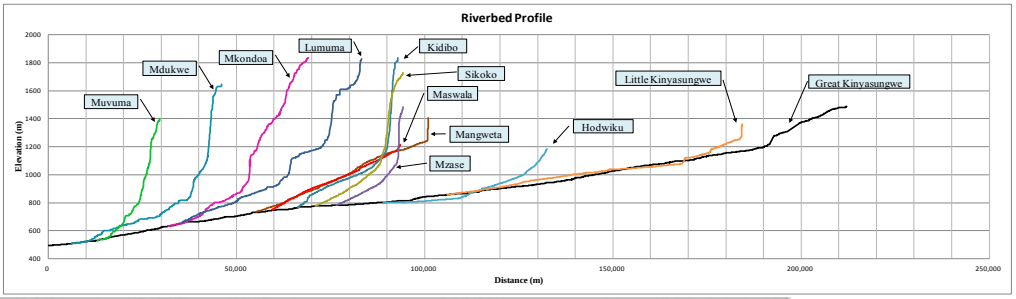


Source: JICA Study Team

Figure 7.6: Outline of Topography

(2) River Profile

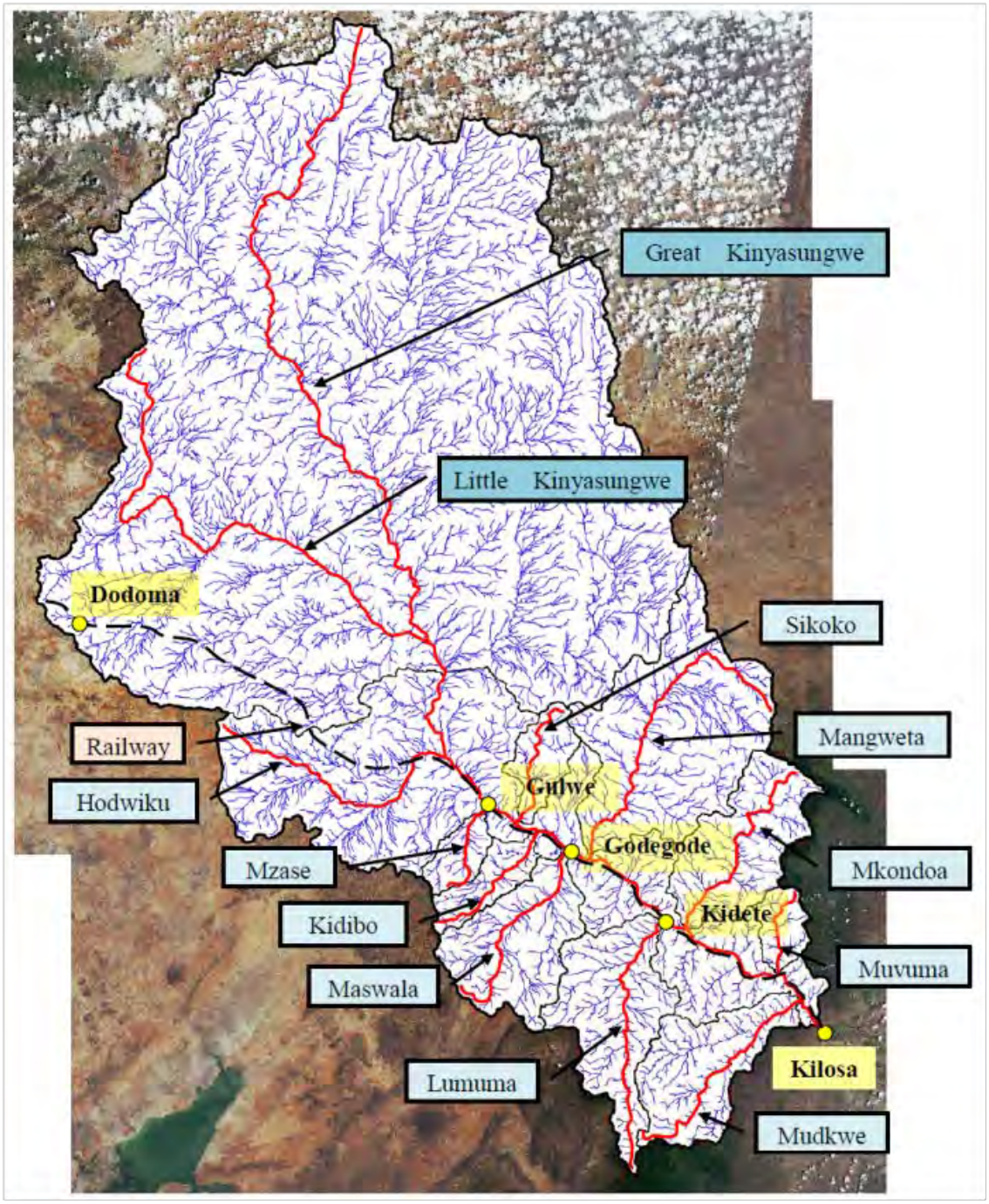
The target area, in particular in the upstream portion from Kilosa to Gulwe, is generally characterized by progressive bank erosion along the mainstream and abundant sediment discharge emptying into the mainstream from several tributaries. The sediment material has deposited and/or been transported to the middle and downstream reaches of the target area. In fact, this tendency can be seen in aggradations near the confluences of the Mzase to the Lumuma by examining the riverbed profile of the mainstream and main tributaries as shown in Figure 7.7.



G. Kinyasungwe	1/213 - 1/285 - 1/583 - 1/246 - 1/81
Mudkwe	1/215 - 1/138 - 1/492 - 1/3
Muvuma	1/126 - 1/34 - 1/10
Mkondoa	1/127 - 1/174 - 1/69 - 1/25
Lumuma	1/93 - 1/35 - 1/92 - 1/5 - 1/245
Mangweta	1/114 - 1/81 - 1/50 - 1/115
Maswala	1/70 - 1/94 - 1/71 - 1/19
Kidibo	1/54 - 1/84 -1/35 - 1/5
Sikoko	1/70 - 1/39 - 1/5 - 1/15
Mzase	1/74 - 1/31 - 1/2
Hodwiku	1/650 - 1/100 - 1/38 - 1/24
L. Kinyasungwe	1/240 - 1/475 - 1/136 - 1/89

Source: JICA Study Team

Figure 7.7: Riverbed Profile in the Target Area

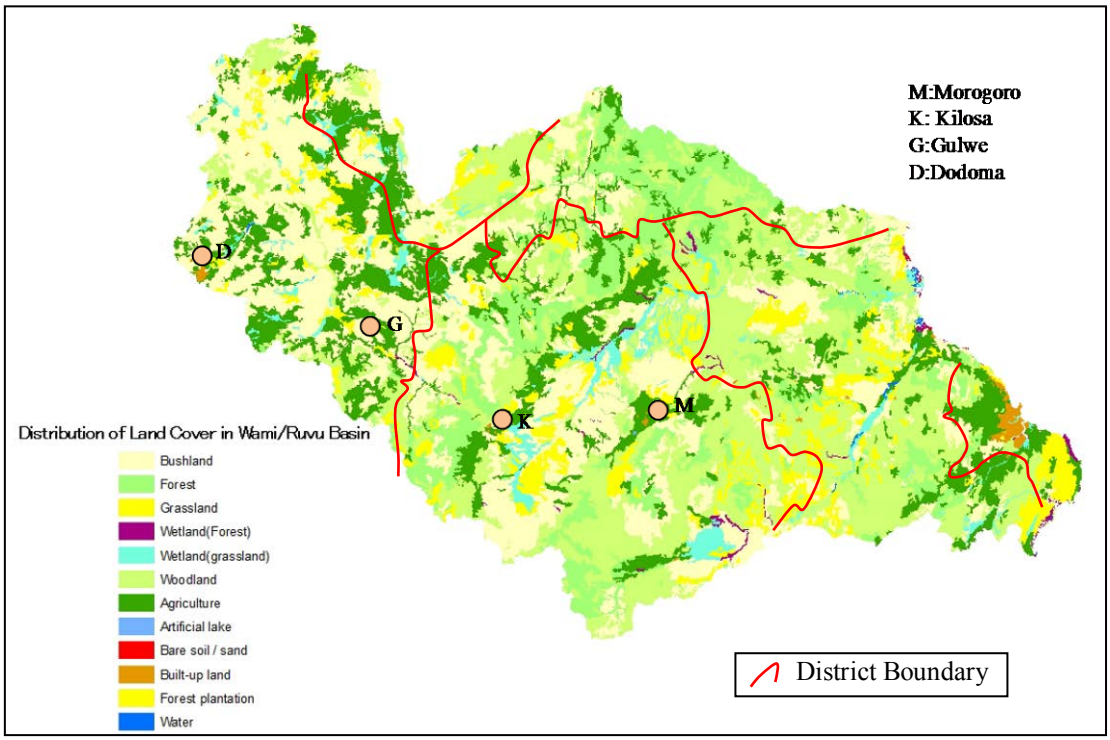


Source: JICA Study Team

Figure 7.8: River System Map

7.1.3 Land Cover

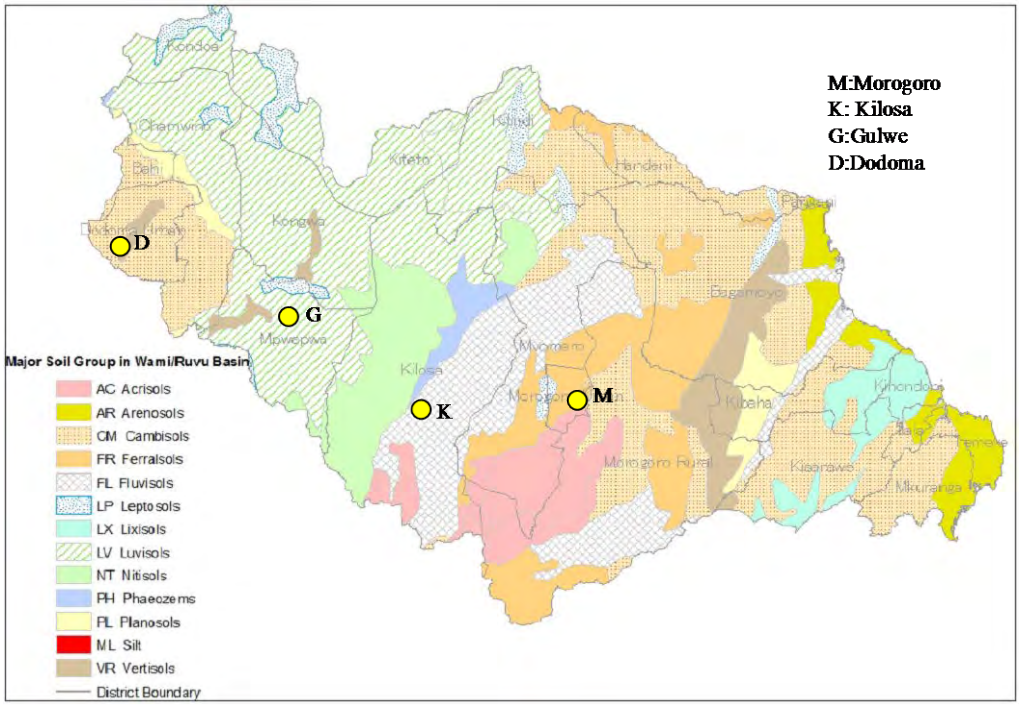
As per the JICA Wami/Ruvu Basin Study, the land cover, namely the land vegetation types in Wami/Ruvu Basin, are shown in Figure 7.9. The Mkondoa sub basin including Kilosa is covered by forested, agricultural and bush land, etc. On the other hand, the western area of Gulwe in the Kinyasungwe sub basion is mostly developed by agricultural land.



Source: JICA Wami/Ruvu Basin Study, 2013

Figure 7.9: Map of Land Cover in the Wami/Ruvu Basin (2002)

According to Figure 7.10, Dodoma area is covered by a group of Cambisols. On the other hand, Mpwapwa, Kongwa, and the other areas are almost covered by Luvisols (as per the classification system of the Food and Agriculture Organization, or FAO). Cambisols and Luvisols are suitable soils for agriculture.



Source: JICA Wami/Ruvu Basin Study, 2013

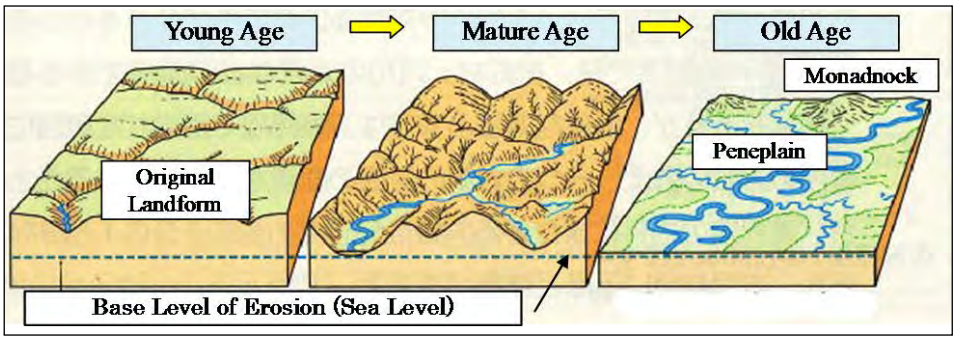
Figure 7.10: Map of Soil Groups in the Wami/Ruvu Basin

7.2 Outline of Historical Development of Landforms

7.2.1 Process of Topographical Change

The topography of Tanzania is governed by the formation of the Rift Valley and the processes of the formation of topography. The formation of mountains is closely associated with the activity of magma, as previously mentioned. Next, the process of topographical change is associated with weathering and erosion. The process of topographical change is divided into three stages (Figure 7.11).

i) Young age: the original topography
ii) Mature age: the mountain is formed, and erosion is actively taking place.
iii) Old age: Peneplain spreads, monadnocks are seen in places



Source: http://blog.goo.ne.jp/morinoizumi33/e/d9662728fd1d07312545d362e62f2f1c

Figure 7.11: Process of Topographical Change

As for the Study Area, 2,000-meter mountains, which are presumed to have been formed by the previously mentioned geological tectonic movements, are distributed to the north and south between Kilosa and Kidete, and rounded mountain and monadnocks are seen in the plains between Kilosa and Dodoma (Figure 7.12). Therefore, the stage of topography between Kilosa and Dodoma is judged to be the old age.

Rounded Mountain
(Mudkwe Watershed)

Rounded Mountain
(Around Mpwapwa)

Monadnock
(Mzase Watershed)

Monadnock
(Mangweta Watershed)

Figure 7.12: Eroded Landforms

7.2.2 Historical Development of Landform

The target area is located in the East Rift Valley, as mentioned above. Therefore, the target area's development was affected by those of the greater rift valley system. Especially, this area is characterized by its plains, lakes and swamps. Figure 7.13 shows these characteristics.

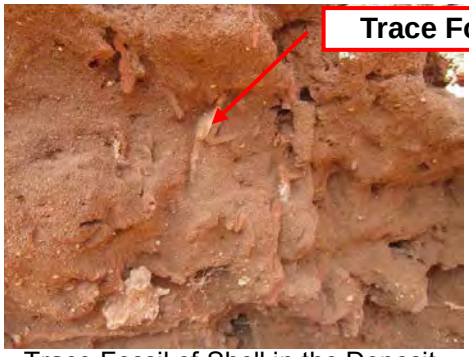
Plain (Swamp in Rainy Season)
(Msagali Area)

Plain (Swamp in Rainy Season)
(Mangweta Area)

Pediment Distributed in the Area
(In the Middle Reaches of Maswala)

Old Deposition observed in Pediment
(In the Middle Reaches of Maswala)

Lake Deposit
(Makutupu Area near Mangweta)

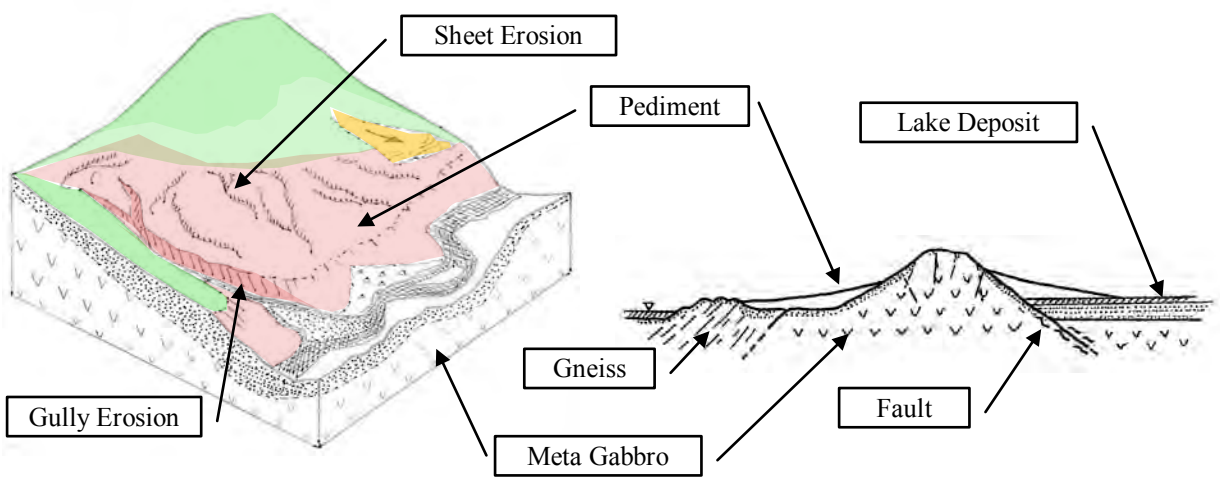


Trace Fossil of Shell in the Deposit
(Same as on the Left)

Figure 7.13: Characteristics of Lift Valley Floor

The historical development of landform in this area is summarized as below. Figure 7.14 shows a diagram of the historical development of landform in this area.

i) There were vast lakes in this area once.
ii) Sediment flowed into the lake and deposited.
iii) Pediment developed at the foot of the mountains at the same time.
iv) When the lakes were disappearing, rivers eroded the lake deposits simultaneously.
v) Traces of current landforms show fresh ones, therefore these phenomena are presumed to have occurred after the glacial period.



Source: JICA Study Team

Figure 7.14: Traces of Development of Landform

7.2.3 Trace of Catastrophic Phenomena

In satellite photos, traces of very unique topography are observed in the upper streams of the Kinyasungwe watershed; their characteristics are as follows:

- A clear gray deposition which is aggraded in the valley is observed in large areas (Figure 7.15A). Figure 7.15B shows the entire location.
- An unclear gray zone is also seen around these depositions.
- These depositions in the valley can be recognized as the traces of flow units.
- For example, in the rift valley in which Lake Natron is located, many streaks, which are presumed to have been eroded by liquid, are observed (Figure 7.15C: the red line in the figure is the presumed fault). The slope degree of this section is about 1/227 (0.25 degree).
- These streaks are not patterns which are formed by the sinking of the rift valley; rather, they are obviously traces which were eroded by hydrodynamic loads.
- Furthermore, in the downstream of these streaks, a plain, which has no vegetation around the foot of mountain, is observed (the area of ocher in Figure 7.15D). Generally, vegetation grows better in lowlands than highlands. But the condition of this zone is entirely opposite of this, in spite of the good environment for vegetation. This is thought to be the result of past vegetation having been deteriorated by huge destructive forces.
- In fact, a trace of the large landslide can be also seen at the Kenya side.
- The East Rift Valley is presumed to have suffered devastation around Lake Turkana in Kenya (in the lake, there is an active volcano).
- At that time, a large landslide (600 km long by 300 km wide) is presumed to have occurred around Lake Turkana in the Quaternary. Because of this, the trace remains a very clear geographical feature (Figure 7.15E).

Considering all these factors, the following hypotheses are able to be extracted:

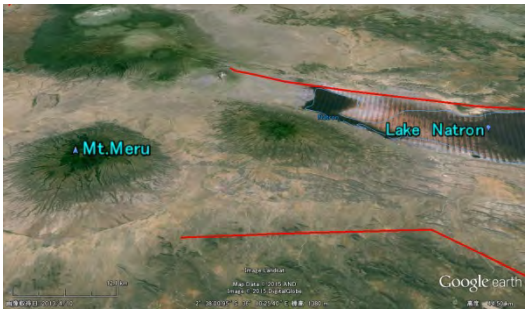
- Volcanoes around Turkana Lake are presumed to have erupted with diastrophism. The old, large, lake is assumed to have been created by the eruption at the same time.

- At almost the same time, the huge landslide occurred, and immediately afterwards, a great deal of sediment flowed out toward the east, south and north sides.
- The sediment which flowed out toward the south side passed through the Rift Valley and reached present-day Tanzania. The traces of Flow Unit 1–5 are presumed to be the traces of this time (Figure 7.15F).
- Figure 7.16 is sediment which was observed in Kibakwe Village. Probably, there might have been a large lake at that time, as mentioned above. But the sediment which was observed in a disturbed condition at the foot of the mountains, which has no lake deposit, has the possibility of being formed by that trace.

A: Flow Unit 1–2

B: Flow Unit 1–5

C: Streaks in the Rift Valley



D: Trace of Outflow

E: Trace of Huge Landslide

F: Trace of Outflow of Large Landslide

Source: JICA Study Team

Figure 7.15: Traces of Catastrophic Phenomena

Deposition has No Structural Lake Deposit

Unnatural Contact with Slope

Figure 7.16: Sediment Observed at the Kibakwe

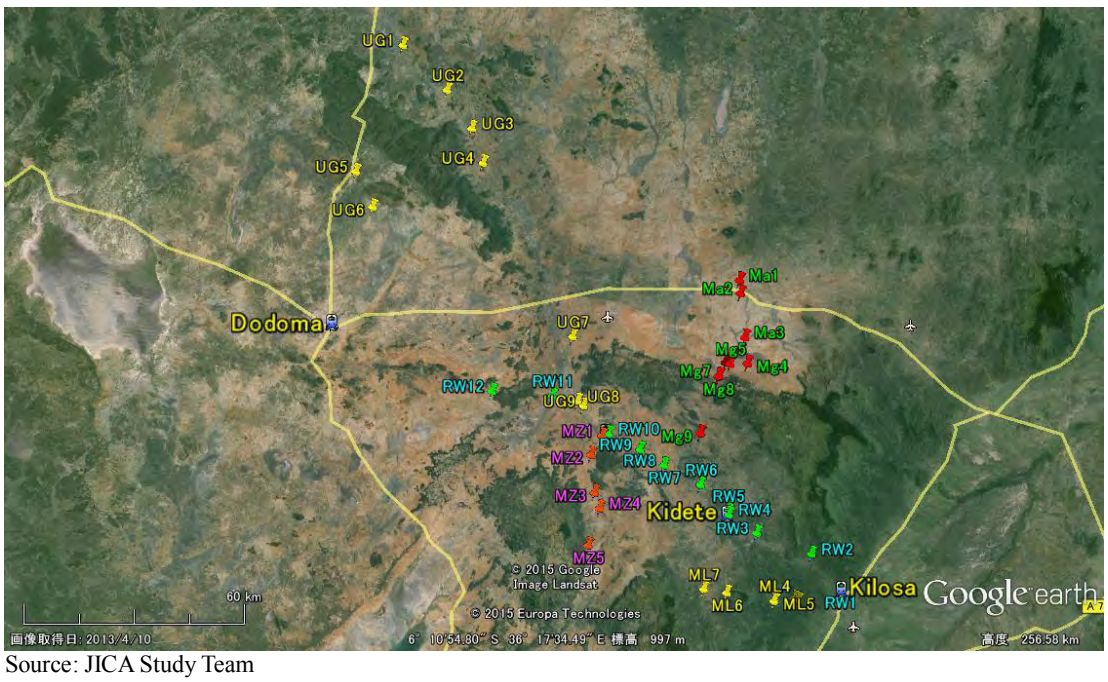
7.3 Reconnaissance Results for Sediment Analysis

7.3.1 Outline of Reconnaissance

The field reconnaissance was conducted in two mobilizations, first in December 2014 and again in February 2015, as follows:

i) Mudkwe–Lumuma watershed (15 December 2014)
ii) Mkondoa–Kinyasungwe River along the railway between Kilosa and Dodoma (16 December 2014, 5/11 February 2015)
iii) Mzase watershed (17 December 2014, 5 February 2015)
iv) Mangweta watershed and near Mpwapwa (18 December 2014, 1 February 2015)
v) Upper reaches of the Kinyasungwe River (3 February 2015)
vi) Dodoma–Gulwe along the railway, Kidibo and Maswala (22–23 May 2015)

A map of field reconnaissance points is shown in Figure 7.17.



Source: JICA Study Team

Figure 7.17: Map of Field Reconnaissance

Table 7.1: Coordinates of Reconnaissance Location

Site	Name	Latitude (S)	Longitude (E)	Site	Name	Latitude (S)	Longitude (E)
ML1	Mdukwe W*	6°51'19.10"	36°52'30.19"	UG1	G* Kinyasungwe	5°30'53.96"	35°55'5.88"
ML2	Mdukwe W*	6°51'9.29"	36°52'17.08"	UG2	Itiso	5°37'24.37"	36° 1'30.91"
ML3	Mdukwe W*	6°51'2.52"	36°51'59.45"	UG3	Ikombo	5°42'58.24"	36° 5'5.55"
ML4	Mdukwe W*	6°51'20.90"	36°49'2.98"	UG4	Dabalo Dam	5°47'58.03"	36° 6'41.55"
ML5	Mdukwe W*	6°51'24.09"	36°48'54.93"	UG5	Mayamaya	5°49'10.24"	35°48'14.58"
ML6	Lumuma W*	6°50'8.88"	36°41'59.87"	UG6	Chihanga	5°54'17.00"	35°50'38.28"
ML7	Lumuma W*	6°49'34.44"	36°38'38.34"	UG7	Kongwa	6°13'4.22"	36°19'37.92"
RW1	Kilosa B*	6°49'54.09"	36°58'41.64"	UG8	G* Kinyasungwe	6°22'23.04"	36°20'21.79"
RW2	Km 297.3	6°44'36.60"	36°54'26.01"	UG9	G* Kinyasungwe	6°23'5.24"	36°21'13.45"
RW3	Km 315.1	6°41'31.82"	36°46'26.09"	UG10	Near Gulwe	6°26'48.33"	36°24'37.77"
RW4	Km 325.2 (Kidete B*)	6°38'48.78"	36°42'20.01"	UG11	Near Gulwe	6°26'59.53"	36°24'48.27"
RW5	Kidete Dam	6°38'17.05"	36°42'11.62"	Ma1	Mangweta (Pundambili V*)	6° 4'57.38"	36°43'52.53"
RW6	Km 338.0	6°34'28.29"	36°38'12.25"	Ma2	Mangweta (Pundambili V*)	6° 6'50.82"	36°43'59.58"
RW7	Maswala	6°31'39.36"	36°32'52.46"	Ma3	Mangweta	6°13'11.55"	36°44'36.74"
RW8	Maswala	6°31'41.61"	36°32'55.18"	Ma4	Mangweta (Mali V*)	6°16'57.25"	36°44'57.58"
RW9	Kidibo River	6°29'23.60"	36°29'25.26"	Ma5	Mangweta	6°17'0.06"	36°42'26.94"
RW10	Mzase River	6°27'6.31"	36°24'49.76"	Ma6	Mangweta	6°16'48.32"	36°41'45.29"
RW11	Msagali	6°21'37.03"	36°16'41.89"	Ma7	Mangweta (Chamkolomo V*)	6°18'15.00"	36°40'57.69"
RW12	Igandu	6°20'54.93"	36° 7'56.76"	Ma8	Mangweta (Chamkolomo V*)	6°18'50.90"	36°40'42.96"
MZ1	Mzase River	6°27'25.37"	36°23'53.19"	Ma9	Mangweta	6°27'2.74"	36°38'9.72"
MZ2	Mzase River	6°30'9.16"	36°22'16.62"	W*: Watershed			
MZ3	Kidibo River	6°35'37.77"	36°22'46.78"	B*: Bridge			
MZ4	Lukole V*	6°37'52.32"	36°23'31.97"	G*: Great			
MZ5	Kibakwe V*	6°43'13.09"	36°21'50.97"	V*: Village			

Source: JICA Study Team

7.3.2 Mdukwe–Lumuma Watershed

(1) Site ML1

The Mdukwe watershed consists of dense forests (Figure 7.18).

Figure 7.18: Condition of Dense Forest

(2) Site ML2, ML3

Site ML2

Although swidden cultivation (shifting agriculture) is conducted in places, obvious surface erosion is not observed (Figure 7.19A).

Site ML3

Streams in the mountain are mostly small and a slight sediment deposition is observed in the riverbed (Figure 7.19B).

A: Swidden Cultivation (No Erosion)

B: Slight Sediment Deposition

Figure 7.19: Condition in Mountain Areas

(3) Site ML4, ML5

Outcrops of bedrock are observed in the riverbed and on the road cutting slopes of the Mdukwe watershed (Figure 7.20). The surface soil (topsoil) of slopes is very thin, or basically non-existent.

A: Outcrop of Bedrock (No Sediment)

B: Outcrop of Sandstone

Figure 7.20: Condition of Outcrops

(4) Site ML6

This site is located in the Lumuma watershed. The mountain shape of the watershed boundary is rounded by long-term erosion through the Quaternary. Although most of the trees in the mountains have been cut, the land surface is covered by vegetation. No slope failures are observed (Figure 7.21).

Figure 7.21: Rounded Mountain Shape of the Watershed Boundary

(5) Site ML7

The river condition of the Lumuma River is almost gentle, without riverbank erosion and sediment deposition (Figure 7.22A). The Lumuma River watershed has a valley plain. A small stream, which is the Lumuma River itself, runs through this plain. Traces of sediment transportation are generally not observed in this riverbed.

However, remarkable river erosion starts from the point near the confluence with the Kinyasungwe River (Figure 7.22B: yellow arrow). This is presumed to be largely influenced by base-level erosion in the Kinyasungwe River.

A: Small River in the Upper Stream

B: Remarkable Erosion
Near River Confluence

Figure 7.22: Condition of the Lumuma River

7.3.3 Mkondoa–Kinyasungwe River along the Railway between Kilosa and Dodoma

(1) Site RW1

Surface water can be seen at the Kilosa Bridge. However, the water depth is very shallow and a great deal of sediment deposition is observed from the bridge (Figure 7.23A). The material of sediment mostly consists of sand (Figure 7.23B).

A: Marked Sediment Deposition

B: Material of Deposition (Sand)

Figure 7.23: Condition of Sediment Deposition

(2) Site RW2

This site is located at the right bank of the Mkondoa River (Km 297.3). The river width at this point is about 350 m. A great deal of sediment deposition is observed (Figure 7.24A), and gabion works are provided as bank protection (Figure 7.24B).

A: Condition of Sediment Deposition

B: Bank Protection by Gabion

Figure 7.24: Condition of Site Km 297.3

(3) Site RW3

This site is located at the right bank of the Mkondoa River (Km 315.1). The Mkondoa River meets the Kinyasungwe River 4.5 km upstream from this site. Riverbank erosion has been proceeding at this site (Figure 7.25A). The rate of erosion is approximately 180 meters over two years. Sediment discharge by riverbank erosion is presumed to be a supply source of sediment production in downstream areas. Bank protection works have been completed in February 2015 (Figure 7.25B).

A: Bank Protection Work

B: Gabion Works

Figure 7.25: Condition of Site Km 315.1

(4) Site RW4

This site is located downstream of the Lumuma River and near the confluence with the Kinyasungwe River (Km 325.2). The Lumuma River is a gentle river which does not have serious sediment deposition. However, remarkable riverbank erosion and sediment deposition are observed near the confluence with the Kinyasungwe River (Figure 7.26A). Sinking of revetments is observed at the downstream areas of the river channel works (Figure 7.26B).

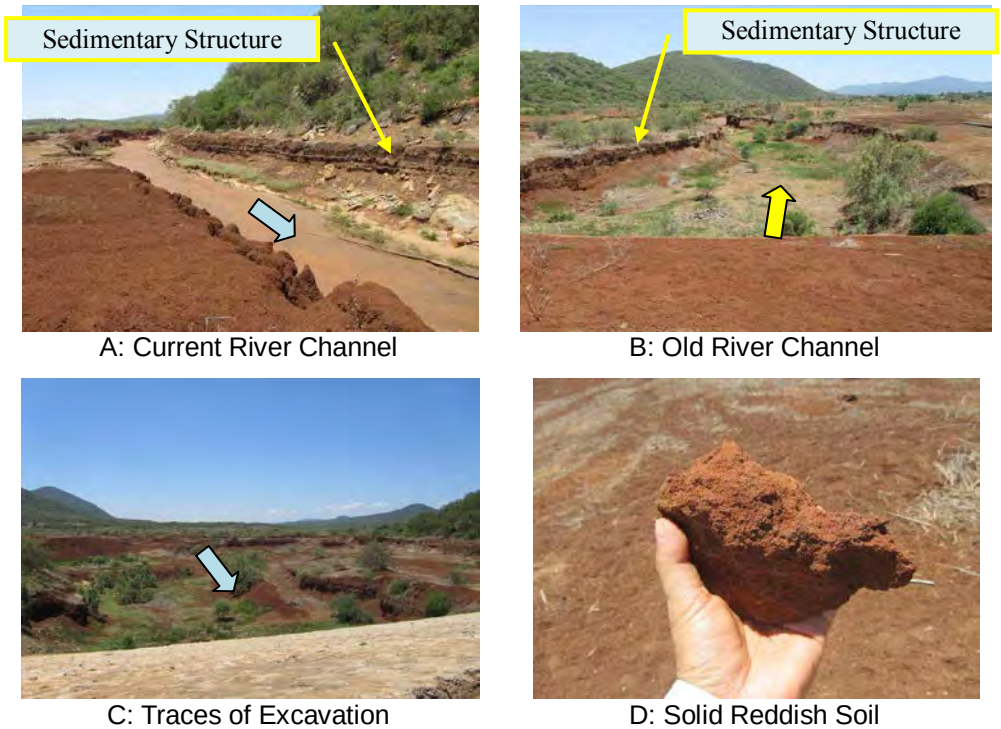
A: A Large Amount of Sediment Deposit

B: Gabion and Channel Works

Figure 7.26: Condition of Site Km 325.2

(5) Site RW5

This site is the Kidete Dam site, the construction of which is presently halted. Sediment deposition is not observed on the current riverbed (Figure 7.27A). An outcropping of bedrock is observed on the left bank. On the other hand, the old river channel remains downstream of the dam (Figure 7.27B). Additionally, the deposition of reddish soil is observed characteristically in both the upstream and downstream areas of the dam (Figure 7.27C). The deposition, which has a sedimentary structure, is observed on top of the existing reddish soil deposition (Figure 7.27D). The reddish soil deposition has a solid formation, but is not layered, indicating that the reddish soil deposition was transported all at once (a single flood event).



A: Current River Channel

B: Old River Channel

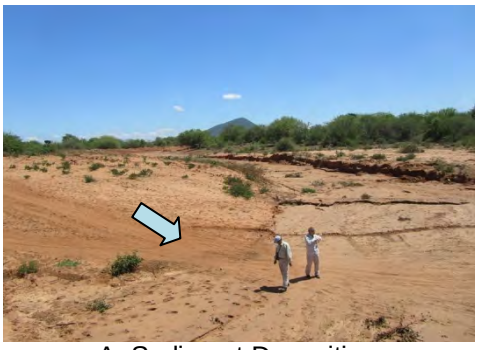
C: Traces of Excavation

D: Solid Reddish Soil

Figure 7.27: Condition of the Kidete Dam Site

(6) Site RW6

This site is located at the right bank of the Kinyasungwe River (Km 337.4) A wide river, forming a floodplain, expands in this section (Figure 7.28A). Lower terrace deposits by floods are observed along the riverbank. The material consists of sands, which are easily eroded (Figure 7.28B).



A: Sediment Deposition on the Wide Riverbed

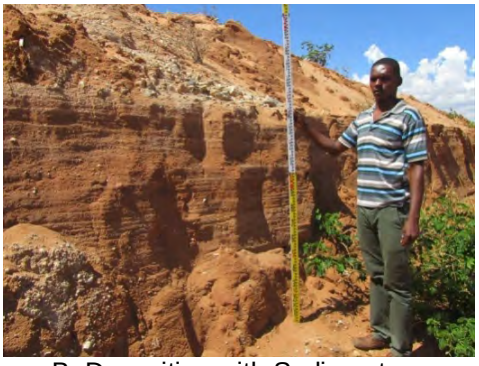
B: Lower Terrace Deposits along the Riverbank

Figure 7.28: Condition of Site Km 337.4

(7) Site RW7, RW8

The adjacent areas of these sites are located about 1.5 km from Godegode Station. This section is located in the floodplain of the Maswala River. A great deal of sediment discharge is observed in the riverbed (Figure 7.29A). A thick deposition is spread over this area (Figure 7.29B). The box culvert of Site RW8 was open at the time of reconnaissance on 16 December 2014, but had been clogged by sediment at the reconnaissance time of 11 February 2015 (Figure 7.30A, B).

A: Condition of Remarkable Deposition (RW7)



B: Deposition with Sedimentary Structure

Figure 7.29: Condition of Maswala River near Godegode Station

A: Box Culvert (RW8)
(16 Dec. 2014)

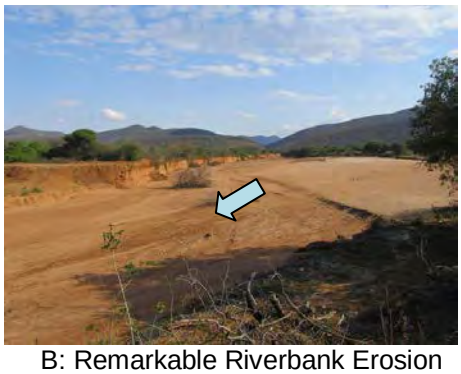
B: Culverts Clogged by Sediment
(RW8: 11 Feb. 2015)

Figure 7.30: Condition of Maswala River near Godegode Station

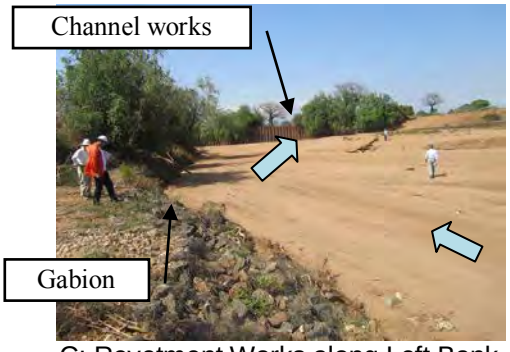
(8) Site RW9

This site is located in the Kidibo River (Km 355.3), which is a right tributary of the Kinyasungwe River. Large areas of cultivated land exist in the upstream areas of the Kidibo River. Therefore, a great deal of sediment is presumed to have been flashed out from there. In this site, channel works were constructed (Figure 7.31A). A large floodplain is observed in the immediate upstream section of Site RW9, and remarkable riverbank erosion is observed along the right bank (Figure 7.31B). On the other hand, the left bank was protected by revetment works (Figure 7.31C, D).

A: Existing Channel Works
(Condition of Confluence)



B: Remarkable Riverbank Erosion



C: Revetment Works along Left Bank

D: Revetment Works along Left Bank

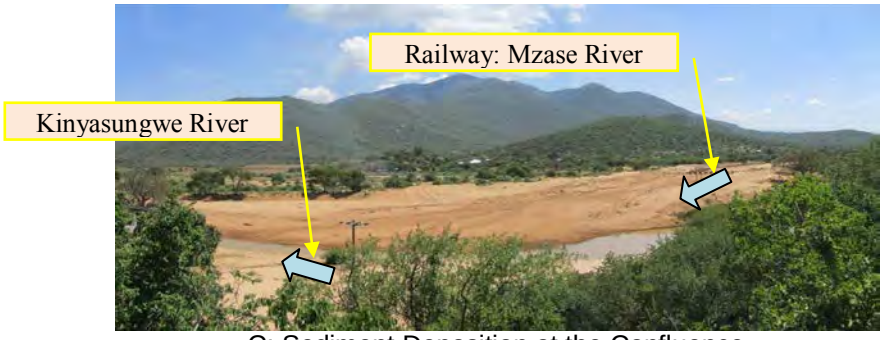
Figure 7.31: Site Condition (Kidibo River)

(9) Site RW10

This site is located in the Mzase River, which is stretching out from the southeast side of Gulwe station. A great deal of sediment discharge has been continuing (Figure 7.32A). Riverbed aggradations are the crucial issue for the railway at this site (Figure 7.32B). A great deal of sediment from the Mzase flows into the Kinyasungwe River (Figure 7.32C).

A: Sediment Deposition

B: Risky Bridge against Flood



C: Sediment Deposition at the Confluence

Figure 7.32: Condition of the Mzase River near Gulwe Station

(10) Site RW11

A large plain spreads along the Hodowiku River through the west side of Msagali Village. The railway runs through this plain. This large plain changes to a swamp in the rainy season (Figure 7.33A). Site RW11 is located in this area. The vast plain emerges at the end of rainy season (Figure 7.33B). Sediment which consists of grayish material is observed along the railway (Figure 7.33C). However, the trace, which has a sedimentary structure formed by flooding, is not observed on the outcrop of the deposition. Probably, this deposition is presumed to have been formed in the old age. Similar depositions are confirmed in the upstream areas of the Kinyasungwe and Mzase Rivers.

A: A Large Plain along the Railway (February 2015)

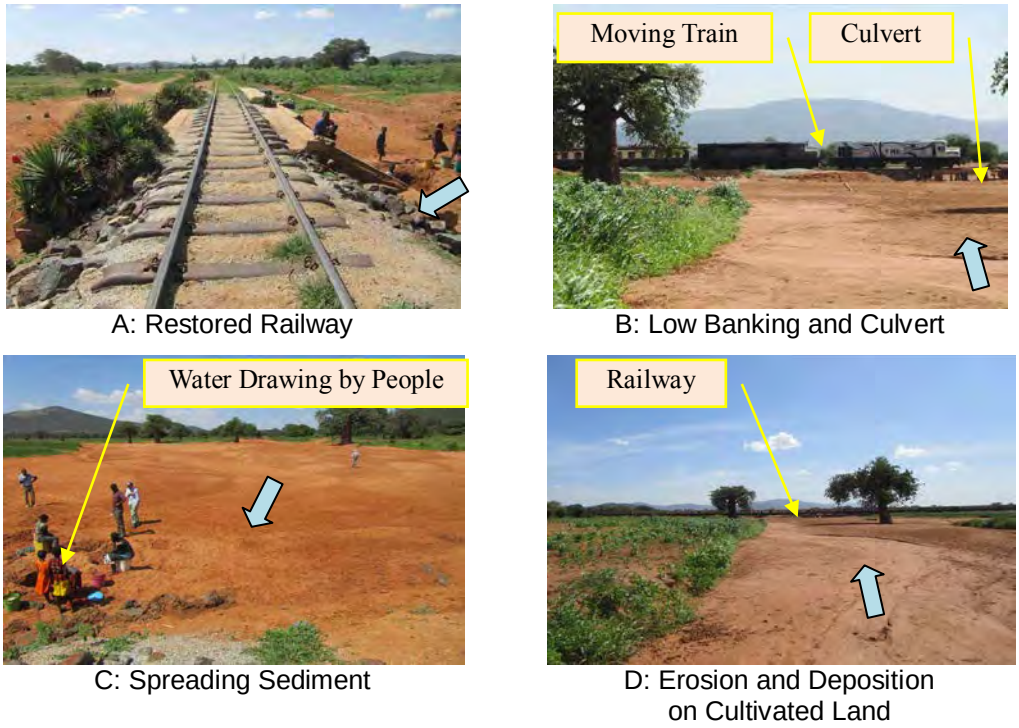
B: Condition in May 2015

C: Old Sediment Deposition

Figure 7.33: A Large Plain Spreading through Msagali Village

(11) Site RW12

This site is located near Igandu Station. This small watershed area has a very gentle slope. The height of the railway banking is low against the riverbed. Therefore, the bottoms of culverts should have been excavated lower than the riverbed height (Figure 7.34A, B). The opening of the culvert is too small for floodwaters to pass through. The floodwaters spread to the cultivated land due to the indistinct river channel shape and small bank height (Figure 7.34C, D). Construction of additional culverts to expand the opening underneath the railway was completed by TRL before December 2014.



A: Restored Railway
B: Low Banking and Culvert
C: Spreading Sediment
D: Erosion and Deposition on Cultivated Land

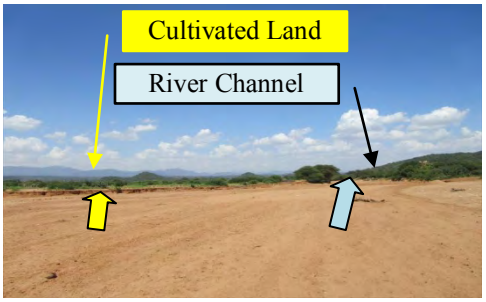
Figure 7.34: Condition at Igandu Area

7.3.4 Mzase–Kidibo–Maswala Watershed

(1) Site MZ1

This site is located about 1.8 km from Gulwe Station. At this site, remarkable riverbank erosion and a great deal of sediment deposition are observed (Figure 7.35A). A large sediment flooding area is observed in this area (Figure 7.35B). An artificial river channel was constructed between this site and confluence (Figure 7.35C). The river length is approximately 2.0 km. On the other hand, the riverbed of the artificial river channel has already covered by a great deal of sediment (Figure 7.35D). Therefore, this site is assumed to have become a floodplain (Figure 7.35E). In fact, the sediment discharge intruded into the cultivated lands of the adjacent village (Gulwe) during the flood on 28 March 2014 (Figure 7.35F).

A: A Great Deal of Sediment Deposition



B: Sediment Flooding Area

C: Sediment Flooding and Narrow River Channel (Artificial River Channel)

D: Artificial River Channel Covered by a Great Deal of Sediment

E: Condition of Sediment Flooding

F: Cultivated Land Covered by the Sediment

Figure 7.35: Condition of the Mzase River near Gulwe Station

(2) Site MZ2

Upstream of the Mzase River, there are widespread large cultivated areas. Figure 7.36A shows the photo during the dry season, and Figure 7.36B shows the condition (covered by grasses) in the wet season. On the other hand, sediment deposition is observed on the upstream side of the road, which has a similar function to the consolidation dam (Figure 7.36C). This sediment was likely transported and deposited by flood discharges from the cultivated lands. The riverbanks of the downstream side are eroded (Figure 7.36D).

A: Cultivated Land of Upstream Side (17 Dec. 2014)

B: Same as (A) (5 Feb. 2015)

C: Road having Consolidation Dam Function

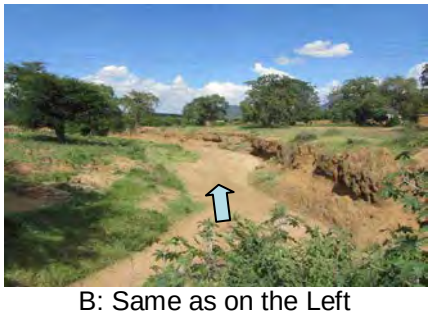
D: Condition of Riverbank Erosion at Downstream Side

Figure 7.36: Condition of Upstream Area of the Mzase River

(3) Site MZ3

This site is located upstream of the Lukole River, which is the left tributary of the Kidibo River. Sediment deposition is observed on the upstream and downstream side of the bridge across the river. However, the deposition is not so significant. Although riverbank erosion is also observed, it is not so serious (Figure 7.37).

A: Sediment Deposition and Riverbank Erosion (17 Dec. 2014)



B: Same as on the Left (5 Feb. 2015)

Figure 7.37: Condition of Upstream Area of the Kidibo River

(4) Site MZ4

This site is called the "Monadnock", which as previously mentioned, is a final stage of the historical development of landform (Figure 7.38A). Namely, the current landform shows that this stage of the erosion process has finished. Therefore, the surface soil has been mostly washed away, and an outcrop of the bedrock is observed in places (Figure 7.38B).

A: Monadnock

B: Exposed Bedrock
and Lack of Surface Soil

Figure 7.38: Monadnock, located near Kibakwe Village

(5) Site MZ5

This site is located upstream of the Maswala River in Kibakwe Village. The sediment discharge in the riverbed is not marked (Figure 7.39A, B). But a great deal of sediment deposition, whose color is grayish brown, is observed at the foot of the mountain (Figure 7.39C). The height of the accumulated deposition of this site is about 10 m. The surface of this deposition forms a very gentle slope. And an outcrop of the bedrock is observed on the river channel at the foot of the mountain (Figure 7.39D). Actually, this landform is unnatural, considering the normal formation process of landforms, because the gentle topographical continuity, which was formed by long-term erosion, is not observed on the boundary between the mountain slope and the deposition. Additionally, the thickness of the deposition is too thick when compared to the height of mountain. In satellite photography, the sediment covering the foot of mountain is clearly observed (Figure 7.39E). Furthermore, according to the satellite photos, it should be noted that this site is located at the end of the small rift valley (Figure 7.39F).

A: River Condition

B: Little Sediment Deposition

C: Thick Deposition

D: River Channel at the Foot of Mountain
(Outcrop of Bedrock)

E: The Foot of Mountain Covered
by Sediment Deposition
(Red Line: Presumed Fault)

F: Site MZ5 Located
in the Small Rift Valley
(Red Line: Presumed Fault)

Figure 7.39: Condition of Upstream Area of the Maswala River

7.3.5 Upstream Area from Gulwe

(1) Site UG1

This site is located in the most upstream reaches of the Great Kinyasungwe River. The landform is almost flat (Figure 7.40A). Sediment deposition with gray color is observed on the river channel during rainfall (Figure 7.40B). The supply source of this deposition is presumed to be lake deposits or sediment transported by a huge landslide (refer to Sections 7.2.2–7.2.3). On the other hand, this river channel does not have an obvious river channel formation. This plain changes to a floodplain during rainy seasons. It is possible to verify the existence of clayey compounds in the sediment deposition by forming a "string" with the deposition by hand (Figure 7.40B). This procedure was successful at this site, and therefore, the sediment contains clayey compounds.

A: River Channel during Rainfall

B: Sediment and String (Clay)

Figure 7.40: Condition of the Most Upstream Reaches of the Kinyasungwe River

(2) Site UG2

This site (Itiso) is located downstream of Site UG1, and is a water level gauging station (Figure 7.41A) managed by the Wami/Ruvu Basin Water Office. A small amount of surface flow was observed at the time of reconnaissance. The landform is almost flat, as in Site UG1. Some river channels are observed in the plain (Figure 7.41B). The sediment is colored gray, as in Site UG1.

A: A Small Amount of Sediment Deposition

B: River Channel during Rainfall

Figure 7.41: Condition of Itiso Site

(3) Site UG3

This site (Ikombo) is located downstream of Site UG2, and is a water level gauging station. The river channel shows a stable river channel. A small amount of sediment deposition is observed (Figure 7.42A, B).

A: A Small Amount of Sediment Deposition

B: Stable River Channel

Figure 7.42: Condition of Ikombo Site

(4) Site UG4

Dabalo Dam is located in the upstream area of the Great Kinyasungwe River. Several tributaries flow into the dam reservoir (Figure 7.43A). Since the landform of the Upper Great Kinyasungwe is flat, the sediment discharge is presumed to be minor, as mentioned above. Even if sediment discharges occur, most of the sediment material will deposit in this reservoir (Figure 7.43B).

A: Dabalo Dam

B: Dam Reservoir

Figure 7.43: Condition of Dabalo Dam

(5) Site UG5

This site (Mayamaya) is located upstream of the Little Kinyasungwe River. This site is a water level gauging station (Figure 7.44A). The surrounding landform is flat, and traces of the sediment discharge from the upstream areas are not observed (Figure 7.44B).

A: Water Level Gauging Station

B: Flat Surrounding Landform

Figure 7.44: Condition of Mayamaya Site

(6) Site UG6

This site (Chihanga) is located downstream of Site UG5, and is a water level gauging station. The surrounding landform is flat, and traces of the sediment discharge from the upstream area are not observed, as in Site UG5. The river channel is not obviously formed (Figure 7.45A, B).

A: Water Level Gauging Station

B: Obscure River Channel

Figure 7.45: Condition of Chihanga Site

(7) Site UG7

This site (Kongwa) is located in the middle reaches of Kinyasungwe River, and is a water level gauging station (Figure 7.46A, B). The surrounding landform is almost flat. Obvious sediment deposition transported by floods is not observed in the riverbed (Figure 7.46C). Instead, deposition which does not have an obvious sedimentary structure is observed on the riverbank (Figure 7.46D). Since the surrounding land is formed and composed of this deposition, this channel was formed in a relatively old era.

A: Full View of Site UG7

B: Water Level Gauging Station

C: Riverbed Condition

D: Old Deposition

Figure 7.46: Condition of Kongwa Site

(8) Site UG8

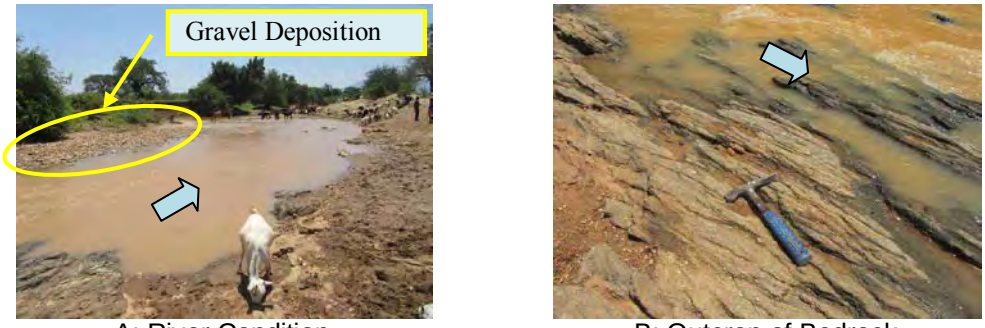
This river is the Hodwiku River. This site is located between Gulwe and Msagali. Sediment deposition is not observed in the riverbed (Figure 7.47A). An outcrop of the bedrock is observed in the riverbed (Figure 7.47B).

A: River Condition B: Outcrop of Bedrock

Figure 7.47: Condition of the Hodwiku River

(9) Site UG9

This site is located downstream of Site UG8. Sediment deposition is almost not observed in the riverbed (Figure 7.48A). But a small amount of gravel deposition is observed on the left bank. An outcrop of the bedrock is observed in the riverbed (Figure 7.48B).



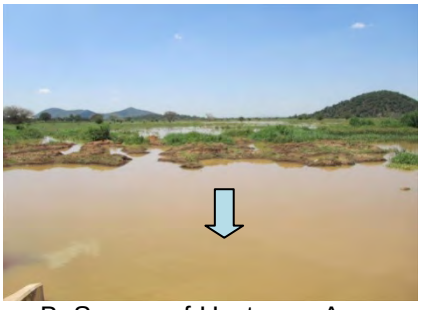
A: River Condition B: Outcrop of Bedrock

Figure 7.48: Condition of the Hodwiku River

(10) Site UG10, UG11

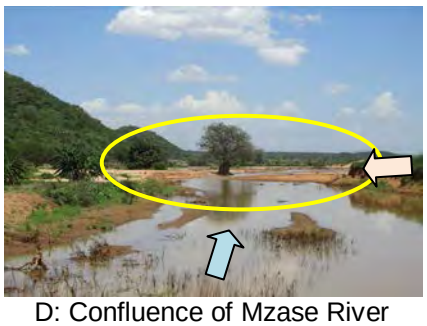
Site UG10 and Site UG11 are adjacent to each other, and are located upstream of Gulwe Station. At Site UG10, a new road with a road embankment has been constructed across the river (Figure 7.49A). Due to the dam effect, the road embankment creates a large swamp on the upstream side (Figure 7.49B). According to satellite photography, cultivated lands are distributed along the small streams of the Kinyasungwe River (Figure 7.49C). On the other hand, at the downstream location of Site UG11, a great deal of sediment, which flowed into the Kinyasungwe River from the Mzase River, is observed (Figure 7.49D).

A: Banking of New Road



B: Swamp of Upstream Area

C: Before Road Construction



D: Confluence of Mzase River

Figure 7.49: Condition of Gulwe Site

7.3.6 Mangweta Watershed

The Mangweta watershed can be divided into the northern and southern areas. The northern area shows the plain land and the southern area is surrounded by mountains. The boundary of these two areas is located in the middle reaches of the Mangweta River. The sediment discharge conditions are observed as follows:

(1) Site Ma1, Ma2

Site Ma1 and Site Ma2 are located near the watershed boundary of the northern part of Mangweta. Site Ma1 is Monadnock, which shows the stage of the old age (refer to Section 7.2.1), and is in the process of topographical change (Figure 7.50A). Site Ma2 reflects the typical landform of the northern area (Figure 7.50B).

A: Monadnock

B: Cultivated Land

Figure 7.50: Landform of the Northern Part of Mangweta

(2) Site Ma3

This site is located at the northern part of Mangweta. The northern area is covered by reddish and gray soils. The gray soil is observed along the small rivers (Figure 7.51A). Since this gray

layer does not have a sedimentary structure, this deposition is presumed not to have been the deposition which was formed by floods (Figure 7.51B).

A: Gray Soil along the River Channel

B: Layer Structure in Deposition

Figure 7.51: Condition of the Northern Part of Mangweta

(3) Site Ma4

This site is located at the northern part of Mangweta. The reddish soil spreads over this northern area, as shown in Figure 7.52A. However, rubbish, which has been caught between soils, is observed here (Figure 7.52B). Surface erosion seems to be active in this area.

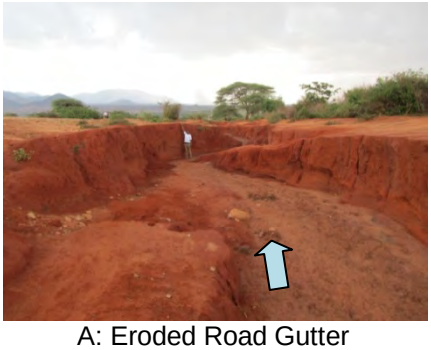
A: Land Covered by Reddish Soil

B: Rubbish Spread throughout the Reddish Soil

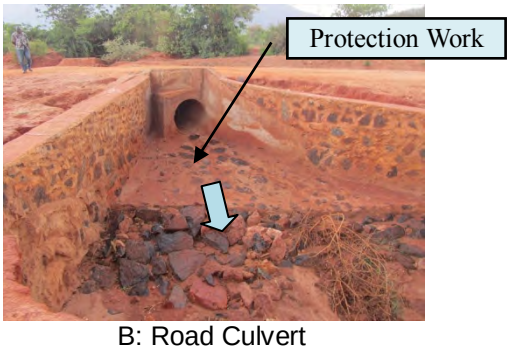
Figure 7.52: Condition of the Northern Part of Mangweta

(4) Site Ma5

Reddish soil has the characteristic of being susceptible against erosion (Figure 7.53A). The road gutter has been eroded by running waters, which flowed out from the culvert during rainfall. The apron protection works seem effective against erosion (Figure 7.53B).



A: Eroded Road Gutter

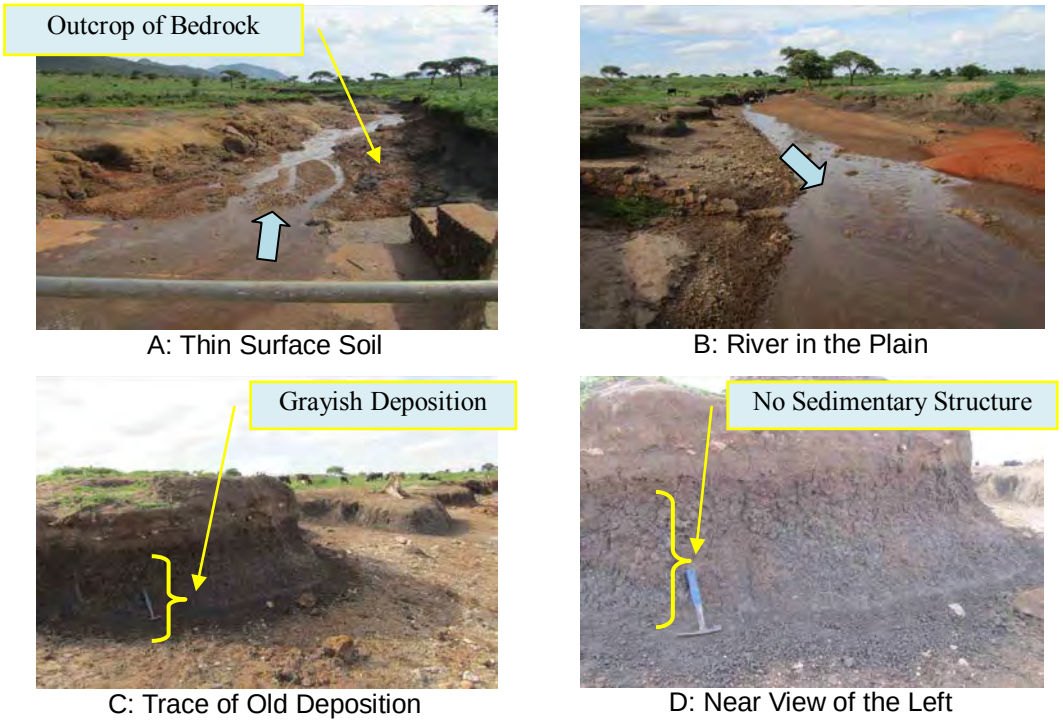


B: Road Culvert

Figure 7.53: Condition of the Northern Part of Mangweta

(5) Site Ma6

This site is located at the south end of the northern area. An outcrop of bedrock is observed in the riverbed (Figure 7.54A). The layer thickness of the surface soil is relatively thin. Marked deposition, which was transported by floods, is not observed in the riverbed (Figure 7.54B). However, the bedrock around this site is covered by grayish sediment (Figure 7.54C). Because the deposition does not have sedimentary structure formed by successive floods, this deposition is presumed to have been deposited in the old age (Figure 7.54D).

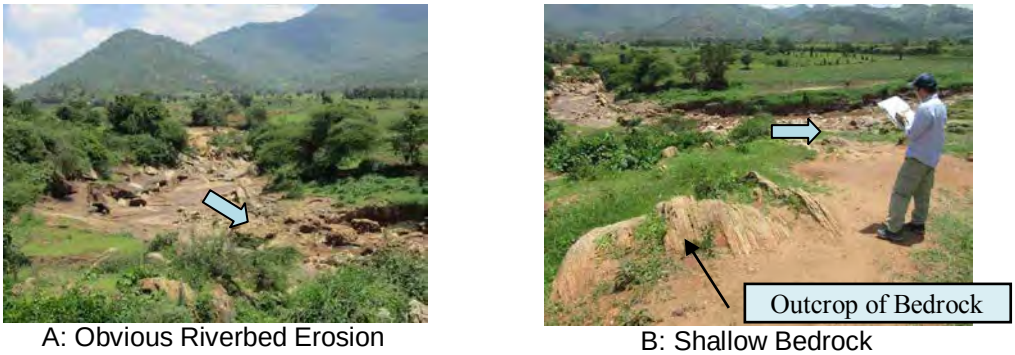


A: Thin Surface Soil
B: River in the Plain
C: Trace of Old Deposition
D: Near View of the Left

Figure 7.54: Condition of the Northern Part of Mangweta

(6) Site Ma7

This site is located at the boundary of the northern area and the southern area. Obvious riverbed erosion starts from this site (Figure 7.55A). Additionally, an outcrop of bedrock is distributed around this site (Figure 7.55B).



A: Obvious Riverbed Erosion
B: Shallow Bedrock

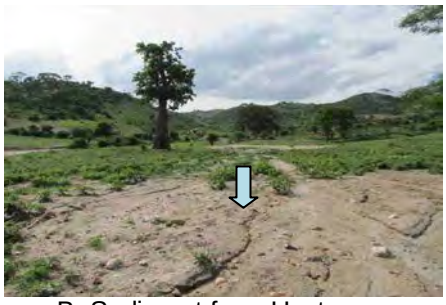
Figure 7.55: Condition of the Middle Reaches of Mangweta

(7) Site Ma8

This site is located at the north end of the southern area. The sediment discharge from the mountain side is the characteristic phenomenon (Figure 7.56A). However, evidence of slope failure is not observed on the mountain slope. Therefore, the discharged sediment is presumed to have been supplied from adjacent cultivated lands (Figure 7.56B). Additionally, a great deal of flood flow from the mountain causes the remarkable erosion on the right bank side (Figure 7.56C).

Steep cliffs which were formed by floods are observed along both riverbanks along the mainstream (Figure 7.56D). Additionally, thick sediment deposition is observed at both sides of the riverbank on the bedrock. This thick deposition is assumed to be the deposition which had been formed in the old age.

A: Trace of Sediment Flood


B: Sediment from Upstream


C: Erosion of Terrace

D: Riverbank Erosion

Figure 7.56: Condition of the Middle Reaches of Mangweta

(8) Site Ma9

This site is located in the middle reaches of the southern area. Remarkable river erosion is observed on both riverbanks, as in Site Ma8 (Figure 7.57A, B). An outcrop is observed in the riverbed (Figure 7.57C). Additionally, a thin deposition is observed partly in the riverbed. According to satellite photography, obvious deposition is distributed in the section from the downstream of site Ma9 up to the confluence (Figure 7.57D). The deposition in this section is presumed to be a source of supply to the Kinyasungwe River.

A: Remarkable River Erosion

B: Remarkable River Erosion

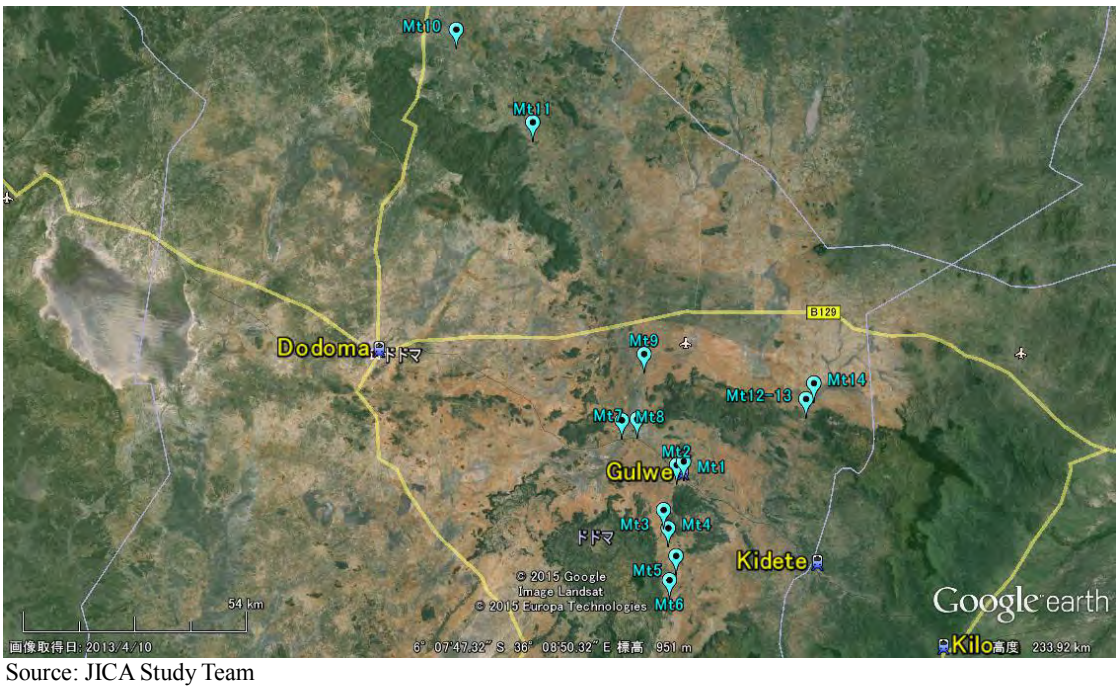
C: Outcrop of Bedrock

D: Deposition in Mangweta River
(in the Southern Area)

Figure 7.57: Condition of the Middle Reaches of Mangweta

7.3.7 Material of Sediment Deposition

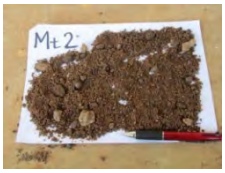
The sediment deposition of the riverbed is characteristic of both the geology and the soils of the watershed. Especially, the color is an indicator of the source(s) of supply. As previously mentioned, the sediment deposition of each site has a distinct color (or colors). Figure 7.58 shows the location of the sampling sites of riverbed materials, and Figure 7.59 shows a list of deposition.



Source: JICA Study Team

Figure 7.58: Map of Sampling Sites of Riverbed Materials

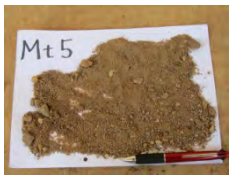

Kinyasungwe River (Gulwe Bridge)

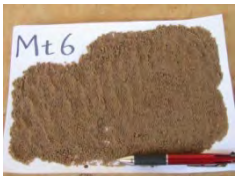
Mzase River


Mzase River


Kilibo River

Kibakwe River (Right Tributary)

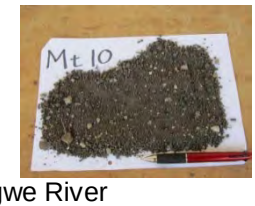



Kibakwe River (Left Tributary)


Msagari River


Msagari (Plain)


Kinyasungwe River

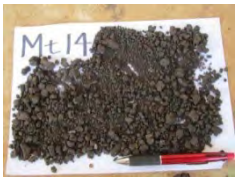



Kinyasungwe River


Kinyasungwe River (Ikombo)


Manguweta River (Riverbed)


Mangweta River (Old Deposition)

Mangweta River (Old Deposition)

Source: JICA Study Team

Figure 7.59: Comparison of Deposition Materials

7.3.8 Characteristics of Sediment Discharge Based on Reconnaissance

(1) Sediment Production from the Perspective of Geology and Topography

Geology and Geological Structure: Meta-igneous, Meta-sediments, gneiss, granulite, Migmatite and granite in Precambrian, which are greater than two billion years old (>2,000 Ma), are distributed in this watershed. The geological structure of Tanzania is characterized by the Great Rift Valley. Therefore, a lot of lineaments which express faults are observed along the Rift Valley.

Historical Development of Landform: The current landform has been formed over a long period of erosion. According to the process of topographical change, the current stage is "the old age". Therefore, the eroded ground has formed a gentle landform. An outcrop of bedrock is observed on the mountain slope, the surface land, the riverbed, etc. Sediment deposition with reddish or gray color is observed in the upstream areas of the Kinyasungwe, Mzase, and Kibakwe watersheds. The deposition is presumed to have been deposited in the old age. As mentioned above, this deposition is presumed to be the lake deposit or the sediment transported from Kenya, which was produced by a huge landslide.

(2) Sediment Deposition in the River

Kilosa–Kidete: Dense forests are distributed in the Mdukwe–Lumuma and Mkondoa watersheds. The surface soil of the mountain slopes is thin, and an outcrop of bedrock is observed on the slope, the riverbed, and the road surface. A small amount of sediment deposition is observed in the riverbed of the small streams.

The Upstream Area from Gulwe: The upstream area from Gulwe of the Kinyasungwe River forms a vast plain. Swamps are formed in the wet season in the lower areas of the vast plain. In this area, sediment deposition which has been obviously transported by floods was mostly not observed. Additionally, a vast plain spreads in the upstream area of the Gulwe Bridge, and traces of sediment discharge are not observed. Therefore, the sediment discharge from the upstream areas of the Gulwe Bridge to the downstream areas is judged as not obvious, except for wash loads.

(3) Source of Sediment Production

The Remarkable Sediment Production Area: The area which has the most remarkable sediment discharge is observed in the section between Kidete and Gulwe. Especially, the Maswala, the Kidibo, and the Mzase Rivers are the ones in which the sediment discharge is quite significant.

The Sediment Discharge Characteristics of Three Tributaries: The bedrock was observed at the channel works of the Mzase River and the channel river of the Maswala River near the railway. The relative height of the confluence of the Maswala and the Kidibo Rivers is a few meters. Basically, these areas consist of the old alluvial fan, of which end parts (tongue shaped by deposited fan) have a steep slope. Currently, the aggradations of bed slope of the mainstream does not affect to those in the tributaries, in other words, the bed slope seems stable in those tributaries. That proves still active inflow of sediment material produced in the tributaries toward the mainstream.

The Source of Sediment Production: The source of sediment production is judged to be the expanded cultivated lands in the upstream areas of the tributaries. Because the surface soil was disturbed by cultivation and overgrazing, they flow out easily during rainfall. The disturbance of surface soil is assumed to weaken the resistance to the raindrop erosion and surface flow. Floods are presumed to accelerate the bank erosion process.

(4) Sediment Transportation Capacity

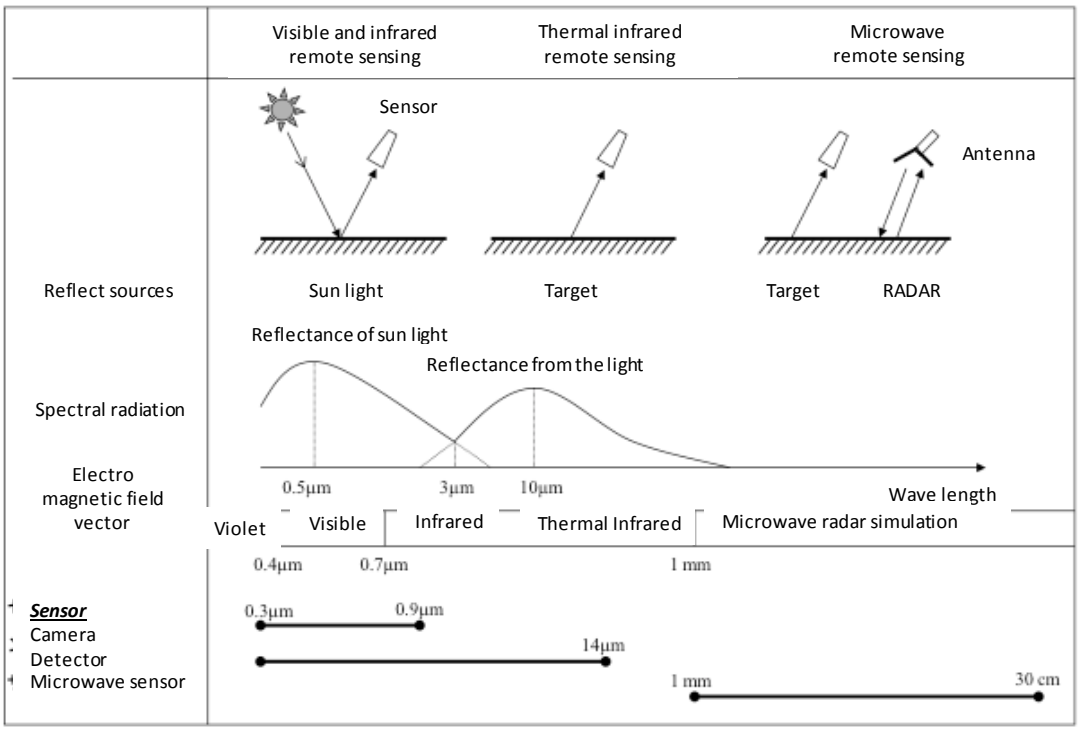
Sediment Transportation Capacity of the Kinyasungwe River: The Kinyasungwe River does not have the required volume of river water to flow continuously and move deposition in the riverbed. Therefore, the riverbed of the Kinyasungwe River has been rising.

Sediment Transportation Capacity of Tributaries: The aggradation of the Kinyasungwe River influences the aggradation of its tributaries.

7.4 Study on Seasonal Changes of Surface Flow Using Satellite Photographs

7.4.1 About Synthetic Aperture Radar (SAR)

The general characteristics of the satellite photographs are as shown in Figure 7.60. Table 7.2 shows advantage and disadvantage of the optical sensors and the radar. Synthetic Aperture Radar (SAR) has the advantage of being unaffected by weather conditions. Figure 7.61 shows the differences in their resulting images.



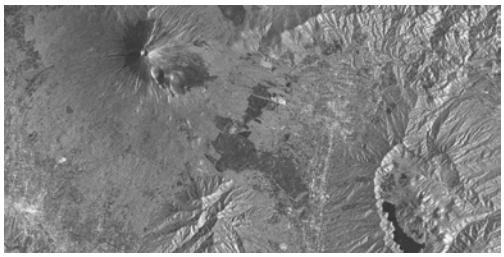
Source: Illustration Remote Sensing, 1992, Japan Association of Surveyors

Figure 7.60: Differences of Sensors

Table 7.2: Characteristics of Different Sensors

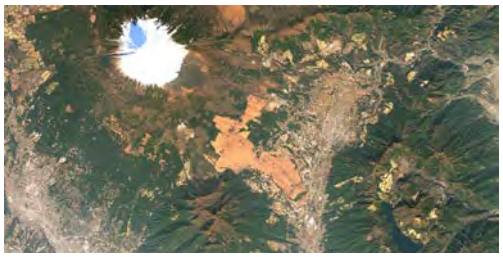
Sensor	Radar	Optical
Advantage	It can observe both day and night and under bad weather conditions.	It can acquire the images similar to the views from an airplane. Therefore, the results can be easily interpreted.
Disadvantage	The images are not easily interpreted.	It cannot observe under bad weather conditions, or at night, unless strong light sources are given.

Source: JICA Study Team



Ortho-rectified (foreshortening) PALSAR imagery, 2006/12/30 10:15 (JST)

Radar Image



Ortho-rectified AVNIR-2 imagery (true color), 2006/12/30 10:15 (JST)

Optical Image

Source: JICA Study Team

Figure 7.61: Differences of Resulting Images: Radar vs. Optical

7.4.2 Result of the Analysis by Radar

The seasonal changes of surface flow were studied using satellite photographs from both the dry season and the wet season. The sensor used for this analysis was PALSAR installed on the Japanese satellite ALOS ("Daichi", in Japanese). The orbit cycle of ALOS is 46 days. Therefore, a proper photographing date has to be selected depending on this cycle. The resolution of the images is 10 m. The selection of the photograph date used for the analysis was done in consideration of the December 2009 flood (Figure 7.62).

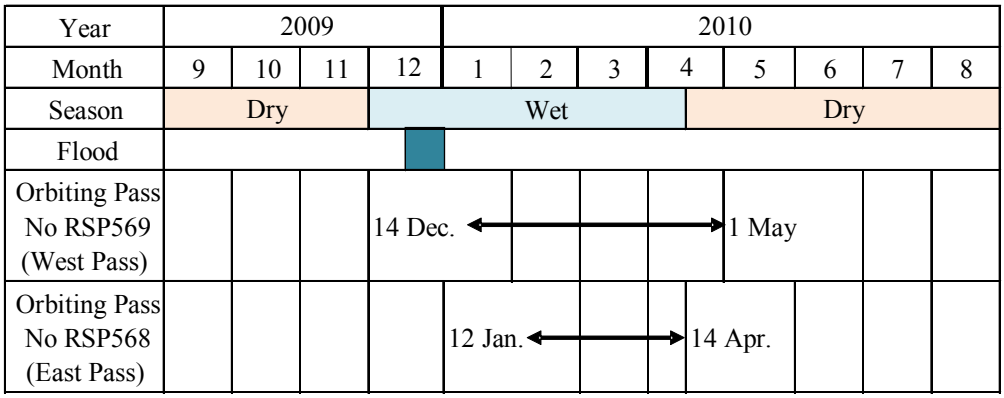
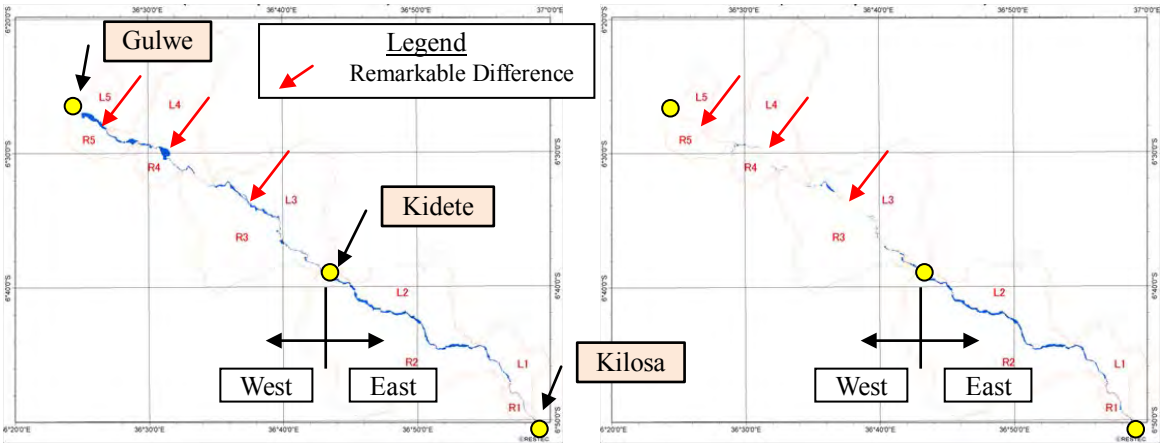


Figure 7.62: Season and Photographing Date

Figure 7.63 shows the results of analysis. Obvious difference between the rainy and dry seasons is confirmed. The river channel, which is not observed in the dry season between Gulwe and Kidete, is observed in the wet season.



A: Result of Wet Season B: Result of Dry Season

Figure 7.63: Difference between the Dry Season and the Wet Season

7.5 Sediment Analysis based on Satellite Photo Analysis

7.5.1 Past Studies Related to Sediment Yield

This section refers to the following document: "Soil Erosion and Sedimentation in Semi-arid Tanzania; Studies of Environmental Change and Ecological Imbalance", by Carl Christiansson, Scandinavian Institute of African Studies, Uppsala and Department of Physical Geography, University of Stockholm (hereinafter called "Document Ch").

This report is written about sediment yield in almost the same area as this Study Area, namely, between Dodoma and Mpwapwa. Especially, this historical information of sediment deposition in the irrigation dams is important data for the Study Team. The investigation spanned from 1968–1974.

(1) Background of Sediment Yield

The following list quotes from various sections of Document Ch:

i) During the latter half of the 1930s and 1940s, the Agricultural Department carried out an intense propaganda program for soil conservation, including contour banking, and restrictions were introduced against cultivation and grazing on the upper pediments.

ii) At the same time, people were taught to use cattle manure, during the 1940s manuring became more and more widespread. A semi-permanent type of cultivation could be maintained in the valleys.

iii) Many of the fields on the upper pediments, which at that time were already badly eroded and most probably gave poor returns, were abandoned. The upper pediments then served mainly as grazing areas and land for fuel wood production.

iv) By 1960 the bush-vegetation had got denser, but grass seemed to be scarce. In the early 1970s, the bush was still denser and partly impenetrable.

v) In 1974 general cultivation campaign was launched in Tanzania. The aim was to increase the production of food crops in order to make the country less dependent on imports.

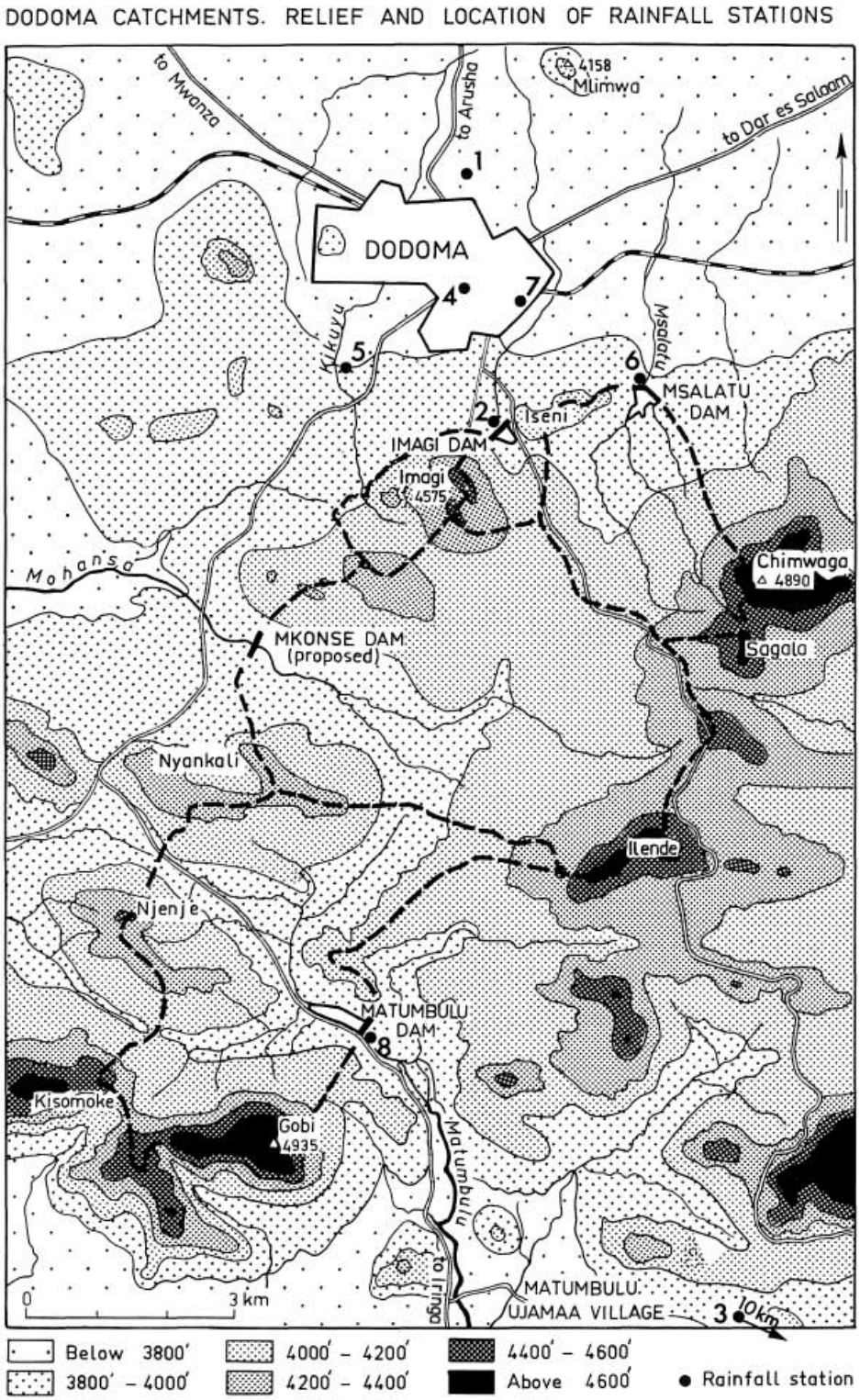
vi) Around Dodoma, many fields were again cleared on the upper pediments.

vii) The result was increased erosion and in some cases new gullies were formed.

viii) After all, the conservation program failed. The banks were not strong enough to keep the runoff water back. On occasion with intense rain the water broke through one contour bank after the other. The reason for the collapses may have been seepage underneath the ridges or defects in the design.

The investigation area of the report is shown in Figure 7.64.

The conditions at that time are shown in Figure 7.65 (quoted from "Document Ch").



Source: Document Ch, p. 19

Figure 7.64: Dodoma Catchments

Kongwa Plain (October 1974)

Msalatu River (March 1970)

Imagi Dam Full View (December 1970)

Deciduous bush in Mpwapwa
(November 1974)

Tor Topography and Cattle Track (December 1971)

Thicket in Ugogo
(Early 20th Century)

Overgrazing
(October 1974)

Erosion in Kondoa
(December 1971)

Sheet Erosion
(December 1971)

Tree-less Land
(September 1971)

Active Gully Erosion
in Kondoa (December 1971)

Wooded Grassland in the
Kongwa (early 20th Century)

Source: Document Ch

Figure 7.65: Condition of This Area in the 20th Century

(2) Real Condition of Dam Deposition

At that time, five irrigation dams were constructed in Dodoma and its surrounding areas. The original function of these dams has declined due to sediment deposition. The condition of the five dams' deposition is reported in "Document Ch". The result is shown in Table 7.3 (edited by the JICA Study Team). The locations of four out of the five dams are shown in Figure 7.66.

Table 7.3: Condition of Dam Deposition

Dam Name	Construction	Catchment Area (km2)	Capacity (m3) (a)	Note
Ikowa	1956-57	612.0	3,807,000	
Matumbulu	1960	15.0	333,000	
Msalatu	1944	8.5	420,000	Excavation: 8,000m3(1953)
Imagi	1929	2.2	169,500	Excavation: 9,000m3(1952)
Kisongo	1960	9.3	129,500	

Dam Name	Deposition Term	Total Sediment Yield (m3) (b)	Sediment Ratio (b/a %)	Annual sediment yield			
				m^3/yr	$m^3/km^2/yr$	$t/km^2/yr$ [1]	$mm/km^2/yr$
Ikowa	1957-60	696,000	18.3	231,700	379	570	0.38
	1960-63	371,000	9.7	123,700	202	300	0.20
	1963-69	425,000	11.2	70,800	116	170	0.12
	1969-74	315,000	8.3	63,000	103	150	0.10
	1957-74	**1,807,000**	**47.5**	**106,300**	**174**	**260**	**0.17**
Matumbulu	1962-71	84500	25.4	9389	626	940	0.63
	1971-74	20000	6.0	6667	445	670	0.45
	1962-74	**104500**	**31.4**	**8708**	**581**	**870**	**0.58**
Msalatu	1944-50	31,000	7.4	5,167	607	910	0.61
	1950-60	39,000	9.3	3,900	458	690	0.46
	1960-71	60,000	14.3	5,455	641	960	0.64
	1971-74	14,000	3.3	4,667	548	820	0.55
	1944-74	**144,000**	**34.3**	**4,800**	**564**	**850**	**0.56**
Imagi [2]	1934-50	17,500	10.3	1,094	497	750	0.50
	1950-60	16,500	9.7	1,650	750	1,130	0.75
	1960-71	15,000	8.8	1,364	620	930	0.62
	1934-71	**49,000**	**28.9**	**1,324**	**602**	**900**	**0.60**
Kisongo [2] [3]	1960-69	37,400	28.9	4,156	447	670	0.45
	1969-71	11,900	9.2	5,950	640	960	0.64
	1960-71	**49,200**	**38.0**	**4,473**	**481**	**720**	**0.48**

1) γ: 1.5g/cm^3 2) edited by JICA study team 3) The other watershed (3° 20' S,36° 35'E)

Source: Document Ch, edited by JICA Study Team

Source: JICA Study Team

Figure 7.66: Map of Existing Four Dams in the Upstream Area of Kinyasungwe

7.5.2 Land Cover Classification by Satellite Photo Analysis

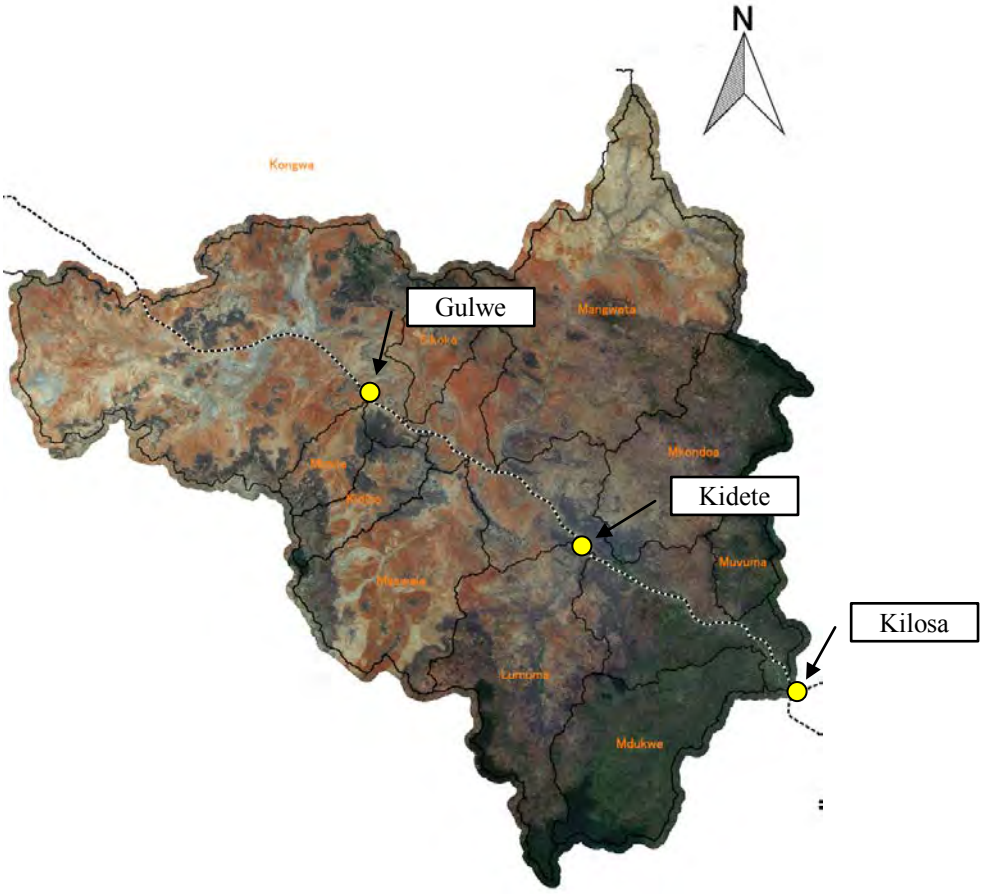
According to the site investigation, the sediment discharge from the upstream areas of the Gulwe Bridge to the downstream areas is judged as not obvious, except for wash loads. Therefore, the sediment productivity between Kilosa and Gulwe is studied further below:

Generally, the type of land cover will indicate the tendency of sediment discharge (or lack thereof). For example, in forested areas, sediment does not flow out easily, because of the high-vegetation cover.

As previously mentioned, the stage of topography in this area is the old age. Because of this, slope failures are generally not observed in this area. On the other hand, the cultivated land allows sediment to flow out easily, as the ground lacks vegetation and is exposed to the rainfall. The Mzase, Kidibo and Maswala areas, which have expanding cultivated lands and overgrazing, exhibit this situation.

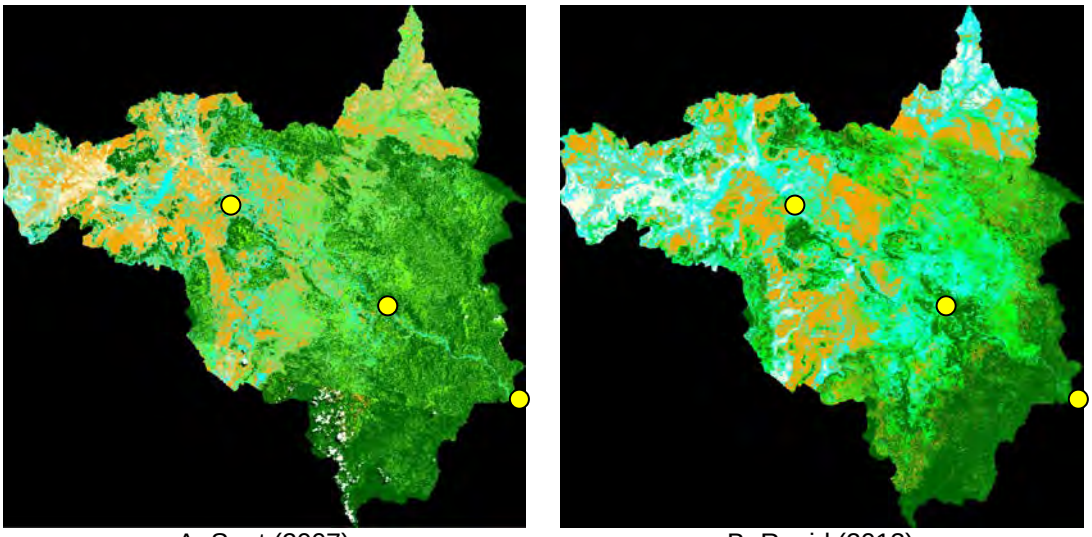
Figure 7.67 shows the optical image of the target area produced by RapidEYE, which was photographed in 2013. The optical image is the same tone as it is visible to the human eye. According to Figure 7.67, a dark tone corresponds to forest zones, a slightly less dark tone exists around the forest, and a reddish-brown tone corresponds to zones where the sediment productivity is high.

The tone classification of the target area was conducted based on the optical image. As a result, the image was classified into five color tones: Green, Yellow Green, Orange, Light Blue and White (Figure 7.68).



Source: JICA Study Team

Figure 7.67: Optical Image (RapidEYE 2013)



A: Spot (2007) B: Rapid (2013)

Source: JICA Study Team

Figure 7.68: Photos by Image Analysis

The Spot image, whose resolution is 10 m, was photographed during 2007 (before the flood of December 2009). The Rapid image, whose resolution is 5 m, was photographed between 2013 and 2014 (after the flood of December 2011).

According to the site survey, areas corresponding to the orange color zone are often seen at the zone where gabbro has been weathered, and areas corresponding to the blue colored zone are often seen in areas in which the metamorphic rocks and gneiss have been weathered.

Considering the field reconnaissance, the color tones of the image are classified as shown in Table 7.4. Figure 7.69 shows the condition of the typical sites of each color.

Table 7.4: Tone Classification of the Image

Color	Characteristics of Distribution Area
Green	Dense Forest Area
Yellow Green	Bush or Cultivated Land Area
Orange	Mainly Weathered Rock Area of Mafic Igneous (main land use: Village, Cultivated Land)
Light Blue	Mainly Weathered Rock Area of Metamorphic Rock and Gneiss (main land use: Village, Cultivated Land and Swamp)
White	Mainly Sediment Deposition Area (main land use: Swamp, Cultivated Land)

Source: JICA Study Team

Green Zone

Light Green Zone

Orange Zone

Light Blue Zone

Figure 7.69: Condition of Typical Sites of Colored Areas

7.5.3 Study of Sediment Yield by Satellite Photo Analysis

(1) Reclassification based on the Characteristics of Land Cover

Orange color zones, in which the sediment productivity is high, are seen also in the forest zone, such as in the Mdkuwe watershed. However, the orange color of the forest zone is presumed to be fundamentally different from the orange color of cultivated land, such as the Maswala watershed. In other words, the sediment productivity of the orange color in the forest zone is judged to be lower than that of the cultivated land. Similarly, the light blue zones in the upstream of Maswala are assumed to be different from the other sites, such as swamp zones. Therefore, considering the characteristics of the sediment productivity based on the field reconnaissance, each color is classified as shown in Table 7.5.

Table 7.5: Classification of Tributaries by Sediment Productivity

Classification	Sediment Productivity			
	High		Low	
	Mzase Kidib Maswala Sikoko	Mangweta	Lumuma Mdukwe Mkondoa Muvuma	Mangweta
Green	(all watersheds have low productivity)			
Yellow Green	○		○	○
Orange	○	○	○	
Light Blue	○		○	○
White	○		○	○

Source: JICA Study Team

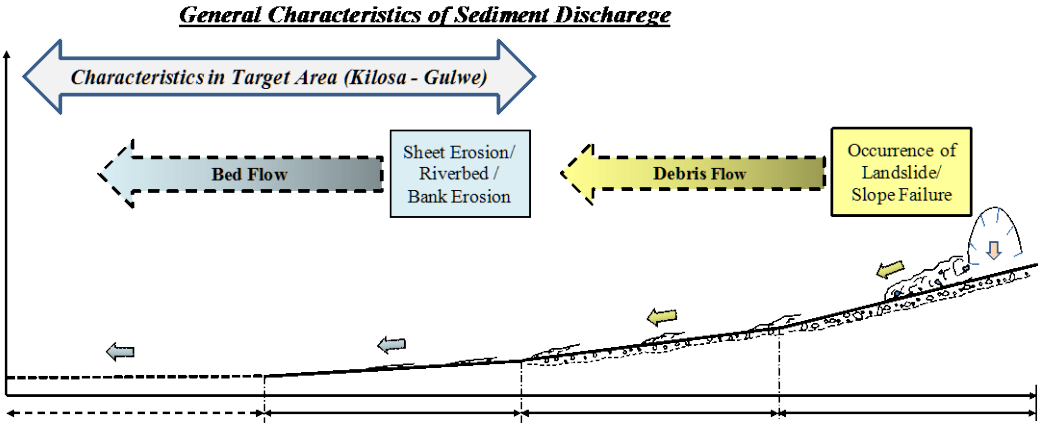
(2) Difference of the Productivity by Slope Gradient

The gradients of the slope and riverbed are important factors in sediment transportation ability. Figure 7.70 shows the general sediment movement pattern according to the gradients. According to this figure, the following things can be pointed out.

There are almost no slope failures in mountains of this target area. Therefore, the sediment production area is judged to be the pediment area. The sediment productivity of slopes of less than three degrees is low. The movement of material on these gentle slopes is of a material which is less than that of sand. The material in the sediment production zone of the target area is the same. On the riverbed, there is bed load transport (as opposed to suspended load, transition).

Figure 7.71 shows the distribution of the slopes less than three degrees. According to this figure, the following points can be made:

i) Vast plains are distributed in the Msagali, in the upstream area of Gulwe.
ii) Slopes less than three degrees are distributed in the Mzase, Kidibo, and Maswala.
iii) However, in the mountainous areas between the Kilosa and Kidete, slopes less than three degrees are basically not present.

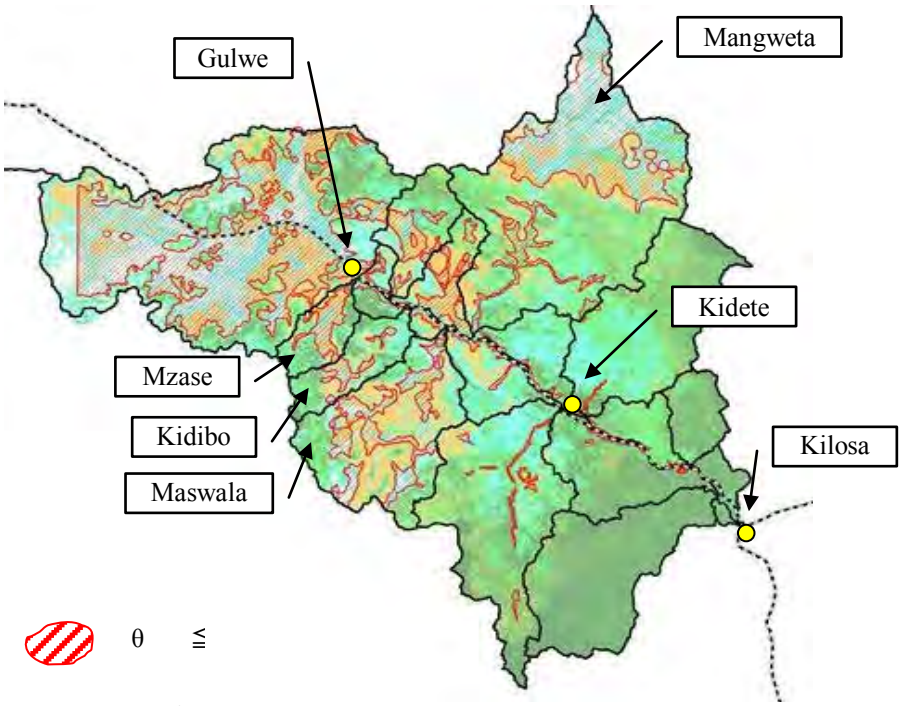


Riverbed Gradient	θ<1/300-1/200	θ<2-3deg (1/30-1/20)	θ<5-10deg (1/7-1/6)	15deg(1/4)<=θ
Occurrence area	Plain / Swamp	Pediment	Foot of Mountain	Mountain Slope
Erosion Form	*(River Bank/ Riverbed Erosion)*	Sheet Erosion *(River Bank/ Riverbed Erosion)*	Sheet Erosion *(River Bank/ Riverbed Erosion)*	Landslide /Slope Failure
Zone of Flow /Deposition	Flow / Deposition Zone	Flow / Deposition Zone	Flow / Deposition Zone	Flow Zone
Flow Form in the River	Bed Load Transport *(Bed Load / Suspended Load /Wash Load)*	Bed Load Transport *(Bed Load / Suspended Load /Wash Load)*	Debris Flow	
Riverbed Material* (Except Wash Load)	Sand, Granule, (Pebble) *(Sorting Process)*	Silt, Sand, Granule, Pebble *(Sorting Process)*	Fine material, Sand, Gravel, Cobble, (Boulder) *(Sorting Process)*	Fine material, Sand, Gravel, Cobble, Boulder

*Refer to Riverbed Material Aanlysis

Source: JICA Study Team

Figure 7.70: Sediment Movement Form



Source: JICA Study Team

Figure 7.71: Distribution of Slopes less than Three Degrees (3°)

(3) Calculation of Sediment Yield

Calculation of the sediment yield is calculated as follows:

i) The sediment yield is calculated based on the existing document about dam deposition (refer to Section 7.5.1 and Table 7.6).
ii) However, annual erosion depth should be considered as characteristic of each watershed.
iii) The value based on the data of dam deposition is average. Practically, each value has a wide range, so erosion depth should be considered at about this range.
iv) This erosion depth includes riverbed and bank erosion.

Table 7.6: Erosion Depth based on the Existing Document

Dam	Area (km^2)	Erosion Depth ($mm/km^2/y$)
Ikowa	3,807,000	0.17
Matumbulu	333,000	0.58
Msalatu	420,000	0.56
Imagi	169,500	0.60
Kisongo	129,500	0.48

Source: JICA Study Team

Table 7.7 shows the determined annual erosion depth of the respective colored zones.

Table 7.7: Annual Erosion Depth

Erosin Depth ($mm/km^2/y$)

Classiffication	Slope < 3°	Slope >=3°	
		Mzase, Kidibo, Maswala, Sikoko, R3, R4, R5, L4, L5, (Mangweta:Orange A)	**Lumuma, Mdukwe, Mangweta, Mkondoa, Muvuma, R1, R2, L1, L2, L3**
Green	0.001	0.01	0.01
Yellow Green (A)	0.001	0.05	
Yellow Green (B)			0.02
Orange(A)	0.01	0.80	
Orange(B)			0.05
Light Blue (A)	0.01	1.50	
Light Blue (B)			0.05
White	0.01	0.60	0.60

Source: JICA Study Team

The result of image analysis by RapidEYE is as shown in Table 7.8. The total sediment yield from the tributaries to the main river is about 680,000 m^3, and about 910,000 m^3 with the addition of the remaining watershed area. Additionally, the sediment discharge can be divided into upstream downstream areas, with Kidete as a boundary, considering the riverbed slope. Figure 7.72 shows the enlarged view of the land cover by RapidEYE.

Table 7.8 shows the high value for specific sediment discharge ($m^3/km^2/year$) in the upstream in comparison with the downstream. The sediment inflow map into the main river is shown in Figure 7.73.

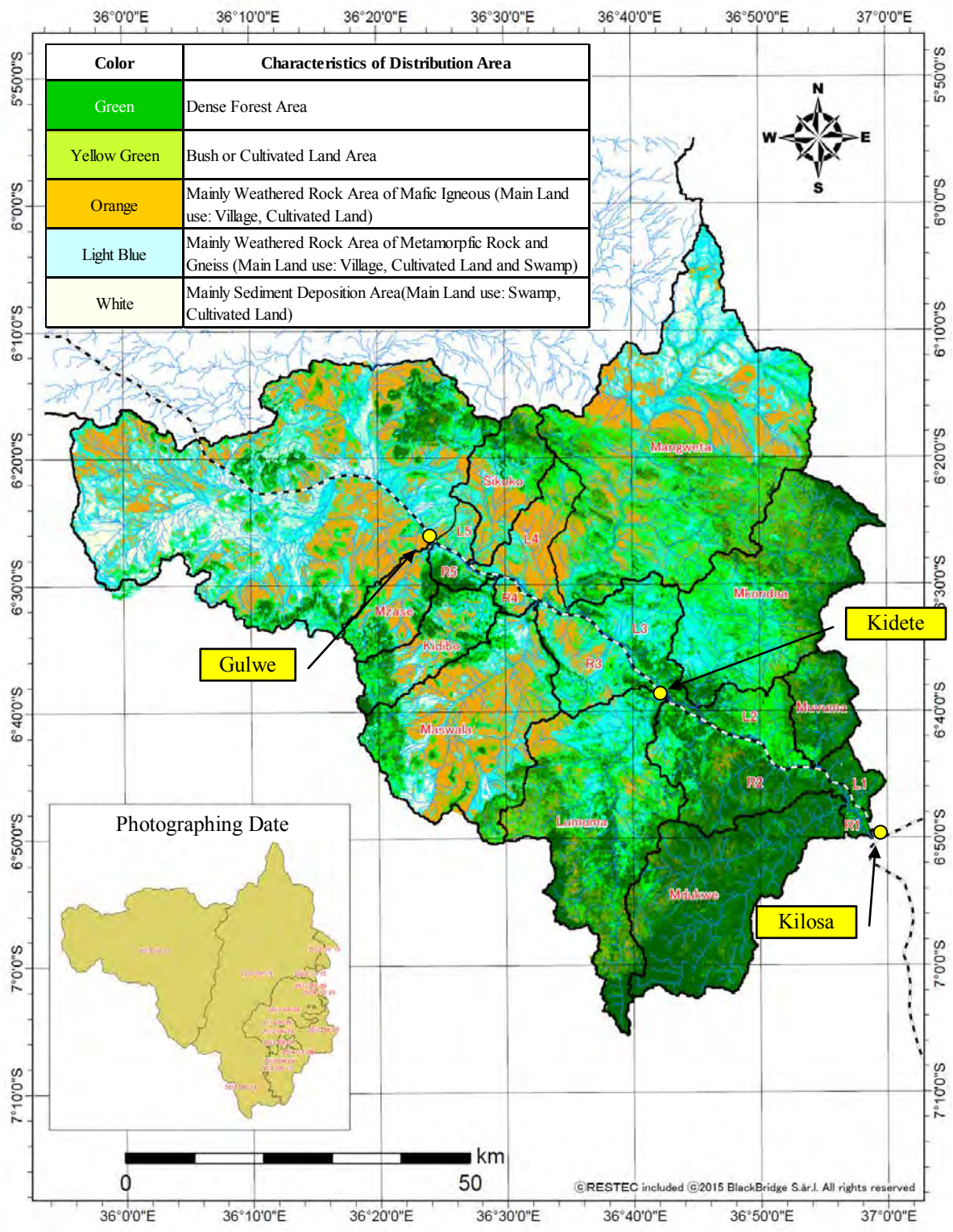
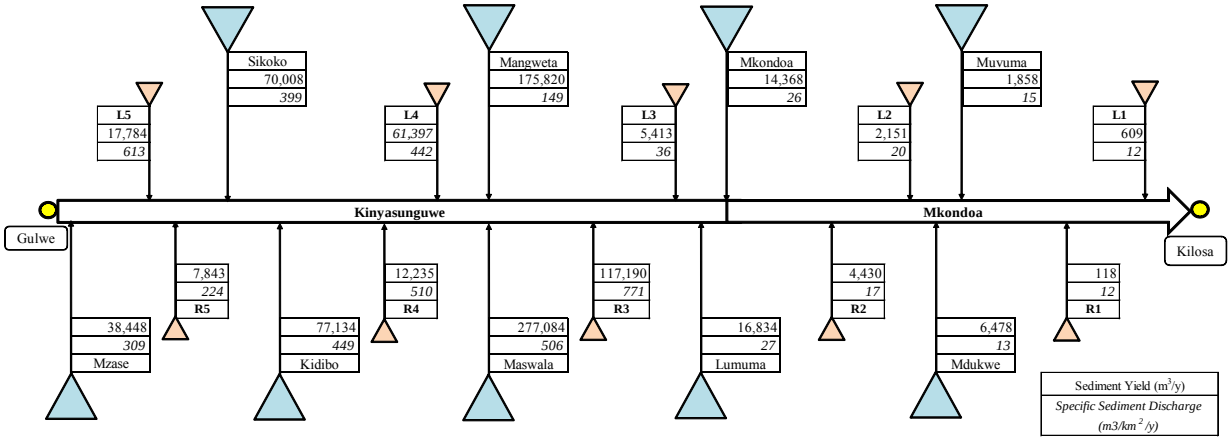


Figure 7.72: Land Cover Map by RapidEYE

Table 7.8: Sediment Yield from Tributaries

Tributary Watershed	Area (km^2)	RapidEYE (2012) Slope Classification	
		Total Sediment Yield (m^3/yr)	Specific Sediment Discharge ($m^3/km^2/yr$)
Mzase	124	38,448	309
Sikoko	175	70,008	399
Kidibo	171	77,134	449
Maswala	548	277,084	506
Mangweta	1,180	175,820	149
Sub-total (U/S)	2,198	638,494	290
Lumuma	629	16,834	27
Mkondoa	550	14,368	26
Muvuma	123	1,858	15
Mdukwe	512	6,478	13
Sub-total (D/S)	1,814	39,538	22
Tributaries Subtotal	4,012	678,032	169
L1	50	609	12
R1	10	118	12
L2	109	2,151	20
R2	266	4,430	17
Sub-total (D/S)	435	7,308	17
L3	149	5,413	36
R3	152	117,190	771
L4	139	61,397	442
R4	24	12,235	510
L5	29	17,784	613
R5	35	7,843	224
Sub-total (U/S)	528	221,862	420
Remaining Areas Subtotal (Gluwe～Kilosa)	963	229,170	238
Total (U/S)	2,726	860,355	316
Total (D/S)	2,249	46,847	21
Grand Total	4,975	907,202	182

Note: U/S: Upstream, D/S: Downstream
Source: JICA Study Team



Source: JICA Study Team

Figure 7.73: Sediment Inflow Map into the Mainstream

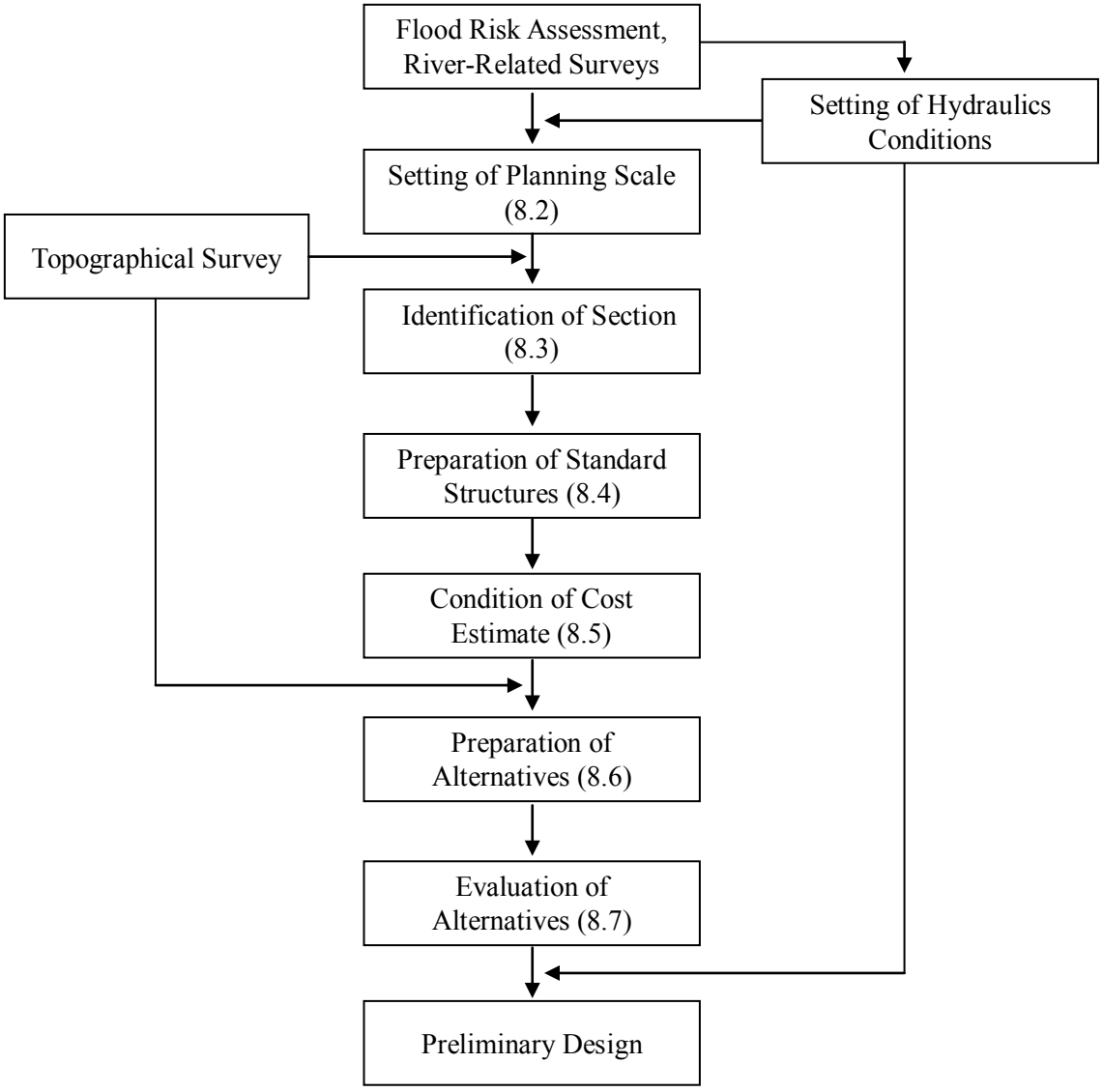
7.6 Study of Countermeasures for Sediment Disaster

<This part has been removed because of confidential information.>

8. Selection of the Alternatives for Flood Protection Measures

8.1 Methodology for Preparing Alternatives for Flood Protection Measures

Figure 8.1 presents the overall work flow of preparing alternatives for flood protection measures.



Note: Figures in parenthesis indicate the section of this Final Report.
Source: JICA Study Team

Figure 8.1: Work Flow of Preparation of Alternatives

8.2 Setting of Planning Scale for Preparation of Flood Protection Measures

8.2.1 Identification of Current Conditions

(1) Runoff Characteristics of Wami River Basin

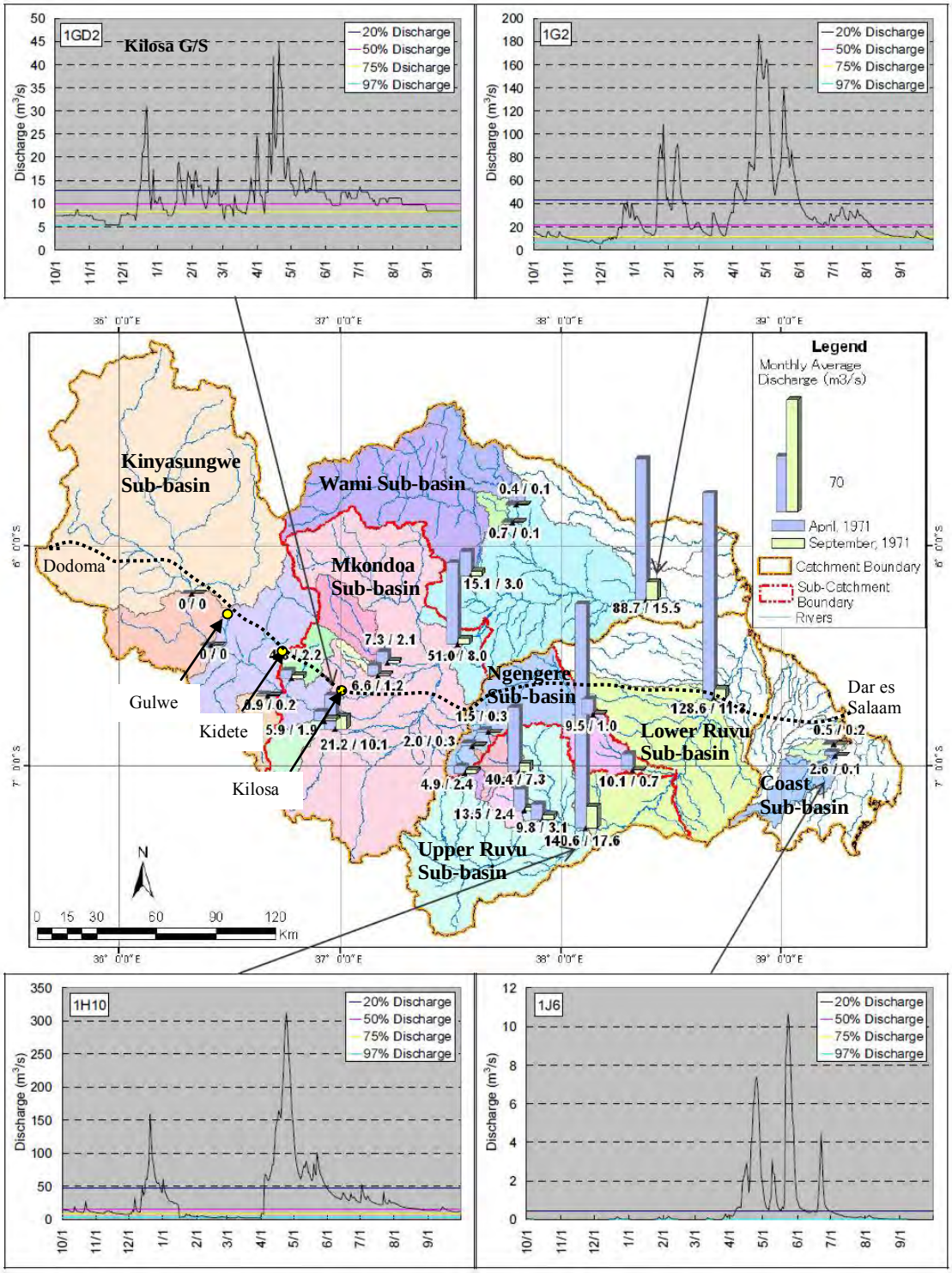
A map of the Wami River basin is shown in Figure 8.2, with its sub-basins and seasonal runoff fluctuation (mean daily discharge fluctuation in a year) statistics at major observatories. Through "the Study on Water Resources Management and Development in Wami/Ruvu Basin" under JICA in 2013, the study areas are divided into total seven sub-basins. The target area for this Study, stretching from Kilosa to Dodoma, is located across the (i) Kinyasungwe and (ii) Mkondoa sub-basins.

The runoff at Kilosa is relatively small with around 10 m^3/s of annual mean daily discharge and 45 m^3/s of annual maximum mean daily discharge. Further, although base flow (approx. 5 m^3/s: 97% dependable discharge) exist at Kilosa, areas upstream of the confluence with the Mkondoa River are seasonal rivers, and seems to have no surface flow for more than a half of year (May to October), based on the discharge measurements and field reconnaissance of this Study. This is one of key premises to discuss sediment transport in the main stream and fluctuations of the riverbed.

(2) Flood Characteristics in Target Areas

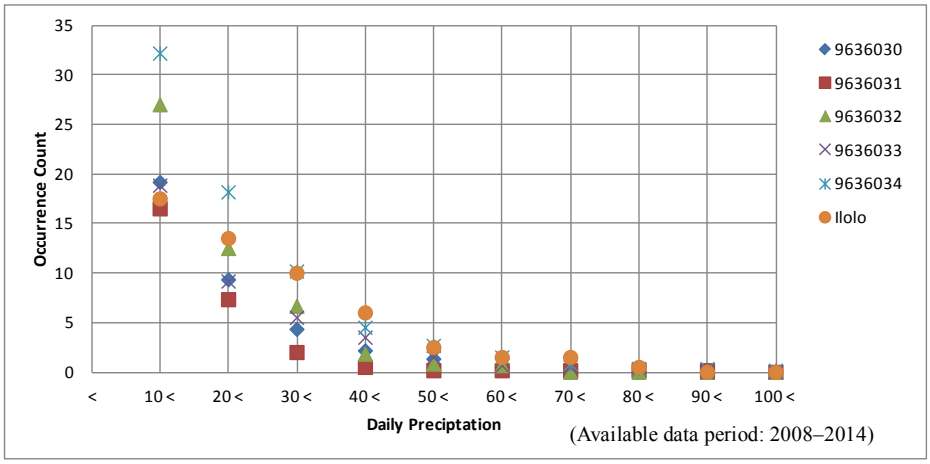
1) Frequency of Flood Occurrences

The frequency of heavy rainfall/short duration events at six major rainfall gauging stations in the Wami River basin is shown in Figure 8.3 (into 10 mm divisions). For instance, the frequency of 50 mm/day or more is counted fewer than three times a year at all stations, and 60 mm/day or more is even less frequent. This shows that frequency of flood occurrence is no so high in this basin. The locations of rainfall and water level gauging stations are shown in Figure 8.4.



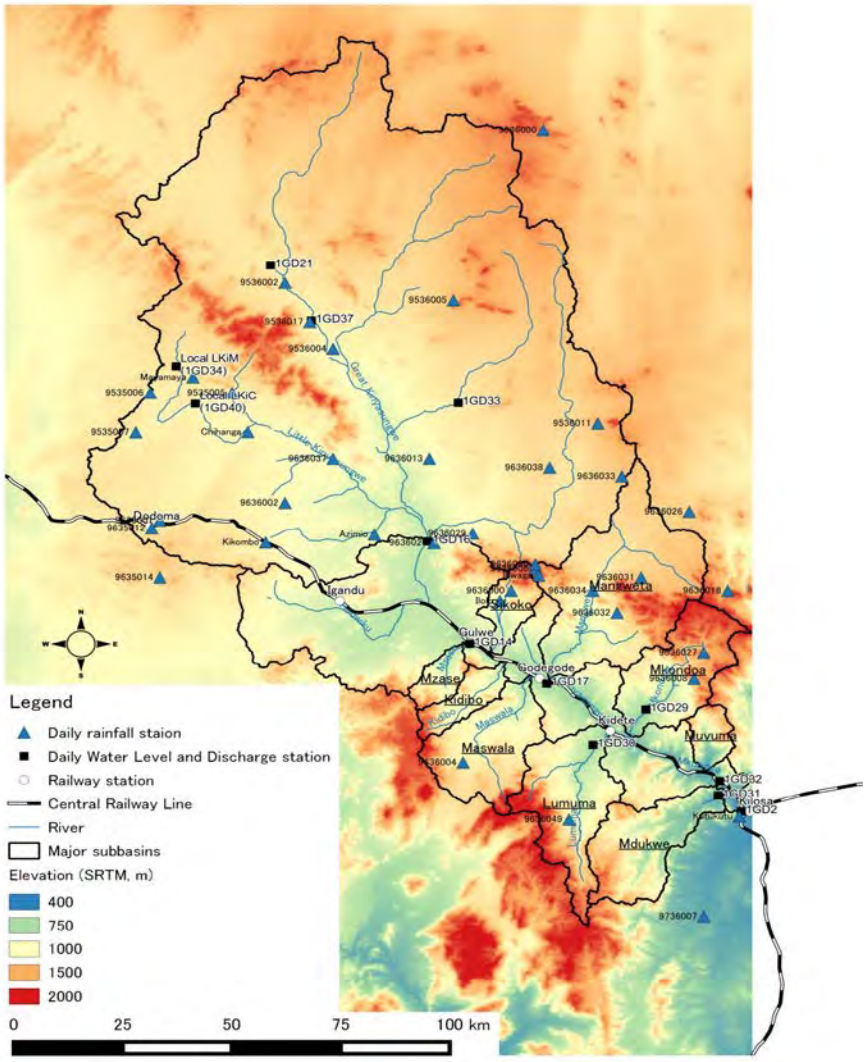
Source: The Study on Water Resources Management and Development in Wami/Ruvu Basin, Final Report, Nov. 2013, JICA

Figure 8.2: Runoff Characteristics of the Wami-Ruvu Basin



Source: JICA Study Team

Figure 8.3: Frequency of Heavy Rainfall Events in the Wami River Basin



Source: JICA Study Team

Figure 8.4: Location of Daily Rainfall Station/Daily Water Level and Discharge Gauging Stations in the Study Area

2) Relationship between Flood Marks and Railway Alignment

(a) Flood Mark Survey

The Flood Mark Survey was conducted between March and June 2015 by a sub-contractor of the JICA Study Team. The results are summarized as follows:

- Objective

To identify the flood marks on houses, buildings, trees, and ground, etc. through interviews with local residents, and to measure the elevation by connection with the bench marks established by the contractor of the river cross-section survey

- Name of Contractor

GeoHydro Consultants, Dar es Salaam, Tanzania

- 42 flood marks identified between Kilosa and Gulwe (on average, a mark every 2 km)

Marking of elevation was conducted on structures (such as revetments and culverts), house walls, tree trunks, and/or on the ground.

(b) Elevation of Flood Marks and Exiting Railway Truck

Three elevations of flood marks, the existing railway track level, and the level of the lowest riverbed (obtained by the river cross-section survey in March 2015) were compared between Kilosa and Gulwe. As a result, it was duly confirmed that flood water levels have reached to the level of the railway track in most of the river sections due to past floods. Furthermore, it was clarified that the flood marks were left by the two remarkable floods in 1997/1998 and 2009/2010, based on the interviews with villagers in the vicinity. Therefore, the survey results coincide with the evidence of devastating flood damage on the railway facilities experienced in most of the low-lying stretches of the existing railway from Kilosa to Gulwe.

(c) Computation of Experienced Maximum Flood Peak Discharge

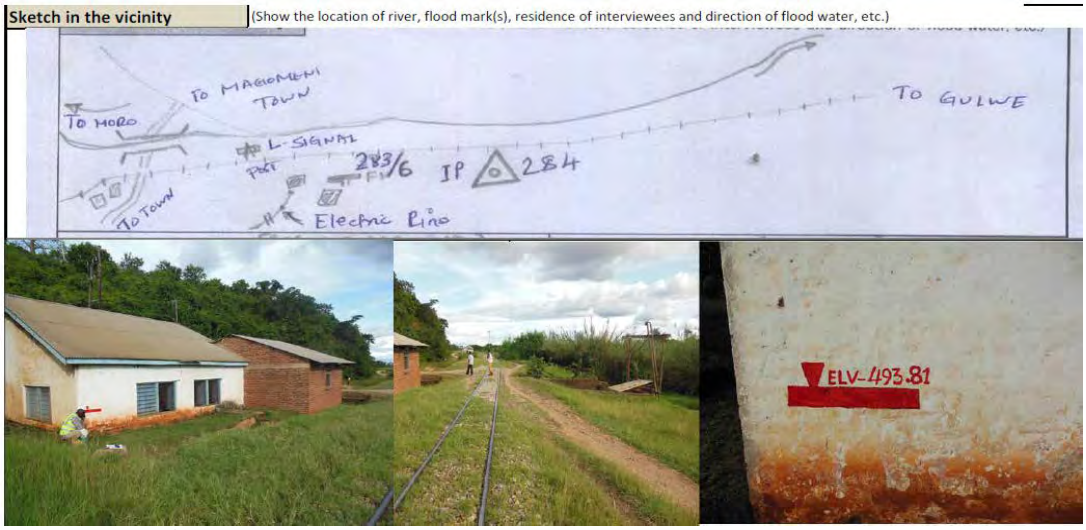
Reliable flood records of discharge and water levels are quite limited in the Wami River basin. Therefore, an attempt to find a discharge value corresponding with the past highest flood marks was conducted for the river section between Kilosa (Km 283) and Gulwe (Km 366).

(i) Basic conditions for computation

- Target section: From Kilosa to Gulwe (Km 283–Km 366)
- River cross-sections: Latest cross-sections by the 2015 survey (average 1.0 km interval)
- Computer software: One dimensional non-uniform flow model (HEC-RAS)
- Parameters for computations: Manning's roughness coefficient n= 0.033 (low water channel) and 0.060 (high water channel)

(ii) Adjustment of peak discharge at downstream boundary (Kilosa)

Hydraulic computation was attempted to replicate the water level set by the flood mark near Km 294 in Kilosa. The site photo of the flood mark near Kilosa is shown in Figure 8.5. Through the trials, it was verified that the discharge of 2,000 m^3/s could represent the reliable flood mark elevation at Kilosa (Figure 8.8).



Source: JICA Study Team

Figure 8.5: Flood Mark at 283.6 km near Kilosa

(iii) Computation of flood peak discharge of a tributary (Lumuma River)

A reliable flood mark was confirmed at the gabion revetment of the railway bridge crossing the Lumuma River near Kidete (EL 670.89, H = 4.55 m) (Figure 8.6). The channel shape of the bridge section is formed by concrete abutment connected with gabion boxes at the up and downstream sides. A drop structure around 30 m downstream of the bridge section creates critical flow. Therefore, it can be judged that a theoretical hydraulic formula of rectangular weir (Figure 8.7) can be applied to estimate the discharge. Based on the flood mark elevation, the discharge corresponding with the water depth was estimated. The flood discharge was estimated at 326 m^3/s by the formula (Figure 8.7).

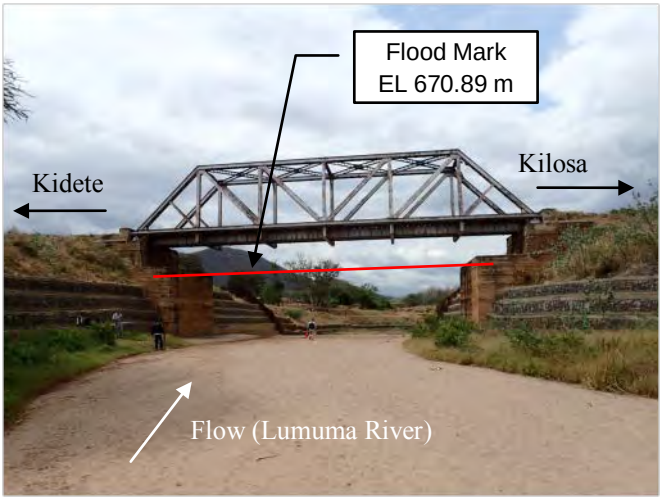
(d) Discharge Distribution to Major Tributaries

At this moment, the flood discharges of the tributaries are still under examination. Therefore, the discharge level at Kilosa was distributed amongst its major tributaries by catchment size, as follows:

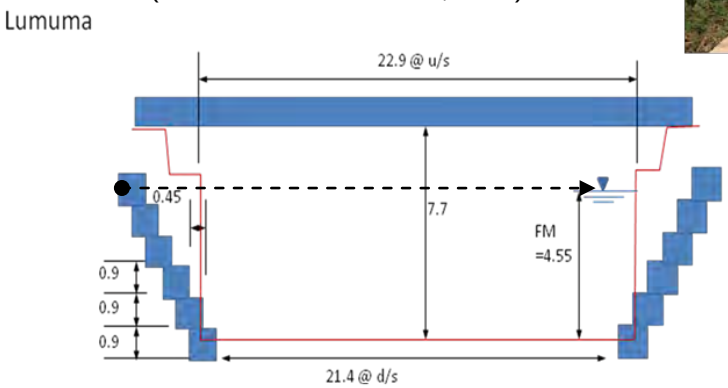
- Specific discharge at Kilosa: 0.402 $m^3/s/km^2$ (= 2,000/4,975)
- Discharge at confluences of tributaries: As shown in Figure 8.8. The discharge at Lumuma is estimated at 330 m^3/s, which coincides with the result estimated in Clause (c) (iii) above.

(e) Computation of Flood Water Levels along Mainstream

Based on the discharge distribution in Figure 8.4, the water levels were calculated and illustrated in Figure 8.6. Since the calculated water levels approximately represent the flood mark elevations between Kilosa and Gulwe, the discharge distribution is judged as appropriate.



Lumuma Bridge Section
(Photo taken on June 19, 2015)



Source: JICA Study Team

Figure 8.6: Lumuma Bridge Section and Remained Flood Mark

Rating Curve at Weir

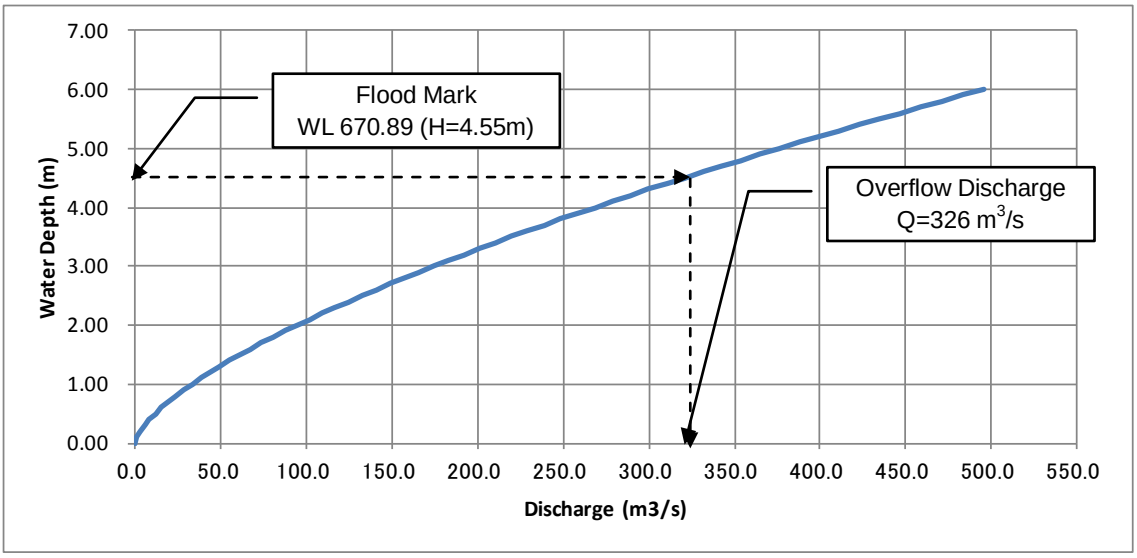
Formula

$Q=CBh^{3/2}$

where,

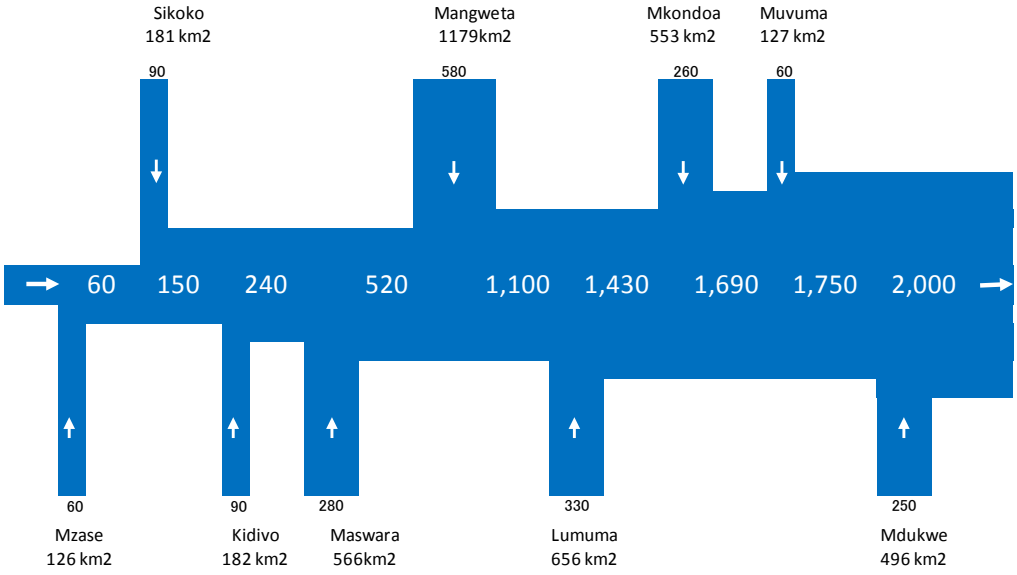
Q:	Overflow discharge (m3/s)			
C:	Coefficient			
B:	Width of weir (m)	=	21.4	m
h:	Overflow depth (m)			
L:	Length of weir (m)	=	20.0	m
W:	Height of weir (m)	=	0.01	m

$0 < h/L \leqq 0.1$:	C = 1.642 (h/L) 0.022
$0.1 < h/L \leqq 0.4$:	C = 1.552 + 0.083 (h/L)
$0.4 \leqq h/L \leqq (1.5 \sim 1.9)$:	C = 1.444 + 0.352 (h/L)
$(1.5 \sim 1.9) \leqq h/L$:	C = 1.785 + 0.237 (h/W)



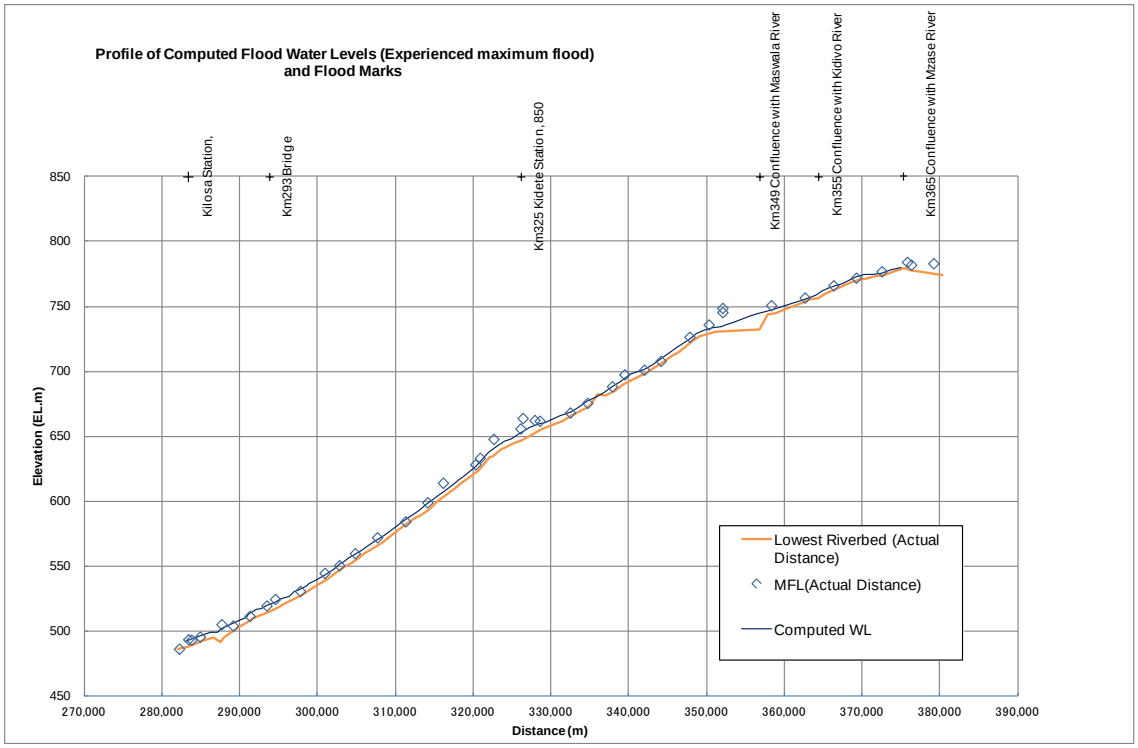
Source: JICA Study Team

Figure 8.7: Carrying Capacity at Lumuma Bridge Section



Note: Catchment areas include the remaining catchments between tributaries.
Source: JICA Study Team

Figure 8.8: Distribution of Design Flood Discharge between Kilosa and Gulwe



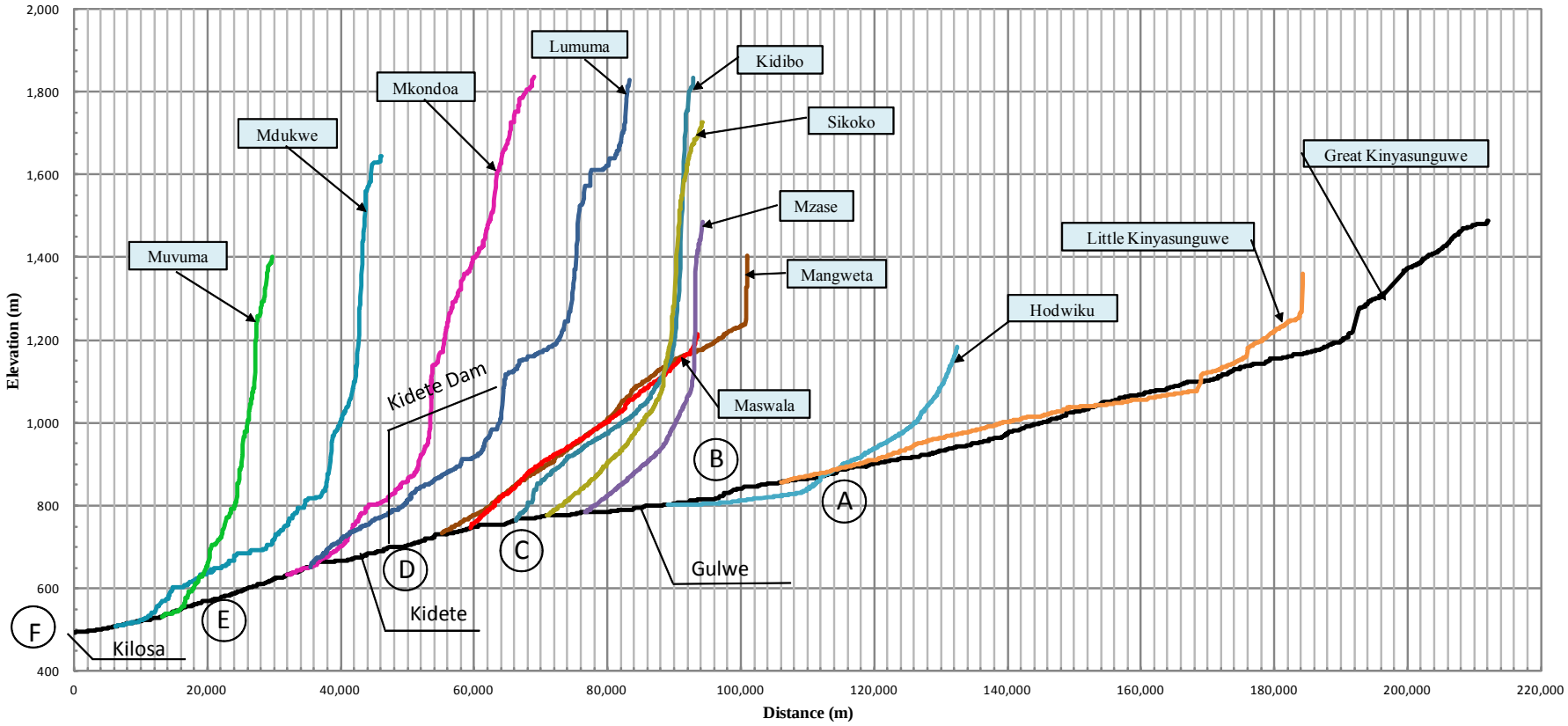
Source: JICA Study Team

Figure 8.9: Flood Marks and Results of Water Level Computation along Kilosa and Gulwe

(3) Characteristics of Sediment Discharge based on Present Riverbed Slope

Figure 8.10 shows the longitudinal profiles of the entire Wami watershed and the Kinyasungwe/ Mkondoa River from Kilosa to the origin. From these profiles, salient characteristics can be identified as follows:

1) The stretches near the confluence of the Great Kinyasungwe, Hodwiku, and upstream of Gulwe have gentle slopes, in low-lying wetlands. (A)
2) There is a rapid-flowing portion at approximately 11 km upstream of Gulwe (approximately 5 km downstream of Msagali). An outcrop of foundation rock is exposed and seems that the sediment deposition on the riverbed is not so significant. (B)
3) Mainly due to the extraordinary sediment inflow from three tributaries (Mzase, Kidibo, and Maswala) and active riverbank erosion (e.g., near Km 337), the riverbed slope is more gentle at this point. (C)
4) Between the vicinity of Kidete Dam and the confluence with the Lumuma River, sediment discharge, supplied by riverbank erosion, is significant, and the riverbed slope is gentle at this point. (D)
5) The downstream stretches from the confluence of the Mkondoa River are considered to be sediment-flushing areas, since the Mkondoa River is a perennial river and has constant discharges. The riverbed slope downstream of the confluence is steeper at its downstream than at its upstream. On the other hand, at water-hitting areas with high banks at meandering sections, active erosion at the toe portions can be observed (e.g., near Km 315). (E)
6) Downstream of Kilosa, the riverbed slope transforms to be gentle, and the Mkata Plain emerges. The river course seems to be relatively stable. (F)

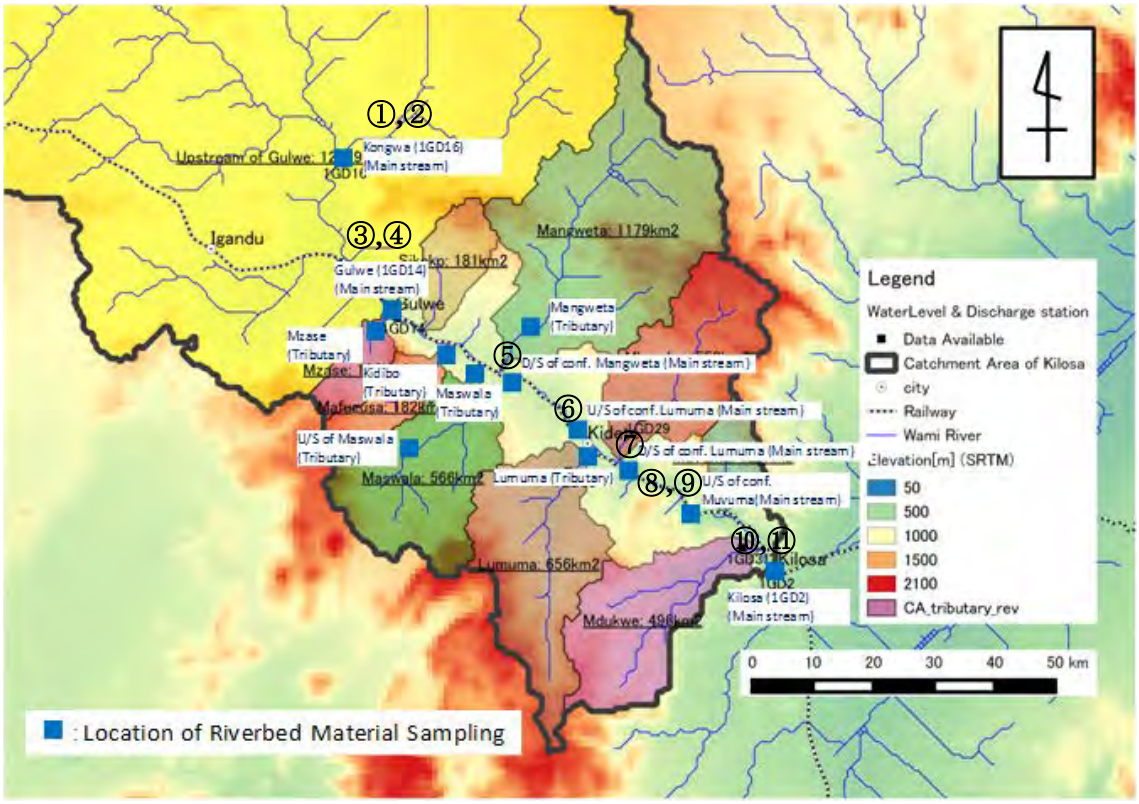


Source: JICA Study Team

Figure 8.10: Longitudinal Profile of Kinyasungwe/Mkondoa River (Origin–Kilosa)

(4) Characteristics of Riverbed Material

In the current study, in order to grasp the characteristics of riverbank and riverbed materials, sampling at a total 13 sites, and laboratory tests, were conducted. A map of the sampling locations is shown in Figure 8.11, and the grain size accumulation of the samples which were taken along the mainstream is tabulated in Table 8.1. (A detailed explanation of the sampling is presented in Chapter 4.)



Source: JICA Study Team

Figure 8.11: Map of Riverbed Material Sampling Locations

Table 8.1: Grain Size Distribution of Samples along Mainstream

Unit: %

Classification	Grain size (cm)	Lumuma MsD RB 1059	Lumuma MsU RB 1060	Lumuma MsU Cult 1061	Lumuma MsD LB 1062	Gulwe Ms RB 1068	Gulwe Ms Md 1070	Mangweta MsD RB 1073
Clay	0.0002 - 0.002	3.44	4.36	10.00	7.00	25.04	1.00	4.78
Silt	0.002 - 0.0075	0.56	0.64	1.95	5.96	4.96	7.04	0.22
Very fine sand/Coarse silt	0.0075 - 0.025	4.26	3.36	10.00	7.95	25.04	1.00	11.55
Medium sand	0.025 - 0.2	83.16	84.08	73.31	73.87	44.96	90.96	80.55
Granule/very coarse sand	0.2 - 0.4	8.33	6.43	4.18	3.96	0.00	0.00	2.28
Pebble	0.4 -	0.25	1.13	0.56	1.26	0.00	0.00	0.62
		100.00	100.00	100.00	100.00	100.00	100.00	100.00

Classification	Grain size (cm)	Mangweta MsD Cult 1074	Kilosa Ms RB 1075	Kilosa Ms RBUB 1076	Muvuma MsU LB 1077	Muvuma MsU RB 1078	Kongwa Ms LB 1083	Kongwa Ma Md 1084	Ave. (cm)
Clay	0.0002 - 0.002	9.99	1.04	2.00	3.00	1.72	10.00	4.00	7.95
Silt	0.002 - 0.0075	14.18	4.96	4.79	1.04	3.28	3.98	0.16	3.05
Very fine sand/Coarse silt	0.0075 - 0.025	11.94	5.04	3.00	3.00	1.72	10.00	6.00	9.02
Medium sand	0.025 - 0.2	61.43	88.96	87.42	92.96	88.79	64.69	81.82	75.84
Granule/very coarse sand	0.2 - 0.4	2.35	0.00	1.72	0.00	3.94	10.82	4.12	3.60
Pebble	0.4 -	0.11	0.00	1.07	0.00	0.55	0.51	3.90	0.55
		100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

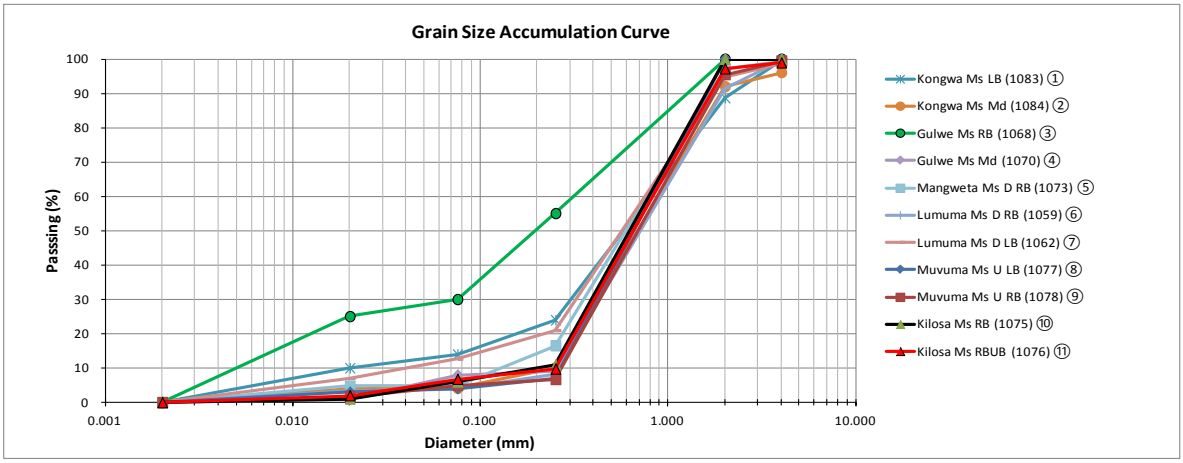
Source: JICA Study Team (results of sub-contract works)

Based on the laboratory tests conducted at the Sokoine University in Morogoro, parameters for tractive force and critical friction velocity, etc., were estimated (Table 8.2). Figure 8.12 shows the grain size accumulation curves of the samples along the mainstream between Kongwa (Mpwapwa) and Muvuma (Kilosa).

Table 8.2: Computation of Medium Grain Size and Other Parameters

Grain size (cm)	F (di) (%)	di (cm)	F (fi) di	di / dm	u_{*ci} / u_{*cm}	Each size u_{*ci} (cm/sec)	Ave size u_{*ci} (cm/sec)
0.0002 - 0.002	6.2	0.001	0.00	0.009	0.85	1.68	0.38
0.002 - 0.0075	3.8	0.004	0.01	0.055	0.85	1.68	0.94
0.0075 - 0.025	7.4	0.014	0.10	0.193	0.85	1.68	1.39
0.025 - 0.2	78.4	0.071	5.54	0.998	1.00	1.98	1.97
0.2 - 0.4	3.4	0.283	0.97	3.993	1.36	2.69	4.77
0.4 -	0.7	0.632	0.45	8.929	1.71	3.39	7.15
	100.0		7.08	dm = 0.071		u_{*cm}= 1.98	

Source: JICA Study Team

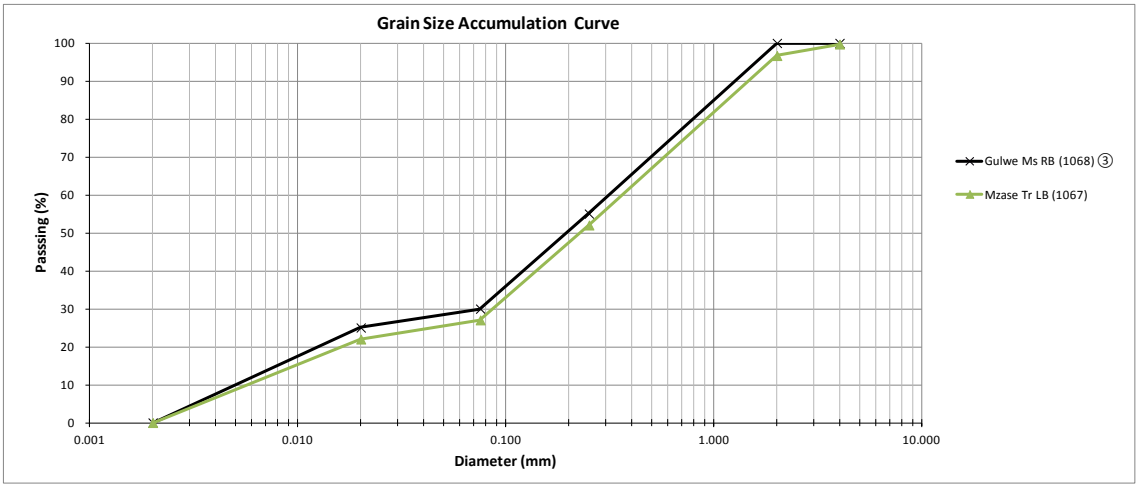


Source: JICA Study Team

Figure 8.12: Grain Size Accumulation Curves of Riverbed Material along the Mainstream

The results of the analysis above can be summarized as follows:

1) Except for the curve at Gulwe (green line), the same tendency of low contents of fine materials can be identified at all sites along the Kinyasungwe mainstream (grain size under 0.25 mm: lower than 20%).
2) As shifting toward upstream, higher proportion of fine material is seen in the samples along the mainstream. This might be caused by small quantity of surface discharge which transports fine material of riverbed and river banks toward downstream. Further, due to existence of natural retarding basin at upstream of Gulwe, continuity of soil transport along main stream of the Kinyasungwe is interrupted.
3) The curve at Gulwe is very similar to the one at Mzase. It seems that the sediment material from Mzase might be accumulated near the confluence (near Gulwe station). Since discharge levels from upstream of Gulwe is minimal (even in rainy seasons), the sediment material from the Mzase cannot be transported downstream by the river's tractive force, and fine material stays still in the riverbed. The grain size distribution curves at Gulwe (mainstream) and Mzase (tributary) are illustrated in Figure 8.13.



Source: JICA Study Team

Figure 8.13: Grain Size Accumulation Curves of Riverbed Material at Mzase and Gulwe

4) Along the mainstream, the riverbed consists mainly (76%) of coarse sand (0.25–2.0 mm), and the average size of all samples is calculated at 0.71 mm (Table 8.2).

8.2.2 Fluctuation of Riverbed

The information and materials which were utilized to verify the sediment deposition in the river channel (along the mainstream) is very limited. The only available river cross-sections (1999 and 2015) were compared to each other.

1) 1999 (Km 284.38–Km 314.6, total 15 sections)
The cross-sectional survey was conducted under supervision of a consultant. It was reported that the staff of TRC engaged in the survey. It was likely conducted between May to July 1999 (dry season), by the descriptions in the report.

2) 2015 (JICA Study Team)
Dunny Geoinformatics Inc. (Tanzania) conducted this survey as one of field sub-contract survey works of this Study. Although the kilometer posts of the railway at that time were not present on site, it was assumed that those points coincided with the existing ones, and perpendicular lines were surveyed at the points crossing over the assumed post locations.

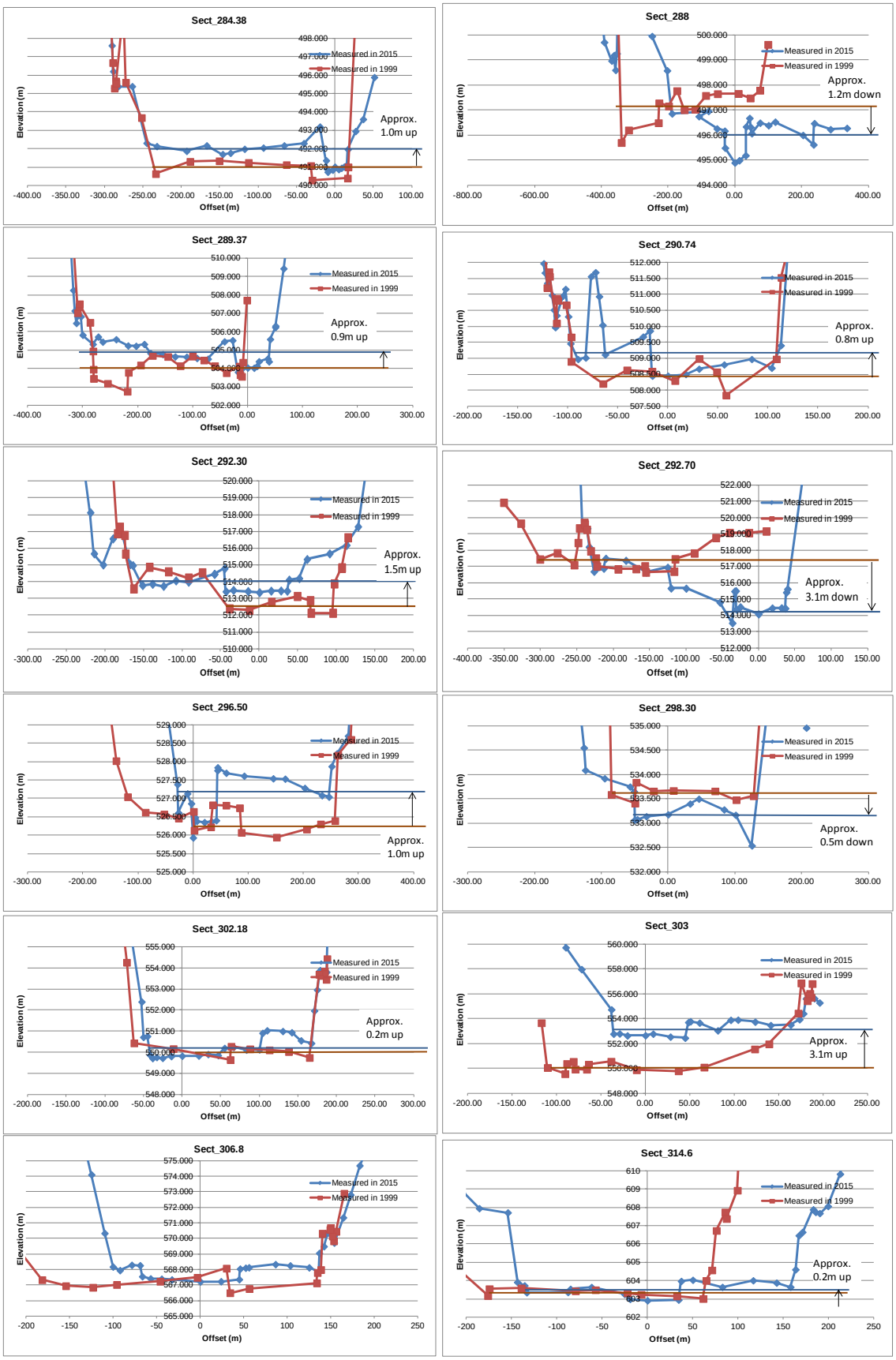
Assuming that the coordinates of kilometer posts are consistent between the surveys, the horizontal and vertical coordinates were overlaid and the average riverbed heights were compared to each other. The results are tabulated as follows:

Table 8.3: Comparison of Riverbed Elevation

No.	Section (km)	Difference of Avg. Riverbed Elevation (m)
1	284.38	+1.0
2	288.00	-1.2
3	289.37	+0.9
4	290.74	+0.8
5	292.30	+1.5
6	292.70	-3.1
7	296.50	+1.0
8	298.30	-0.5
9	302.18	+0.2
10	302.99	+3.1
11	306.80	+0.7
12	314.60	+0.2
Avg. of plus values		**+1.0**

Note: Plus values mean aggradations and minus values mean degradation.
Source: JICA Study Team

As seen in Table 8.3 above, the riverbed partially went down at (i) Km 292.70 (downstream of a steel bridge) and (ii) Km 288.0 (downstream of the confluence with the Mdukwi). However, the upward trend of aggradations in the riverbed in this stretch is obvious, and an average depth of deposition among nine sections, at +1.0 m over 16 years (1999–2015). Figure 8.14 shows the two kinds of cross-sections at the 12 sites, to evaluate aggradations and erosion.



Source: JICA Study Team

Figure 8.14: Comparison of River Cross-Sections (1999 and 2015)

8.2.3 Sediment Yield in Watershed

(1) Estimate of Sediment Yield Based on Land Cover in Tributaries

Sediment yield in a watershed composes of (i) sheet erosion, (ii) gully erosion on slopes, and (iii) bank erosion, etc. For this Study, satellite photos were utilized to examine sediment yield, because those are suitable for a wide array of analyses over a wide area. Satellite photos can distinguish geological conditions and vegetation cover by means of distinct color tones (five grades of colors). Using the land cover discerned from satellite images, sediment yield was estimated in reference to the sediment data of the dam reservoirs that were constructed in the 1970s in the Wami River basin.

The reservoir sediment volume data implies various erosion processes. Because it is difficult to estimate the erosion volume of individual events, the sediment volume of the reservoir was estimated by dividing by the catchment area and converting it to a sheet erosion rate. Further, the factors connected with sediment yield (such as land cover conditions, geological structure, riverbed gradient, and rainfall characteristics etc.) are different in the upstream and downstream areas of Kidete (as per through site reconnaissance). Therefore, the target areas (from Kilosa to Gulwe) are divided into two zones on either side of Kidete.

Two kinds of satellite photos, RapidEYE (2014) and SPOT5 (2007), were purchased and analyzed. The RapidEYE data, which has higher resolution of data (5 m cells), was used for this Study. Table 8.4 shows the sheet erosion rates estimated by tributaries and residual catchments, respectively. In the estimates for sediment production volume, the production levels are minimal in areas with a slope of less than 3 degrees (3°), and thus the sheet erosion rates were assumed small.

The color-coded sheet erosion rates were set in reference to the site reconnaissance results and reservoir sediment data (Table 8.5):

Table 8.4: Sheet Erosion Rate by Land Cover Classifications

Unit: mm/km^2

Colours on Satellite Images	Mzase, Kidibo, Maswala, Sikoko, R3, R4, R5, L4, L5, (Mangweta:Orange A)	Lumuma, Mdukwe, Mangweta, Mkondoa, Muvuma, R1, R2, L1, L2, L3
Green	0.01	0.01
Yellow Green (A)	0.05	
Yellow Green (B)		0.02
Orange(A)	0.80	
Orange(B)		0.05
Light Blue (A)	1.50	
Light Blue (B)		0.05
White	0.60	0.60

Source: JICA Study Team

Table 8.5: Estimated Annual Sediment Production Volume (Kilosa–Gulwe)

Tributary Watershed	Area (km^2)	RapidEYE (2012) Slope Classification	
		Total Sediment Yield (m^3/yr)	Specific Sediment Discharge (m^3/km^2/yr)
Mzase	124	38,448	309
Sikoko	175	70,008	399
Kidibo	171	77,134	449
Maswala	548	277,084	506
Mangweta	1,180	175,820	149
Sub-total (U/S)	2,198	638,494	290
Lumuma	629	16,834	27
Mkondoa	550	14,368	26
Muvuma	123	1,858	15
Mdukwe	512	6,478	13
Sub-total (D/S)	1,814	39,538	22
Tributaries Subtotal	4,012	678,032	169
L1	50	609	*12*
R1	10	118	*12*
L2	109	2,151	*20*
R2	266	4,430	*17*
Sub-total (D/S)	435	7,308	*17*
L3	149	5,413	*36*
R3	152	117,190	*771*
L4	139	61,397	*442*
R4	24	12,235	*510*
L5	29	17,784	*613*
R5	35	7,843	*224*
Sub-total (U/S)	528	221,862	*420*
Remaining Areas Subtotal (Gluwe～Kilosa)	963	229,170	*238*
Total (U/S)	2,726	860,355	*316*
Total (D/S)	2,249	46,847	*21*
Grand Total	4,975	907,202	*182*

Source: JICA Study Team

(2) Bank Erosion along the Mainstream

Bank erosion is progressive along the Kinyasungwe–Mkondoa mainstream. In the course of mainstream, bank erosion is remarkable at Km 297.3, Km 302.7, Km 315, and Km 337, located upstream of the Mkondoa confluence. In particular, the bank at Km 337 was encroached upon in the 2014/2015 rainy season. On 6 March 2015, the riverbank had been encroached about 20 m of width at Km 337 and shifted approximately 40 m to the mountain side.

The bank erosion volume was estimated by the following equation:

Bank height (*H*) x Annual erosion width (*B*) x Length of erosion = Annual average sediment yield due to bank erosion (Table 8.7).

8.2.4 Estimate of Future Riverbed Aggradations

(1) Methodology

The factors which determine sediment discharge volume are (i) riverbed slope, (ii) river width, (iii) riverbed material, and (iv) discharge volume. In the case of the Wami River basin, runoff conditions differ distinctly on either side of the Mkondoa confluence along the mainstream. The JICA Wami-Ruvu Study presents the surface water resources potential of seven sub-basins (Table 8.6) (refer to Figure 8.2 above for sub-basin divisions).

Table 8.6: Potential of Surface Water Resources at Seven Sub-Basins (10-year Probable Drought Year and Normal Year)

		10-year Probable Drought Year		Normal Year	
Sub-basin	Area (km^2)	Annual Yield (million m^3/ year)	Specific Yield (million m^3/ year/km^2)	Annual Yield (million m^3/ year)	Specific Yield (million m^3/ year/$km^{2)}$
Kinyasungwe	16,509	37.84	2,292	312.98	18,958
Mkondoa	12,964	443.89	34,240	788.83	60,848
Wami	14,270	612.33	42,910	1,118.60	78,388
Upper Ruvu	7,623	774.58	101,611	1,223.44	160,494
Ngerengele	2,913	73.42	25,203	115.00	39,477
Lower Ruvu	7,253	26.96	3,716	220.23	30,363
Coast	4,763	103.58	21,747	209.39	43,963

Source: Final Report of Wami-Ruvu Water Resources Development Study, 2013, JICA

In accordance with Table 8.6, the specific discharge in the Kinyasungwe sub-basin (upstream area) is 31% (=18,958/60,848) in a normal year and only 7% (=2,292/34,240) in the 10-year probable drought year, compared with the one for the Mkondoa sub-basin (downstream area). These figures indicate that the variations in discharge may influence sediment transport and transformation of the riverbed slope in the survey area. Further, the water resources potential for the 10-year probable drought year is approximately 12% of normal year in the Kinyasungwe sub-basin (37.84/312.98). In the aspect of water resources utilization (surface water), it can be easily recognized that Kinyasungwe sub-basin might suffer from severe water deficits in drought years. At the same time, the movement of sediment deposit accumulated on the riverbed toward downstream might be disturbed.

Water revel records during floods are not available at observatories in the study area. Therefore, conducting an assessment of the return period of flood occurrence through statistical analysis of actual observed records is rather difficult. In addition, since the Kinyasungwe/Mkondoa River has huge sediment discharge potential from its tributaries, and tends to meander its main river course after every flood events, common methods of hydraulic calculations (by one-dimensional riverbed fluctuation) cannot be appropriately adapted to model it. Because of this, the following methodology was applied for this Study:

1) Setting of River Stretches Division
   The river stretches are divided into two segments: (i) from Kilosa to the confluence of Lumuma, and (ii) from the confluence of Lumuma to Gulwe, to the Lumuma confluence (near Kidete) where there is the transition point of riverbed gradient and tractive force of sediment. (The division coincides with the division of water resources sub-divisions as well.)

2) Target Time Span
   In order to assess future riverbed aggradations along the mainstream, the target time span of flood protection structures was determined to be 30 years, considering the following:

- In the long term, riverbed degradation and aggradations will be balanced normally based on the dinamic riverbed equilibrium theory. However, sediment transport from several tributaries is significant and currently a rising trend of riverbed in the mainstream is obvious although only two series of data (river cross sections) are available for comparison. Therefore, it was judged that influence for such riverbed rising by sediment deposit should be considered to decide design high water levels.
- Since it is not certain how the rising trend will change in the future, a height of accumulated sediment deposition during a certain period should be assumed as the worst scenario in order to avoid unfavorable design change in the future.
- As for a period of assumed sediment deposition, in many cases 20 to 30 years is normally applied as a time span of one group of river improvement works in Japan. Therefore, 30 years was applied for the target time span in the current study.

3) Future Sediment Deposition in River Channels
Based on the average annual rising of riverbed elevation due to sediment deposition downstream of the Lumuma confluence, the accumulated depth of sediment deposition in 30 years was estimated.

(2) River Stretches between Kilosa and Lumuma Confluence (Downstream Stretches)

Through the comparison of river cross-sections (Section 8.2.2), riverbed aggradations were confirmed to be approximately 1.0 m per 16 years (1999–2015). Based on the rate, it is assumed that the riverbed in the subject stretches will rise approximately 2.0 m over the 30-year period.

(3) River Stretches between Lumuma Confluence and Gulwe (Upstream Stretches)

Applying the average rate of sediment density in water of 0.1 % (which was actually measured through discharge measurement and suspended load sampling survey), the average riverbed rise was estimated at approximately 2.5 m (Table 8.7). That rate is 25% faster than that of the downstream stretches:

Table 8.7: Computation of Sediment Balance (Lumuma Confluence–Gulwe)

No.	Descriptions	Values	Unit
1	Inflow sediment discharge from u/s of Gulwe (A)	0	m^3/yr
2	Inflow sediment discharge from tributaries (B)	860,355	m^3/yr
3	Volume of river bank erosion (C)	63,000	m^3/yr
4	Volume of sediment transport to downstream (D)	51,680	m^3/yr
5	Volume of sediment deposition in river channel (E) (E) = (B) + (C) – (D)	871,675	m^3/yr
6	Total sediment deposition in 30 years (F) = (E) x 30	26,150,265	m^3
7	Average sediment depth in river channel (G)	**2.47**	m

Conditions for estimate:
- Catchment area : A=2,726 km^2
- Average river width: W= 200 m
- River length: L=53 km
- Density of sediment contents: 0.1 %

(B) = Ref. Table 8.5
(C) = 20 m (W) x 4.5 m (H) x 700 m (L) (Assumed that the same scale of bank erosion at Km 337, which happened in March 2015, might occur every year in the stretches between the Lumuma confluence and Gulwe.)
(D) = 312.98 x 10^6 x (2,726/16,509) x 0.001 (Ref. Table 8.6)
Where, 313.98=Annual volume of discharge in the whole Kinyasungwe River basin
2,726: Catchment area between Gulwe and Lumuma confluence
16,509: Catchment area between Gulwe and Kilosa
(G) = (F) / (53,000 x 200)

Source: JICA Study Team

8.2.5 Estimation of Flood Water Level Rising in the Future

As discussed in the previous subsection 8.2.4, riverbed aggradations are separately estimated in the river sections (i) from Kilosa to the confluence of Lumuma, and (ii) from the confluence of Lumuma to Gulwe, because situation of sediment production and transport seems to be different. Therefore,, the required heightening level is examined in the two cases to provide the conditions for the alternative study of railway re-routing as below:

(1) Target Planning Scale for Heightening

It is to be the equivalent scale of the experienced maximum flood level between Kilosa and Gulwe.

(2) Design Flood Discharge

Peak discharge of 2,000 m^3/s at Kilosa is estimated to coincide with the flood marks in the vicinity.

(3) Estimation of Water Level Rise due to Sediment Deposition on Riverbed

The conditions of heightening for flood protection were set as follows:

1) Conditions of Hydraulic Calculations

- **River section**: From Kilosa to Gulwe (Km 283 – Km 366)
- **Topography**: Results of river cross-section survey (average 1.0 km interval)
- **Discharge**: Flood discharge values were examined to meet the flood mark elevations near Kilosa, and found that the peak discharge at Kilosa (2,000 m^3/s) can represent the experienced maximum flood discharge. This discharge value was distributed among major tributaries by the ratio of catchment areas.
- **Hydraulic analysis**: One-dimensional non-uniform flow computation (by HEC-RAS)

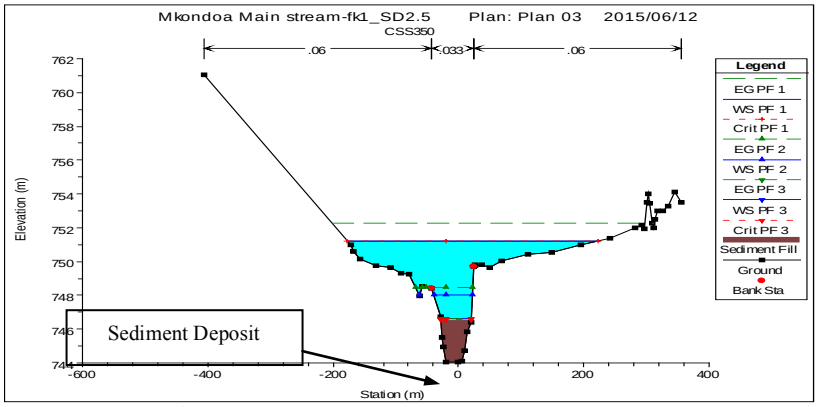
2) Condition of Sediment Deposition

- **Shape of riverbed**: Assumed that sediment material is accumulated and flattened horizontally at each cross-section. The sediment deposition area is treated as dead space of flow. Movable riverbed was not considered in the hydraulic calculations. The typical cross-section is shown in Figure 8.15.

3) Calculation Cases

Since the trend of aggradations between areas at upstream and at downstream of the Lumuma confluence seems rather different, two cases of calculation were examined:

- Case 1: Sediment deposition +2.0 m
- Case 2: Sediment deposition +2.5 m



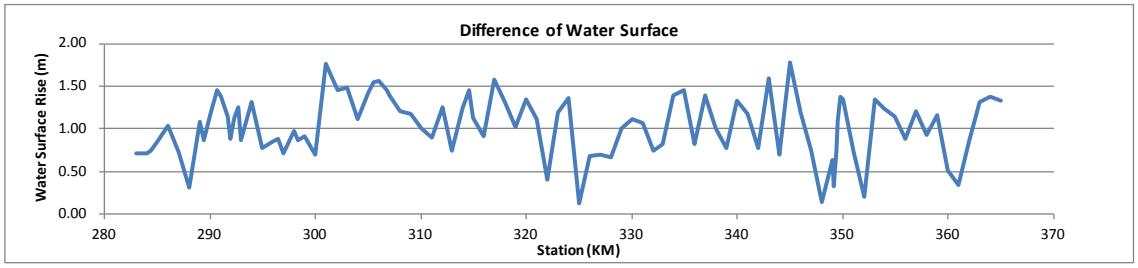
Source: JICA Study Team

Figure 8.15: Example of Sediment Deposition in River Channel (near Km 350)

(4) Results of Computations

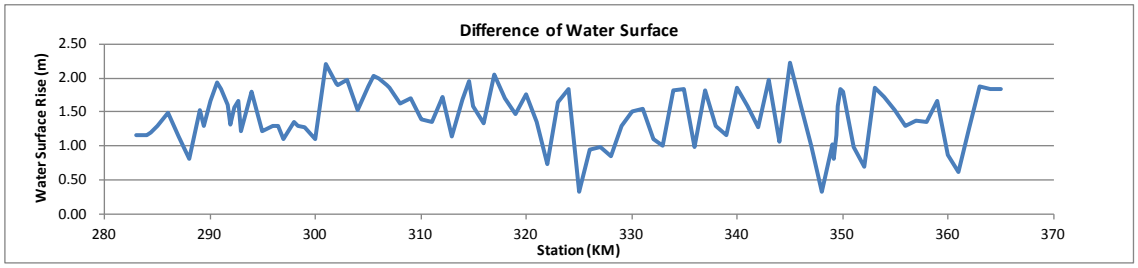
The results of the hydraulic computations of the two cases are illustrated in Figure 8.16 and Figure 8.17. The rise of water levels can be summarized as follows:

1) Case 1: Average water level rise due to sediment deposition of 2.0 m
   = +1.04 m ≈ 1.1 m
2) Case 2: Average water level rise due to sediment deposition of 2.5 m
   =+1.45 m ≈ 1.5 m



Source: JICA Study Team

Figure 8.16: River Water Rising due to Sediment Deposit of 2.0 m



Source: JICA Study Team

Figure 8.17: River Water Rising due to Sediment Deposit of 2.5 m

8.2.6 Setting of Planning Scale for Alternative Study of Re-Routing

River water levels are affected by wave action, sediment deposit on riverbeds, debris flowing down, etc. Additionally, the accuracy of flood marks, which were identified through the field

survey, has some level of uncertainty, because they are principally based on interviews with villagers. Therefore, in order to provide an additional allowance for a conservative estimate, a freeboard is given above the Design High Water Level as follows:

(1) Freeboard subject to the magnitude of design flood discharge (Design Standard of Tanzania)
(2) Water rise due to riverbed aggradations by sediment deposition

An explanation of these two factors is as follows:

(1) Freeboard Subject to the Magnitude of Design Flood Discharge

The design standards in Tanzania, which are currently applied by TANROADS, were similarly applied for this Study. The standard for clearances under bridges was interpreted as the required free board for earth embankments as well.

Table 8.8: Free Board of Vertical Clearance for Bridges

Discharge (m^3/s)	Minimum Vertical Clearance (m)
< 0.3	0.15 m
0.3 < to 3.0	0.45 m
3.0 to 30.0	0.60 m
30 to 300	0.90 m
> 300	1.20 m

Source: TANROADS[1]

(2) Water Rise due to Riverbed Aggradations by Sediment Deposition (including the Height of Sediment Deposition)

From the results of Subsection 8.2.5, water level rising due to sediment depositions on the riverbed is set 1.5 m and 1.1 m for the upstream and downstream sections, respectively.

Based on the examination above, the freeboard in the planning scale (heightening of rail) is summarized in Table 8.9:

Table 8.9: Freeboard for Structures Applied to Alternative Study

Item	Segment 1 Upstream of Lumuma Confluence Km 283–318	Segment 2 Downstream of Lumuma Confluence Km 318–366
(1) Freeboard subject to Design Discharge (Design Standard of Tanzania, via TANROADS)	1.2 m (Q=1,690–2,000 m^3/s)	1.2 m (Q=60–1,690 m^3/s)
(2) Estimated rising of water level due to sediment deposition	1.1 m	1.5 m
Total Freeboard	**2.3 m**	**2.7 m**

Note: This assumes flood water levels rising due to Kidete Dam construction, further agricultural development, and deforestation in the upstream watershed of the Kinyasungwe River basin, etc.
Source: JICA Study Team

[1] Source: "OVERSEAS ROAD NOTE 9, A Design Manual for Small Bridge", International Division, Transport Research Laboratory

8.3 Identification of Section of Flood Protection Measures

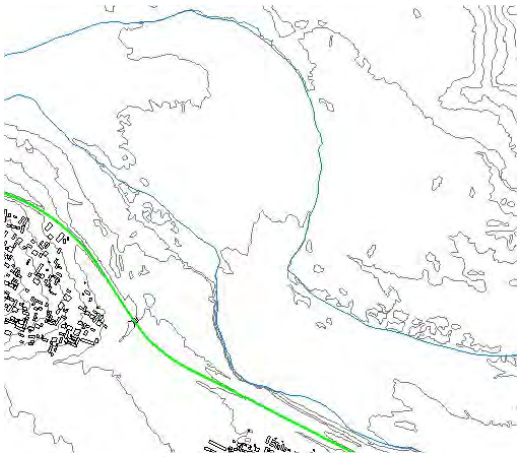
8.3.1 Proposed Section of Flood Protection Measures to be Implemented by Yen Loan Project

Of the study area from Kilosa to Dodoma, the section requiring flood protection measures has been identified based on the careful review of the following data and documents:

- Site inspection and survey data including photos.
- Table 3.23: "Classified Damage Patterns to the Railway, Possible Measures and Protection Priority".
- High-resolution color aerial photos taken in March/April 2015 (e.g., Figure 8.18).
- Topographical maps with 2.0 m contours (e.g., Figure 8.19).
- Data obtained from the river-related surveys, including the River Cross-Section and Longitudinal Profile Survey, Discharge Measurement and Suspended Load Sampling, Flood Mark Survey, River Material Sampling, and Satellite Image Analysis and Flood Risk Assessment (e.g., Figure 8.20 and Figure 8.21).
- Planning scale set in Section 8.2.

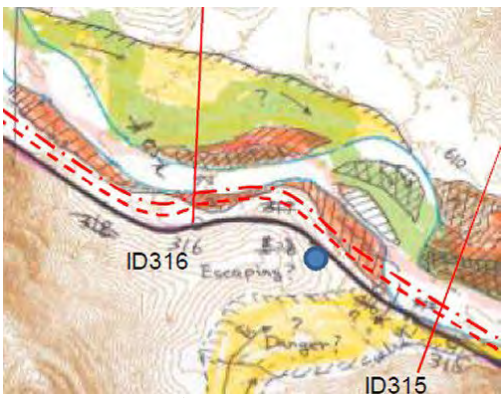
Source: JICA Study Team

Figure 8.18: An Example of High-Resolution Color Aerial Photos (near Km 315)



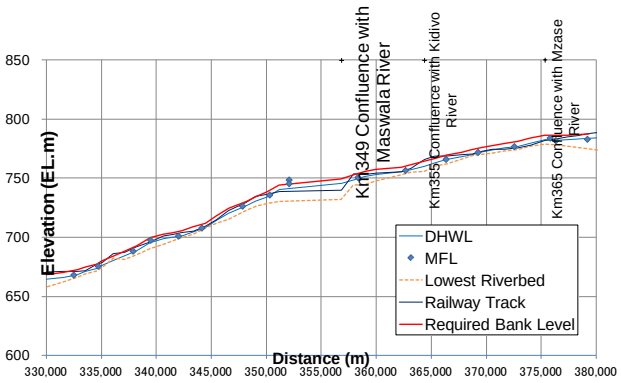
Source: JICA Study Team

Figure 8.19: An Example of Topographical Maps



Source: JICA Study Team

Figure 8.20: An Example of Data from the Analysis of the Past Flood Traces



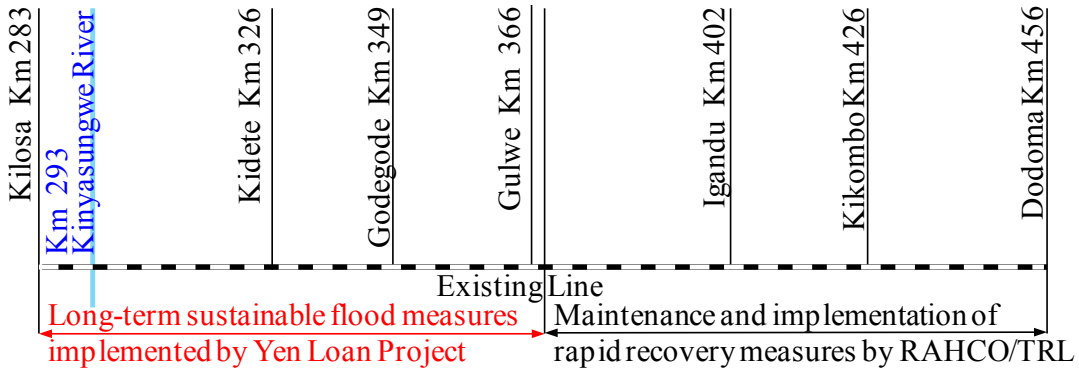
Source: JICA Study Team

Figure 8.21: An Example of a Longitudinal Profile of Kinyasungwe River

Through extensive technical discussions between the Railway Group and the River Group, the following conclusions have been reached:

- **Long-term sustainable flood protection measures are required for the Kilosa–Gulwe section, which will be included in the Yen Loan Project.** In the case of relocating the existing Mzase Bridge and/or Gulwe Station, an additional new track is required to connect the re-routed line to the existing line around Km 370.
- **The Gulwe–Dodoma section will not be included in the Yen Loan Project.** According to Appendix D, neither "Medium" nor "High" areas exist in terms of priority for flood protection on the Gulwe–Dodoma section, except Igandu, where the priority for flood protection is "Medium". Aside from this, in this section including Igandu, both RAHCO and TRL have been maintaining the railway structure, and have been implementing rapid recovery measures whenever the railway structure has been damaged by floods.

Figure 8.22 summarizes the above conclusions.



Source: JICA Study Team

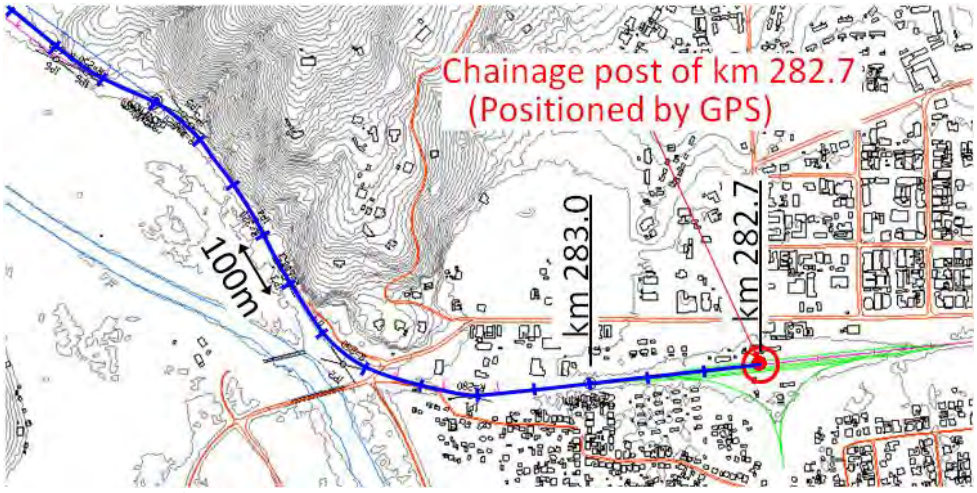
Figure 8.22: Proposed Section to be Implemented by the Yen Loan Project

Box 8.1: Use of New Kilometrage

The Kilometrage shown on the posts along the existing railway line do not show the actual railway length. For example, the actual length from Km 349 to Km 350 on site is not 1.0 km, but approximately 3.9 km.

From the following section, a new Kilometrage, calculated based on the AutoCAD drawings produced with the aerial survey data, will be used to carry out the design work and cost estimation.

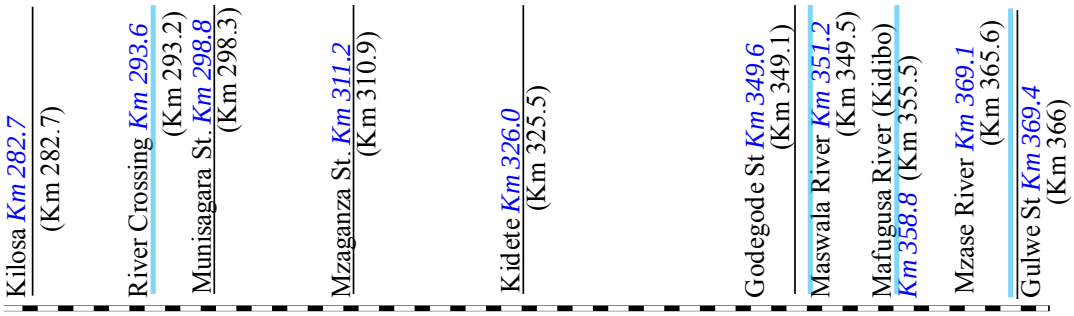
It is noted that the starting point of the new Kilometrage is the chainage post at the center of Kilosa Station (i.e., Km 282.7), the same as the old Kilometrage shown in Figure 8.23.



Source: JICA Study Team

Figure 8.23: Starting Point of Kilometrage

The difference between the old Kilometrage and the new Kilometrage is shown in Figure 8.24, in which the old Kilometrage is indicated in black and the new Kilometrage is indicated in blue. (Hereinafter, the new Kilometrage is displayed in italics.)



Note: Old kilometrage is quoted from the Governments of Tanzania, Rwanda and Burundi, Phase II of the Dar es Salaam–Isaka–Kigali/Keza–Musongati Railway Project Study, Final Report, Volume 2B, March 2014.
Source: JICA Study Team

Figure 8.24: Difference between Old and New Kilometrage

8.4 Standard Structures to be Applied in the Flood Protection Measures

8.4.1 Overview

Table 8.10 shows the list of key design parameters that have been applied to alternatives of flood protection measures, with details provided in Subsection 8.4.2 for the river structures and Subsection 8.4.3 for the railway structures.

Table 8.10: List of Key Design Parameters for Alternative Study

Item	Parameter
River Structures	
1. Riverbed aggradation rate	1.0 / 16 yrs (≈ 2.0 m / 30 yrs)
2. Total sediment deposition (30 years)	26,150,265 m^3
3. Total freeboard above DHWL	
Upstream of Lumuma confluence	2.3 m
Downstream of Lumuma confluence	2.7 m
4. River channel design parameters	see Table 8.13
5. Embankments	
Crest width	5.0 m
Side slope	1:3.0
6. Spur dikes	
Length	< 10% of river width
Width	0.2-0.3 times design flood water depth; higher than normal water level by 0.5-1.0 m
Interval	2-4 times length of dike, 10-30 times the height
Slope	downward, 1/20-1/100 to river center
Direction	Perpendicular to riverbank
Railway Structures	
7. Minimum curve radius	
Common	400 m
Unavoidable	200 m
8. Max vertical gradient	1.0%
9. Vertical curve radius	3000 m
10. Station track	
Straight track length	apx. 700 m
Track gradient	apx. 0.2%
11. Embankments (standard)	
Max height	apx. 15 m
Max cutting height	19 m
Slope (height < 6 m)	1:1.5
Slope (height > 6 m)	as per Japanese standards
12. Embankments (width > ROW; non-standard)	
Slope	1:1.5
Formation width	4.572 m
Height	18.3 m
13. Berms	
Included if	embankment height > 6.0 m
Width	4.0 m
14. Cutting earth	
Max gradient	1:0.35
15. Culverts	
Draft standard dimensions	2 m x 2 m; 3 m x 3 m (at the time of ITR only)
16. Steel bridges	
Span < 15 m	kept, if proven track record
Span > 15 m	tandem arrangement of 15 m girders
Miscellaneous	
17. New kilometerage	
Kilosa Station	Km 282.7
Gulwe Station	Km 369.4

Source: JICA Study Team

8.4.2 River Structures

<This part has been removed because of confidential information.>

8.4.3 Railway Structures

<This part has been removed because of confidential information.>

8.5 Condition of Cost Estimate

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8.6 Preparation of Alternatives

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8.7 Evaluation of Alternatives

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9. Railway System

9.1 General

(1) Basic Concept

The Study Team does not consider gauge conversion into a 1,067 mm or a 1,435 mm gauge, but rather adopts the 1,000 mm-gauge, as track conversion while continuing to run trains entails some technical difficulties, and provides little benefit to justify the long period and cost required for the gauge conversion work. During the period of track conversion work, the vast amount of transshipment work occurs at the junction of different gauges. Regarding the transportation capacity, the influence of the gauge difference is quite small as proven in the example that Japanese 1,067mm gauge railways transport almost equal volume to 1,435 mm gauge railways in other countries. Additionally, the axle load should be set at 16 tons. With this, freights of approximately 1,000 tons can be hauled by a locomotive having a weight of 100 tons. For such tonnage, therefore, the Study Team proposes a 6-axle locomotive with an axle load of 16 tons. In case freights are heavier, or are on sharp gradients, a double-heading operation can cope with this.

A maximum speed of 80 km/h is guaranteed for train operation in meter-gauge sections when tracks have appropriate cant and transition curves. In short sections, however, the Study Team maintains an immediate target of train speed at the current level of approximately 50 km/h, even in the rerouted section, as speedups in short sections do not cut much of the total travel time between Dar es Salaam and Kigoma. To facilitate speedups up to 80 km/h or more in the future, the Study Team designs the minimum radius of curves as 400 m, in general, sections, while adopting line profiles to guarantee easy extension of transition curves.

(2) Train Operation

Blocking the sections between stations is indispensable for the safety of train operation. However, the existing wired transmission system between stations is not practical, as it is often subject to vandalism/pilfering. As a communication means between stations, therefore, the Study Team adopts in principle a cellular phone system through lines for public telephone services, with train handling solely resorted to human attention, even though some stations in poor radio wave area are forced to close.

The installation of wireless satellite telephones on locomotives and stations seems useful not only for the blocking of the section but also for the countermeasures against natural disasters. However, it costs around 20 thousand USD[1] a year for one transmitter-receiver. Therefore, it is more practical to use the messenger system by gangs deployed in each 8 km section. After the recent flood disaster in Gulwe, Tanzania Railways Limited (TRL) reviewed the messenger system and decided the procedure to stop the train operation by the gang's information.

Regarding the future communication system, the optical fiber cable without any copper wire plays the leading role as it is not a target of thieves. When it combines with the automatic signaling and the disaster detecting instrument, the train operation becomes safer dramatically. The key is the electric power supply along the railway.

The effective track length in the station yard, which is approximately 420 m, governs the length of train composition. Extension of the effective track length is not practical, as enormous costs are involved. Therefore, the Study Team assumes a scenario to operate trains having a load of

[1] This is the cost in Japan communicating 30 minutes per day. The availability of a satellite wireless transmission system in Tanzania is not confirmed.

approximately 1,000 tons hauled by a single locomotive. The 1,000 tons hauling system can implement the transportation volume of 1.4 million tons per year.

In case transport demand increases beyond the line capacity in the future, not only the quantity but also the quality of the transportation, such as frequency and punctuality required by customers, should be considered. From this point of view, high-frequency operation by a single locomotive should be the focus, rather than a long train by double locomotives for the time being. Because of long train operations, it is hard to recover a level of normalcy of train operations, in the case of a train disorder. Additionally, the Study Team proposes installation of signal stations one-by-one in bottleneck sections, while considering partial double-tracking simultaneously, thereby aiming at reinforcing transport capacity in addition to the usage of long trains.

(3) Track

As the frequency of train operation increases, track deterioration progresses to augment the volume of track maintenance work. Despite that, the next left Figure shows ballast spreading and raising, and right Figure indicates alignment markers for curve adjusting by TRL. Thus, the track maintenance progresses steadily with a good technical capacity. Therefore, TRL does not need to change the method of track maintenance for the Central Railway Line for the time being, as the volume of transport has decreased from the levels seen in the past.

Source: JICA Study Team

Figure 9.1: Track Maintenance by TRL

In the section of flood protection work, track maintenance machines are introduced for line rerouting work. After completion of the work, it is conceivable that those machines would be re-appropriated for a mechanized track maintenance system, to change maintenance work from the current manpower-intensive method to one oriented around track maintenance machines. In discussing changes in track maintenance methods, consideration for social conditions and cost performance is required.

(4) Rolling Stock Maintenance

Locomotive rehabilitation work now in progress and new locomotive procurement plans suggest that the number of active locomotives is expected to increase for the time being. In this opportunity, it is desirable for TRL to switch its rolling stock maintenance from breakdown maintenance to preventive maintenance.

(5) Stations and Related Facilities

As a part of flood protection work, stations are relocated together with their facilities (such as buildings and passing tracks). In general, the basic concept of the relocation is to maintain the present condition. However, it is important to consider the volume and function of the relocating facilities. Because they affect the future railway service and investment cost. The concrete plan should be drawn out through discussions with TRL and RAHCO on the train

operating system, the loading and unloading facilities at terminal stations, and the freight information system.

9.2 Basic Concept

(1) Gauge

East-African railways use the 1,000 mm gauge widely, including the Central Railway Line. The UK constructed 1,000 mm gauge railways in Kenya and Uganda, and Germany constructed a railway having a gauge of the same dimension in Tanzania, which later connected into one international rail system. Although no trains are currently running from Tanzania to Kenya or Uganda at present, the tracks are still connected from Dar es Salaam to Mombasa and further to Kampala.

Although some people hold a view to converting the Central Railway Line into a 1,435 mm standard-gauge railway, the Study Team cannot find advantages. Because the difference of speed and transportation capacity between 1,000 mm gauge and 1,435 mm gauge is small and gauge conversion entails some technical and operational difficulties under the condition of running trains. A compromise is to run a mixture of standard and meter gauge trains on three-rail tracks, an application of which is not seen for long-section railways in any country, however. Based on the above, the Study Team concludes that it is appropriate to adopt the existing 1,000 mm gauge intact, to promote flood protection measures along the Central Railway Line.

(2) Axle Load

A diesel locomotive, which can haul a freight train of approximately 1,000 tons on 1% gradients, normally weighs 100 tons, which makes the axle load 16 tons when the locomotive weight is born with six axles. A freight train of 1,000 tons in weight is normally approximately 400 m long, which means that the single locomotive haulage of a 1,000-ton freight train balances with the effective track lengths (approximately 420 m) at different stations along the Central Railway Line.

Some people hold a view to deploying heavier locomotives, thereby aiming at increasing the number of freight cars in a train composition hauled by a locomotive. This idea, however, necessitates the extension of the effective track length at stations, which requires an enormous amount of station remolding cost.

For the reinforcement of the transport capacity, therefore, it is appropriate to increase the frequency of train operations and implement double-heading operation with locomotives (100 tons in weight). Increasing the frequency of train operation is on the right track to satisfy the requirement of shippers though it necessitates more train drivers. From the above viewpoint, it is reasonable to adopt an axle load of 18.5 tons.

(3) Train Speed

It is possible to realize a maximum train speed of 80 km/h for 1,000 mm gauge trains on tracks having appropriate cant and transition curves. As the scheduled train speed is approximately 70% or less of the maximum speed, however, speedups on short sections do not sufficiently cut the travel time to the destination.

If we run a mixture of trains at different speeds, we cannot help but to adopt cant to accommodate trains of any speed. It would result in excessive or insufficient cant for running trains as a consequence. As excessive cant are not desirable for low-speed freight trains, it is

appropriate for TRL to determine the dimensions of track facilities based on the Civil Engineering Manual of TRC, while assuming the train speed at the current level about 50 km/h.

(4) Curve Radius

Assuming a maximum train speed of 80 km/h in the future, the Study Team adopts a minimum curve radius of 400 m, in general, sections, or 250 m when 400 m is impractical for various reasons, such as geographic considerations. For the time being, however, the Study Team used cant and lengths of transition curves for the tentatively assumed maximum train speed of 50 km/h. For the possible future speedups, however, the Study Team shall design line profiles to allow necessary correction of cant and extension of transition curves.

9.3 Train Operation

9.3.1 Train Timetable

(1) Current Situation of Train Operation

According to TRL, two to seven trains per day, or an average of 3.8 trains per day in a month (May 2015), are operated between Dar es Salaam and Dodoma. The one-way travel time is around 50 hours from Dar es Salaam to Kigoma (1,251 km) on the Central Line. It is 45 hours from Dar es Salaam to Mwanza (1,218 km), which gives a scheduled speed of 25–27 km/h and a dwell-time disregarding average speed of 29–31 km/h between stations. Regarding train operation diagrams, the Study Team learned the followings from TRL:

1) TRL does not have a master train operation diagram to cover TRL's entire railway network.
2) TRL has two fixed weekly round-trip diagrams for passenger trains.
3) TRL does not have fixed daily operation diagrams for freight trains but uses those drawn up the previous day.

(2) Method of Drawing Train Operation Diagrams for the Next Day

As TRL does not have a master train operation diagram, it draws up a diagram from 15:00 to 17:00 every day by controllers for the next day's operations. Information required for drawing up the train operation diagram reach through voice communication on the telephone to the controller office. After the completion of drawing, the controller office informs related organizations (including station masters) of the train operation diagram for the next day.

(3) Traffic Controller

Controller Offices, i.e., a Headquarters Controller Office and Division Controller Offices functioning thereunder, supervise drawing and implementation of train operation diagrams. Division Controller offices are at Dar es Salaam and Tabora. The former is in charge of the Dar es Salaam–Tabora section, and the latter is in charge of the Tabora–Kigoma and Tabora–Mwanza sections. Controllers assigned to these offices are on duty on a 3-shift/8-hour shift rotation. Refer to Table 9.1 and Table 9.2 for the lineups at these controller offices.

Table 9.1: Number of Staff in Chief Controller Office at Dar es Salaam

Person	Number
Chief Controller	1
Stock Controller	3
Desk Controller[2]	3
Locomotive utilization	1

Source: TRL

Table 9.2: Number of Staff in Division Controller Office

Person	Number	Role
Division Controller	1	
Stock Controller	3	
Desk Controller	4	Traces the movement of trains
Data Recorder	3	Recorder

Source: TRL

Source: JICA Study Team

Figure 9.2: Chief Controller Office at Dar es Salaam, 30 June 2015

9.3.2 Line Capacity

This Section compares and discusses the line capacities before and after reinstatement of the stations currently out of service between Kilosa and Dodoma. "Line capacity" means the number of trains operable on the relevant section per unit time length, or normally per day, which roughly gives the number of trains that can run on that section. See the defining equation for line capacity in the footnote[3].

As suggested by the defining equation, the line capacity is not an exact value, but depends on the time required for trains awaiting others running in the opposite direction to cross at midway stations and reflects ample time lengths calculated and set by different methods to adjust train operation in case trains have delayed. The line utilization factor and block establishing time in the defining equation are values deduced by empirical rules. The line capacity also depends on the train running time between stations selected for calculation out of those of so many trains

[2] Signal and Telecommunication Engineer in RAHCO is called a "Line Controller," which means a person who records the actual diagrams.

[3] Line Capacity = Line utilization factor × (24 hours / Travel time between stations)
= Line utilization factor × {24 hours / (Average running time between stations+ Block establishing time)}

running at different speeds. Therefore, the value of line capacity calculated by the defining equation does not give an exact value of the number of operable trains. Despite that, however, it is an index conveniently used to assess the status of relevant sections, when applied with its real meaning duly born in mind.

Whereas the object of flood protection measures in this Study is the Kilosa-Dodoma section, below discussed is the line capacity between Dar es Salaam and Isaka, where TIRP plans the operation of block trains. For the railway station map of Central line and Mwanza line, see Figure 9.3.

(1) Present Line Capacity

Between Dar es Salaam and Isaka, the longest section between stations is the 60 km-long Gulwe–Kikombo section, in between which there were two stations Msagali and Igandu. Both stations are now out of service, as the frequency of train operations does not warrant their usage.

The longest distance between stations in a section determines the line capacity of the whole section, which is calculated to be 11 trains per day in two directions in the present case, as shown below.

Here, the assumption of the line utilization factor is 0.8 (used by the World Bank) and average running time bases on actual data of 1.58h, and block establishing time under a train ticket blocking system as 5 min. The running time bases on the Working Timetable, published by TRC (Tanzanian Railways Corporation) on 16 July 2001.

Line capacity = 0.8 × (24 hours / travel time between stations)
= 0.8 × {24 hours / (average running time between stations+ block establishing time)}
= 0.8 × 1,440 min. / (1.58 h + 5 min.)
= 0.8 × 1,440 min. / (94.8 min. + 5 min.)
= 11.5

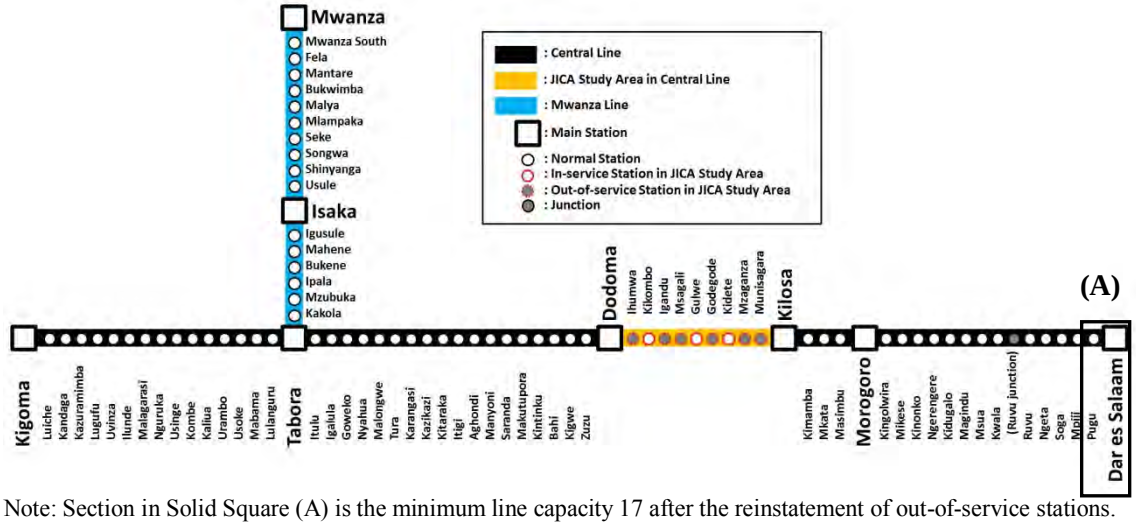
In actuality, however, only 2 to 7 trains are operated per day in two directions as of October 2014. Even though there are stations out of service, therefore, the line capacity is sufficient enough to suggest that there is no need to raise immediately train speed through improvement of tracks or block systems.

(2) Line Capacity after Reinstatement of Stations Out of Service

There are six stations in the section of the JICA Study between Kilosa and Dodoma, which are now out of service: Munisagara, Mzaganza, Godegode, Msagali, Igandu, and Ihumwa.

After the reinstatement of Mzaganza, Godegode, Igandu and Ihumwa stations, Dar es Salaam - Pugu section settles into the minimum line capacity of 17 between Dar es Salaam and Isaka.

The line capacity is estimated using average train speed and time for blocking that are taken as the same as those applied in the above calculation for the Kikombo–Gulwe section. The small line capacity at Dar es Salaam - Pugu comes from the long running time of 1 hour even the distance between stations is only 20 km.



Note: Section in Solid Square (A) is the minimum line capacity 17 after the reinstatement of out-of-service stations.
Source: JICA Study Team

Figure 9.3: Railway Stations Map of Central line and Mwanza line

Thus, line capacity is influenced by the running time between the stations, and the running time is the consequence of the station distance, train speed and block establishing time. If the block system were improved to cut the block establishing time, line capacity would also increase. In this manner, reinstatement of dormant stations increases the line capacity from 11 to 17 trains/day as shown in Table 9.3.

9.3.3 Freight Transport Capacity

(1) Volume of Freight Transport Capacity under the Present Line Capacity

In this section, the Study Team calculates the volume of freight transport capacity based on Subsection 9.3.2 for the 970 km Dar es Salaam–Isaka section, which aims at running block trains under the Tanzania Intermodal and Rail Development Project (TIRP).

According to TRL, the loading weight of a container car operated in TRL is 40 ton/wagon (tare weight 16.8 ton/wagon). As a locomotive is currently hauling 20 container cars, the volume of freight transport capacity (payload) of one train-set is 800 ton/train-set or 40 ton 20 wagon/train-set. The Study Team takes the ratio of passenger trains to freight trains as 1 to 6, the same value as TRC's timetable in 2001. See Table 9.3 for the results of the calculation. The average running speed between Dar es Salaam and Isaka is 33.3 km/h, dividing the distance by the running time excluding stoppage time at stations.

If TRL transports freight every day for a year (365 days) from Dar es Salaam to Isaka, the volume of cargo capacity amounts to 890,000 tons under the current line capacity, which is roughly the same as the record of 833,000 tons achieved by TRL in 2007. If the dormant stations reopen as signal stations, the volume of freight transport capacity reaches 1,350,000 tons per year, which is close to TRL's maximum record of 1,570,000 tons in the past. It means that the early restoration of dormant stations, by itself, is effective as a first step to increasing the potential capacity of freight transport.

The assumptions are as follows;

1) Empty wagon ratio = 0.1 (Number of empty wagon/ Number of total wagon)
2) Load efficiency = 0.85 (Load/Payload of wagon)

Next table shows the line capacity and the freight capacity after the reopening of the dormant stations and the speed up to 50km/h as well.

Table 9.3: Estimation of Freight Capacity from Dar es Salaam to Isaka

	Average running Speed	Line Capacity	All Train Number per day	Freight Train Number per day	Freight Capacity per day	Freight Capacity per year
		Total of two-way	Outward	Outward	Outward	Outward
Unit	km/h	trains/day	trains/day	trains/day	ton/day	ton/year
Present (TRC's timetable in 2001)	33.3	11	5	4	2,448	893,520
After Reinstatement of Dormant Stations	33.3	17	8	6	3,672	1,340,280
After Operational Speed Advancement	50.0	23	11	9	5,508	2,010,420

Assumed value: Carrying capacity per Container is 40 ton/wagon, Ratio of Freight to Passenger is 6.0, Empty wagon ratio is 0.1, and Load efficiency is 0.85.
Source: JICA Study Team

(2) Foresight and Subjects in TIRP's Long Trains

In the prioritized policy "Big Results Now," Tanzania aims at transporting three million tons per year of freight. The Study Team discusses below, therefore, the number of trains required to attain this target. The concept of TIRP is to run long freight trains on a regular basis between Dar es Salaam and Isaka. In concrete terms, TRL is expected to implement a double-heading operation of freight trains, each hauling 40 wagons by two locomotives. In this regard, TIRP states that the payload of a freight train set amounts to 1,200 tons.

For the wagons used for this purpose, TIRP assumes an axle load of 15 tons and a loading capacity of 2 TEU. From these Figures, the Study Team can surmise that the payload per wagon is 30 (or 1,200/40) tons. The term 2 TEU suggests that the maximum volume of freight transport is 56.160 tons (two sets of 20 ft. containers, each having a loading capacity of 28.080 tons, according to ISO668 Amendment 1). It seems to have been suppressed to 30 tons (one of 40 ft. containers) to cope with the regulated axle load.

TIRP proposes the freight transportation system as follows;

1) Two tandem locomotives haul 40 wagons.
2) One wagon has a payload of 30 tons.

It means that nine freight trains shall run every day in each direction for the whole year (365 days) to transport three millions tons.[4] In the estimation, the empty wagon ratio and the load efficiency is assumed 0.1 and 0.85 respectably, as well.

If passenger and freight trains ran at the ratio of 1 to 6, two additional passenger trains per day would make their debut in each direction (decimals are all rounded to the nearest whole number). In total, therefore, 11 passenger/freight trains shall run in each direction, which requires a line capacity of 22 trains/day or over when both the up and down trains run. Therefore, the Study Team discusses a line capacity of 22 trains/day.

According to the assumptions in TIRP, each trainset is 620 m long, including 40 wagons (580 m in length) and two locomotives, which is longer than the effective refuge track length (about

[4] (3,000,000 ton/365 days)/(1,200 ton/train)/{0.85/(1-0.1))=8.9≒9 trains/day

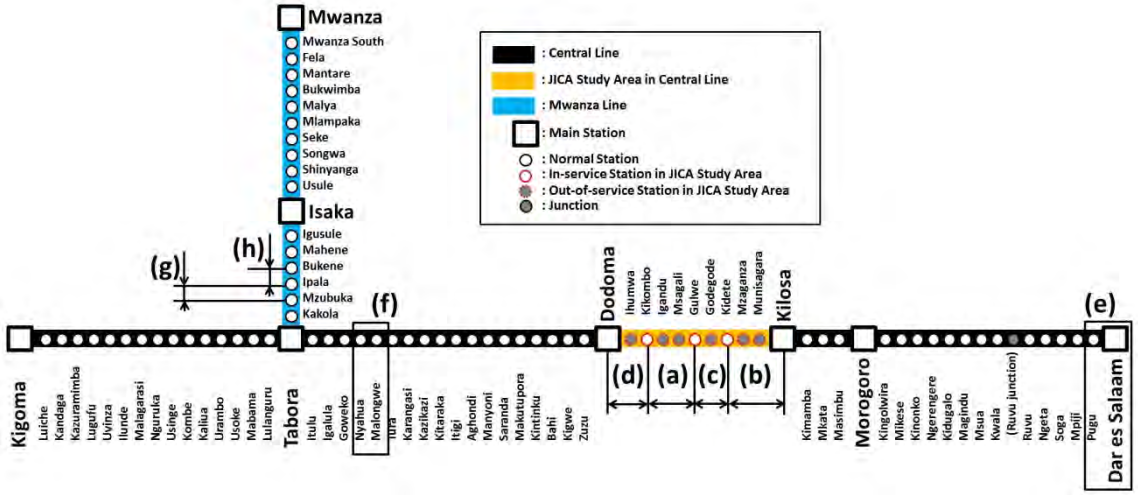
420 m) of the current TRL stations. According to TRL, TIRP requires the extension of effective track length as refuge tracks for the long trains at some ten major stations among the 56 stations from Dar es Salaam to Isaka.

The following assumptions/plans are necessary under TIRP concept:

1) The following eight sections require a signal station or double tracking to obtain the line capacity of 22 trains/day.

   (a) Gulwe–Kikombo, (b) Kilosa-Kidete, (c) Kidete–Gulwe, (d) Kikombo–Dodoma,
   (e) Dar es Salaam-Pugu, (f) Malongwe–Nyahua, (g) Mzubuka–Ipala, (h) Ipala–Bukene
   Note: The Alphabets (a)-(h) are arranged in ascending order of the line capacity.

   i. The reason the line capacity is low, except in sections (e), (f), (g), and (h), is that midway stations are out of service. If these stations begin service for train operation, the line capacity increases to 22 trains/day or more. The bottleneck sections are the Dar es Salaam-Pugu section in (e), the Malongwe–Nyahua section in (f) above existing between Dodoma and Tabora, and the Mzubuka–Ipala section in (g), and the Ipala–Bukene section in (h) above existing between Tabora and Isaka.
   ii. When trains of 20 wagons go into operation, the refuge track length is 420 m for each station. In this case, a total 1,680 m of additional refuge track is required for the bottleneck as mentioned above sections, excluding additional turnouts and curves needed to connect to the mainline.
   iii. In case that the average speed is 50 km/h on each section, a line capacity less than 22 trains/day is only in the section of Gulwe–Kikombo in (a), Kilosa-Kidete in (b), and Kidete-Gulwe in (c). These bottlenecks are wiped off, however, by reinstating dormant stations.



Note: Sections in (a)-(h) are with Line Capacity Less than 22 trains/day.
The Alphabets show the line capacity in ascending order.
Source: JICA Study Team

Figure 9.4: Location of Stations with Line Capacity Less than 22 Trains/Day

2) When the TIRP's long trains of 40 wagons run, the refuge track length must be extended up to 620 m for at least 10 stations. Therefore, the total length of refuge track is 2,000 m in total.[5] As other trains cannot refuge from long trains at stations remaining intact, the recovery of normal train operation is delayed, in the case that the train operation diagram has been disturbed.

3) In total, the construction of an additional 1,680 m track is required for 20 wagon sets, and 2,000 m for 40 wagon sets, at the current train speed. When the average speed is 50km/h, the total refuge track length is zero for 20 wagons and 2,000 m for 40 wagons except for in addition to turnouts and curves to connect to the mainline.

(3) Subjects in Operation of Non-Long Trains

To attain the target of transporting freights of three million tons per year under the current operational formation (hauling 20 wagons, each having a payload of 40 tons, by a single locomotive), 14 freight trains[6] shall run every day in each direction for the whole year (365 days). Here, Empty wagon ratio and Load efficiency are assumed 0.1 and 0.85 respectably as is the case with 9.3.3(1).

If passenger and freight trains ran at the ratio of 1 to 6, three additional passenger trains per day would make their debut in each direction (decimals are all rounded to the nearest whole number). In total, therefore, 17 passenger/freight trains shall run in each direction, which requires a line capacity of 34 trains/day or more for both up and down direction.

Therefore, the improvements are necessary such as the installation of signal stations or double-tracking for the sections where the line capacity is less than 34 trains/day that corresponds to 3 million tons per year. Currently, the line capacity between Dar es Salaam and Isaka is 11 trains/day and the reinstatement of the dormant stations increases up to 17 trains/day that correspond to 1.34 million tons per year. The upper right cell of Table 9.4 shows the present 33 sections that require improvement. The top left cell indicates the 35 sections that have priority next to the reopening of the dormant stations. The reason for the increase of sections is that the reinstatement of the stations adds the number of stations. In Table 9.4, sections are arranged in ascending order that indicates the priority of the improvement.

Above estimation bases on the assumption that the train speed, indicated in the TRC's timetable in 2001, doesn't change and the average speed between Dar es Salaam and Isaka settles into 33 km/h. When the running speed increases up to 50 km/h in every section, the number of low line capacity sections decrease as shown in the lower cells in Table 9.4. It indicates that high-speed train operation increases the line capacity as well.

[5] (620−420) m/station × 10 stations =2,000 m

[6] (3,000,000 ton/365 day) /(800 ton/train)/{0.85/(1-0.1)) = 13.4≒14 trains/day

Table 9.4: List of Sections between Stations with Line Capacity Less than 34 Trains/Day

Running Speed	Section between Stations (Reinstatement of dormant stations)	Section between Stations (Present situation)
33 km/h (average between Dar es Salaam and Isaka)	Dar es Salaam-Pugu, Malongwe–Nyahua, Mzubuka–Ipala, Ipala–Bukene, Makutupora–Saranda, Morogoro–Masimbu, Masimbu–Mikata, Mikata-Kimamba, *Kidete–Godegode, Igandu–Kikombo, Ihumwa–Dodoma,* Saranda–Manyoni, *Kilosa–Munisagara,* Zuzu–Kigwe, Kigwe–Bahi, Aghondi–Itigi, Tura–Malongwe, Bukene–Mahene, Kimamba–Kilosa, Ngeta–Ruvu, Ruvu–Kwala, Kwala–Msua, Ngerengere–Kinonko, Kinonko–Mikese, Mikese–Kingoleira, *Godegode–Gulwe, Msagali–Igandu,* Kitaraka–Kazikazi, Kazikazi–Karangasi, Karangasi–Tura, Nyahua–Goweko, Goweko–Igalula, Igalula–Itulu, Tabora–Kakola, Msua–Magindu (35sections)	(Gulwe–Kikombo), (Kilosa–Kidete), (Kidete–Gulwe), (Kikombo–Dodoma), Dar es Salaam–Pugu, Malongwe–Nyahua, Mzubuka–Ipala, Ipala–Bukene, Makutupora–Saranda, Morogoro–Masimbu, Masimbu–Mikata, Mikata–Kimamba, Saranda–Manyoni, Zuzu–Kigwe, Kigwe–Bahi, Aghondi–Itigi, Tura–Malongwe, Bukene–Mahene, Kimamba–Kilosa, Ngeta–Ruvu, Ruvu–Kwala, Kwala–Msua, Ngerengere–Kinonko, Kinonko–Mikese, Mikese–Kingoleira, Kitaraka–Kazikazi, Kazikazi–Karangasi, Karangasi–Tura, Nyahua–Goweko, Goweko–Igalula, Igalula–Itulu, Tabora–Kakola, Msua–Magindu (33 Sections)
50 km/h (in every section)	Malongwe–Nyahua, Mzubuka–Ipala, Ipala–Bukene, Kigwe–Bahi (4 Sections)	(Gulwe–Kikombo), (Kilosa–Kidete), (Kidete–Gulwe), Malongwe–Nyahua, (Kikombo–Dodoma), Mzubuka–Ipala, Ipala–Bukene, Kigwe–Bahi (8 Sections)

Note: The sections in parentheses show closed mid-stations.
The sections are in ascending order of Line Capacity.
The sections in italics show the section emerges after the reinstatement of the dormant stations.
Source: JICA Study Team

The train operation plan has the following features when the current operational formation continues.

1) The necessity of double-tracking or installation of the signal station for sections where the line capacity is less than 34 trains/day.
   (1) 35 sections require such measures to reinforce the transport capacity under the following conditions (The line utilization factor 0.8; Same average train speed as present; 5 minutes of block establishing time; Reinstatement of dormant stations). The extension length of refuge track is 14,700 m in total[7].
   (2) Four sections require such measures to reinforce the transport capacity when the average train speed is 50 km/h. The extension length of refuge track is 1,680 m in total[8].
   (3) In the case of a 20 wagon train: the total refuge track length is 14,700 m for the current train speed, and 1,680 m for the speed of 50 km/h, excluding additional track required for turnouts and curves to connect to the mainline.

[7] 420 m/station × 35 stations =14,700 m
[8] 420 m/station × 4 stations = 1,680 m

2) As there are no long trains, however, the train operation diagrams can be adjusted in the same way as before. Therefore, this operational formation is strong against transport disturbance, with train operations planned without restrictions.

When the volume of cargo capacity is 1.3 million tons or less per year, as shown in Table 9.3 above, a line capacity of about 17 trains/day is sufficient enough. Investment into equipment/ facilities is not necessary as far as the volume of freight transport capacity per year is equal to or less than the above-quoted Figure.

When the volume of cargo capacity per year is two million tons, the line capacity shall be nearly 22 trains/day under the same assumption as that used for calculation when TRL shall transport of three million tons per year. In this scenario, signal stations shall be constructed in four sections between stations, i.e., Dar es Salaam-Pugu, Malongwe–Nyahua, Mzubuka–Ipala, and Ipala–Bukene sections, at the current train speed, with the services at dormant stations resumed. When the average train speed is 50 km/h, new signal stations do not need to be constructed, if dormant stations reopen.

(4) A Draft Transport Plan for the Future

As explained above, a capacity to transport freights of 890,000 tons per year is guaranteed under the current operational formation of hauling 20 wagons by a single locomotive, even without installing new signal stations or implementing measures to increase train speed. If dormant stations were reinstated further in train operation services, the volume of freight transport capacity would potentially reach 1.3 million tons per year. Only in the case where the volume of freight transport further increases, the installation of signal stations and other measures become inevitable.

Whereas the option to run long trains as envisaged in TIRP enables massive cargo capacity (despite that the line capacity is not yet sufficient for this), it is indispensable for 10 stations to be expanded to allow trains of shorter length refuge from long trains. This option cannot be introduced before the expansion of refuge tracks, because the number of conventional short trains is limited even after that, and it may be prone to cause confusion in train operation diagrams. Delay in transport, both in passenger and freight services, breaks the confidence of customers, which potentially lead to adverse effect on transport demand.

Different transport systems have merits and demerits at the same time. It seems appropriate to increase transport capacity stepwise while seeing the trend of transport demand. The Study Team does not stick to the operation of long trains in actuality, but rather, keeps an eye on reinforcing transport capacity at early stages and stepwise implementation through different policies.

1) In phase 1, the Study Team targets cargo of 1.3 million tons per year and reinstates stations currently out of service as signal stations, in particular, Igandu, Munisagara, Godegode, and Ihumwa, thereby aiming at increasing freight transport capacity as a key to invite further transport demand.
2) In phase 2, the Study Team targets cargo of 2.0 million tons per year or more and proposes to consider utilizing long trains for operation. In this context, demand for passenger trains may have increased, as well as the need for regular operation. The Study Team believes, therefore, that it is desirable while seeing through this tendency, to construct new signal stations and implement partial double-tracking stepwise in different sections, starting with bottleneck sections.

3) It is recommended to consider the future policy repeatedly until the time limit comes because there is a big demand risk for the railway investment. The practical way is to increase transportation capacity by adopting, after discussions, a preferable policy to select either (1) operation of long trains or (2) high-frequency operation of standard train length, considering the capacity and stability of transport.

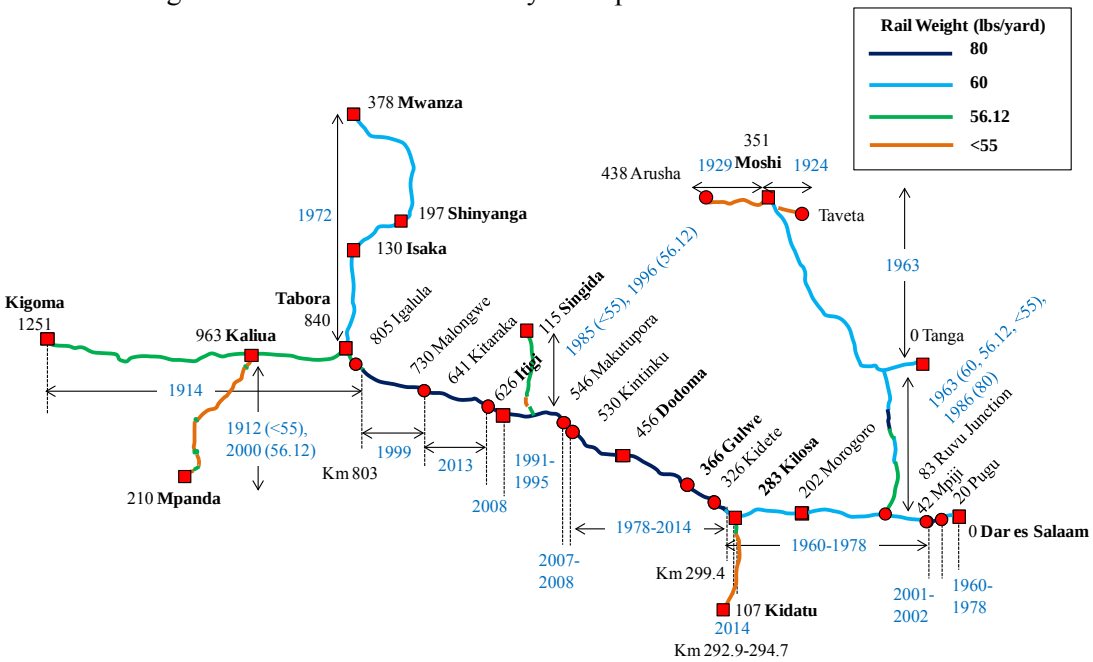
9.4 Track Maintenance

9.4.1 Track Condition

(1) Rail

Figure 9.5 shows the distribution of rail weight and installed year on the Central Railway Line. The track from Km 299.4 to Gulwe (Km 366.0) and Dodoma (Km 457.0) re-laid with 80 lb/yd rail between 2001 and 2002 as part of a project to replace 60 lb/yd rail. The track between Km 292.9 and Km 294.7 re-laid with 80 lb/yd as in 2013 as part of a project to construct a new bridge at km 293. The two sections of Kilosa (Km 282.7) to Km 292.9 and Km 294.7 to Km 299.4 remain with 60 lb/yd rail that laid in the 1970s. All 80 lb/yd rails had pandrol compatible sleepers and fastened with pandrol clips while the old 60 lb/yd rails have clip bolt-and-nut type fasteners on K-type sleepers.

Mainline turnouts between Kilosa and Gulwe are of 1:12 dimensions. There are no siding turnouts. There are six 80 lb/yd turnouts between Kilosa and Gulwe while seven similar turnouts are between Gulwe and Dodoma. The intention was to replace all 60 lb/yd turnouts with 80 lb/yd turnouts, but the latter were not in sufficient numbers. Therefore, there are still two 60 lb/yd turnouts between Kilosa and Gulwe and three similar turnouts between Gulwe and Dodoma. All 60 lb/yd turnouts are overdue for replacement due to wear and tear. Turnouts of density 80 lb/yd have some wear but are still in fair condition, except for one monoblock-type turnout at Mzaganza station that wears out beyond repair.



Source: JICA Study Team

Figure 9.5: Types of the Rails Used on the Central Railway Line

(2) Sleepers

The Central Line adopts iron sleepers except at turnouts and in ballast-less bridge sections. On 80 lb/yd rail, there are 17 sleepers per 12 meter of rail or 2,244 sleepers per mile. In the section with "Short Welded Rails," the rails are welded in panels of 40 m length. In general, the distance between sleepers is 30 cm. Sleepers are at closer intervals near joints.
Some iron sleepers bear buckling scars at their center, presumably because train loads are directed mostly to the center of the rails, due to insufficient ballast thickness underneath, as shown in Figure 9.6.

Source: JICA Study Team

Figure 9.6: Iron Sleepers

(3) Ballast

The formation level is unclear, with rails laid at a level almost the same level as the ground surface. It means that the ballast thickness is not enough. Track sides change as a walking pass. Ballast and roadbeds are washed away to expose sleeper ends and generate gaps underneath. Ballast should be spread at sleeper shoulders and arranged properly to secure the ballast layer section. Furthermore, sleepers should be protected at the bottom against erosion from rainwater.

At some places, the ballast is left unattended after spreading in excessive volumes within the track gauge, making it impossible to check the conditions of fish bolts or fishplates (Figure 9.7). The ballast within the track gauge is meaningless for tracks. For the purpose of mechanical maintenance work possible in the future, it is necessary to make sleeper positions clear to determine the tamping points.

The densely grown grass on the track proves that ballast contains large volumes of sand and soil, with the loss of bearing capacity apprehended when floodwaters stay on the roadbed. The Study Team visually confirmed the existence of track irregularities due to ballast subsidence at the joints between bridges and ground-level tracks, presumably because abutments installed on soft grounds had laterally displaced or roadbeds/ballast behind abutments runoff. It is conceivable that reinforcing work is necessary for the future for such civil engineering structures that cannot support ballast track.

Exposed Sleeper Ends

Ballast Covered with Grass

Source: JICA Study Team

Figure 9.7: Ballast

9.4.2 Track Maintenance

(1) Heavy Machine and Maintenance Structure

The introduction of heavy maintenance machines is inevitable by increasing destruction of track caused by frequent train operations in the future. TRL owns five tamping machines. One of them is usable of which capacity is 500 m/day. The other four machines do not work because of problems in procuring spare parts.

Source: JICA Study Team

Figure 9.8: Tamping Machine

The heavy maintenance machine requires a reform of track maintenance structure to match with the future big machine performance. Therefore, TRL introduced the "Mobile Gang" concept in the sections Tabora–Kigoma and Tabora–Muwansa. One mobile gang party of 15 workers covers nearly 60 km of track under a ganger and several key men. One key man inspects nearly 8 km of his territory. A ganger controls movements by trolley. These introductions of heavy machinery and the organization reform are right steps taken by TRL.

Table 9.5: Ordinary and Mobile Gang Man

	Ordinary Gang (person)	Mobile Gang (person)	Role
Ganger	1	1	Foreman of a gang of laborers
Key man	1	8	Track inspection
Gang man	8	15	Manual laborers
Walk	8 km	60 km	

Source: JICA Study Team

(2) Subjects

Heavy machine maintenance becomes more important than now, and following viewpoints should be examined:

Separation of Inspection from Maintenance Work

The current track inspection regime relies mainly on human/visual assessment rather than measuring instruments. However, it becomes more necessary to schedule the maintenance work quickly based on the numerical information, such as track irregularity. For this purpose, the introduction of efficient inspection machines, such as a track inspection trolley car is useful. When the track inspection system is changed to use these efficient machines, the organization of inspection party should be independent of the maintenance work party.

Improvement of Maintenance Technology

TRL has multiple manuals on track maintenance, even though TRL sets them aside. However, when the train speed is up, the track maintenance must obey the technical standards strictly. Before the speedup, the technological level/competency of the workers should be improved as well. It refers to not only track maintenance but also to roadbed and structures.

Other

TRL seems to have enough potential to adapt to the future, judging from the manuals as shown in Figure 9.9, an extraction from Civil Engineering Manual 1998 and the morale of workers. Additionally, a constructive approach is already taken, as seen in the mobile gang organization and procurement of heavy track maintenance machine from Austria. Therefore, Japanese assistance does not seem necessary, except the material supply for exchanging to 80 lb/yd rails.

2.2.3 SAFETY TOLERANCES

Safety tolerances establish the maximum deviation from the design track geometry that can be permitted for each "Speed Class" of track.

Should any non-complying track geometry (deviations which exceed the limits for each "Speed Class" as stated in the following table) be detected by the track recording car or by hand measurement, train movements must be protected by imposing speed restrictions. The track defect must then be repaired at the earliest opportunity and the speed restriction removed.

Figure 2-2 - Track Geometry Safety Tolerances

Track Geometry Parameter	Class of Track				
	1	2	3	4	5
	Maximum Permissible Speed (km/hr)				
	15	35	55	75	90
Wide Gauge (mm)					
• on straight track	35	25	15	15	15
• in curves & transition curves	35	25	15	15	15
Tight Gauge (mm)	-10 mm	-7 mm	-6	-5	-4
Change in Gauge (per sleeper)	7 mm	6 mm	4	3	2
Cross Level (mm)					
• on straight track	40	30	25	20	15
• in curves	40	30	25	20	15
Twist (mm/m)	10	8	6	5	4
Alignment (mm)	35	30	25	25	20
Unevenness (mm)	40	30	25	24	20
Acceleration (g)					
• vertical	0.4	0.3	0.28	0.25	0.25
• lateral	0.35	0.3	0.28	0.26	0.25

Source: TRC, Civil Engineering Manual, 1998

Figure 9.9: Safety Tolerances

9.5 Rolling Stock Maintenance

As locomotive rehabilitation work is in progress, with a new locomotive procurement plan envisaged simultaneously, the availability of locomotives increases in the immediate future. However, despite that locomotives shall be overhauled once per eight years, which is equivalent

to the general inspection schedule in Japan, TRL has not yet implemented this most significant renewal work in recent years, as spare parts are in short supply. It means that the preventive maintenance system disrupts in TRL. When newly manufactured or rehabilitated locomotives have superannuated, the once-decreased frequency locomotive accidents increase again.

While the maintenance work is not so busy because of the procurement of new locomotives, it is desirable for TRL to secure required spare parts and switchover the rolling stock maintenance from the current system breakdown maintenance to one of preventive maintenance.

9.5.1 Locomotive Situation

(1) New Purchase and Rehabilitation of Locomotive

Newly-Built Class 90 Locomotives

TRL has procured 13 newly-built Class 90 locomotives (Table 9.6).

1) Out of the 13 locomotives, four were already delivered to the Morogoro workshop, of which two have already been in service. (See the following photo for a Class 90 locomotive.) Of the other nine locomotives, three are on the ship moored at the Dar es Salaam Port and six are now under assembling in South Africa.
2) Electro-Motive Diesel Africa (EMD Africa) assembled the locomotives, mounting engines made by GE (from the US), with the contract awarded to EMD Africa after a competitive bidding. The warranty period is two years, which is common to all TRL locomotives of different classes. The procurement price is US$ 3.6 million per locomotive.
3) The Class 90 locomotive is a mainline diesel electric locomotive, having a total weight of 82.2 tons and an axle load of 13.7 tons. Table 9.7 summarizes the detailed specifications of all TRL locomotives, including Class 90 locomotives.
4) Class 90 locomotives equip with DC main motors that are the same as those used for other locomotives. TRL explains that it does not use AC motors for the reason that they are expensive though it acknowledges their manpower saving features in maintenance services.

Table 9.6: TRL Locomotive Holding as of 25 June 2015

Type		Class	Country of Car body manufacturer	Year purchased	Registered on Book	Active Holding	Under Maintenance in Workshop	Actual Outage for Today's Operation
Locomotive	Main Line	90	South Africa	2015	13*	**2**	0	2
		89	German	1992, 1993	9	**3**	2	1
		88U	Tanzania (supported by Malaysia)	2014, 2015	8	**8**	3	5
		88	Canada, India	1972, 1979	27	**9**	2	7
		73	India	1975, 1976	10	**5**	4	1
		Subtotal			67	**27**	11	16
	Shunting	65	German	1991, 1992	4	**2**	0	2
		64	German	1978, 1979	24	**2**	2	0
		37	German	1985	5	**2**	0	2
		Subtotal			33	**6**	2	4
		Total			87	**33**	13	20

Note: * 4 Locos are now at the Morogoro workshop, 3 at Dar es Salaam Port, 6 are under assembly in South Africa.
Source: TRL

Table 9.7: Locomotive Specifications

Class	Weight			Engine			Max. Tractive Effort (kN)
	Total weight (ton)	Axle load (ton)	Wheel arrangement	Type	Manufacturer	Horse Power (PS)	
90*	82.2	13.7	Co-Co	DE	GE	2,000	N/A
89	74	12.3	Co-Co	DE	MTU	2,130	252
88U**	96	13.7	1Co-Co1	DE	GE	2,150	234.5
88	103.446	13.5	1Co-Co1	DE	ALCo	1,880	239.5
73	72	12.6	Co-Co	DE	ALCo	1,380	124
65	38.4	10.1	B-B	DH	MTU	760	124
64	38.6	10.3	B-B	DH	MTU	740	120
37	36.2	13.2	C	DH	N/A	***401	107.9

Notes: *Class 90 is the newest locomotive. **Class 88U is a remanufactured locomotive of Class 88. ***: converted from 295[kW] to metric horsepower [PS]
Abbreviations: DE = Diesel Electric, DH = Diesel Hydraulic
Source: TRL

Rehabilitated Class 88U Locomotives

1) Regarding the rehabilitation of Class 88 locomotives that a Malaysian enterprise, SMH Rail undertakes, the Study Team witnessed five locomotives under rehabilitation work at the Morogoro workshop on 6 June 2015. Locomotives for which rehabilitation has finished put affixing "U" at the end of the designation, such as "Class 88U."

2) The Study Team heard that the rehabilitation cost is approximate US$ 2.0 million per locomotive.

3) Twenty Malaysian engineers stay at the Morogoro workshop, with workers employed by these engineers working in the workshop yard. Six TRL employees are being educated on locomotive maintenance through OJT, included as part of the procurement contract terms, with manuals and technical documents provided by SMH Rail.

Procurement in the Future

1) TIRP states its expectation that the acquisition of three more locomotives, each having an axle load of 25 tons and engine power of 2,000 HP, is probable in the future.

(2) Number of Active Locomotives

As it has procured the new Class 90 locomotives, TRL now has 33 active locomotives, 27 for mainline and six for shunting services, as of 25 June 2015. Table 9.6 above summarizes the number of active locomotives at the time of this Study.

(3) Number of Locomotive Failures

1) According to TRL, a locomotive failure occurred almost every day in the past on average. In recent years, however, they have dropped by half (for example, only 11 failures were recorded for the month of June 2015), presumably thanks to the introduction of new Class 90 locomotive and the rehabilitation of old Class 88 locomotives.

2) TRL states that failures, mostly occurring in diesel engines, do not concentrate on any particular Class of locomotives.

Source: JICA Study Team

Figure 9.10: The Newest Locomotive, Class 90

9.5.2 Locomotive Maintenance

(1) Inspection

Inspection Cycles

1) Mainline locomotives have different inspection cycles, which depend on each class based on the running times and working days. The specified inspection cycles are different for different classes for the reason that different manufacturers fabricate them. However, the specified cycles are not those offered by manufacturers, but they TRL determined based on the recommendation of manufacturers by reviewing the records of failure occurrence of different locomotives. TRL's activities to evaluate the frequency of failure occurrence and review inspection cycles by itself is praiseworthy from the viewpoint of productivity and improvement of locomotive quality.

2) Regarding the rehabilitated locomotive, Class 88U, five service categories have been adopted and put into trial application. They are (i) weekly service, (ii) monthly service, (iii) quarterly service, (iv) one-year service and (v) 4-year service. The Study Team hears that TRL is now discussing the inspection cycles for new locomotives Class 90.

3) The overhaul or heavy maintenance of locomotives (8-year cycles) has not been implemented in recent years, as spare parts are in short supply, as explained below.

Status of Spare Parts in Stock

1) Major spare parts in short supply are those used for engines, air compressors and main motors, all related to the propulsion and braking function of locomotives to directly govern their availability. TRL remarks that engines for the overhaul are in short supply, in particular.

2) As a result, the structure of preventive maintenance has virtually collapsed. For instance, shop-in locomotives for overhaul cannot be provided with repair services due to a shortage of spare parts. Therefore, they cannot be returned to revenue service operation again. Consequently, locomotives on the verge of the overhaul are degraded to a valuable fountain of spare parts for other locomotives, thus terminating their service life. In the workshop yard, the Study Team witnessed many such defunct locomotives. (See Figure 9.13 below for a defunct locomotive.)

3) According to TRL, the shortage of spare parts stems from the shortage of funding. TRL explains that they are procuring new locomotives and undertaking rehabilitation work as a measure of expensive spare parts required for repair services. Therefore, because TRL could purchase the new locomotives, it does not have an overall fund shortage, but rather a budget shortage for repairs. The Study Team suggests that the shift of the emphasis on budget allocations from new purchases toward maintenance is favorable while scrapping the old-type locomotives.

(2) Workshop

Workshop Organization

1) At the workshop, 120 TRL employees are working. The workshop organization consists of works manager and assistant works manager, under which there are seven inspection sections separately for different fields of inspection, i.e., power units, traction motors, machining tools, fabrication, superstructures (assembling/disassembling), bogies, and wheels.

2) Disassembling and cleaning of engines/DC motors are not outsourced but are implemented under its direct management, proving that TRL has the skills required for inspection.

Outline of Workshop Equipment/Facilities

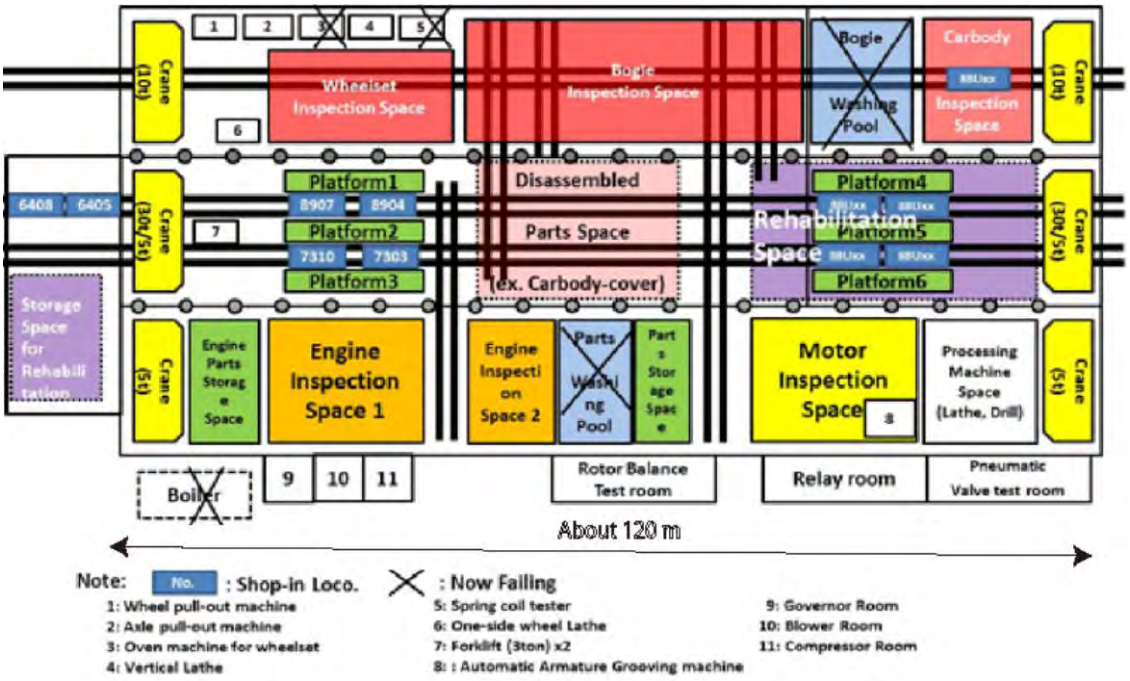
Figure 9.11 shows the layout of the inspection shop at Morogoro Workshop.

1) At the center, there are two sets of main inspection line for an overhaul. Four locomotives can enter the accommodation tracks on the left-hand side platform in the Figure.

2) The platform on the right-hand side, having the same locomotive accommodation capacity, is now used for rehabilitation work. Therefore, the site can accommodate eight locomotives in total, after completion of rehabilitation work.

3) Among the inspection and repair facilities, wheel lathes and processing machines are functioning well, but some machines and a boiler are out of order. Before the completion of boiler repair work, machine parts cannot be subject to hot-water washing and now dealt with cold-water washing. Figure 9.12 shows a parts washing pool.

4) Figure 9.13 displays the situation of old locomotives in the Morogoro Workshop Yard. The remains of old-type locomotives are left in the Morogoro Workshop yard after some parts were removed from and appropriated to repairing other locomotives.



Source: JICA Study Team

Figure 9.11: Layout of Inspection Shop in Morogoro Workshop

Source: JICA Study Team

Figure 9.12: Parts Washing Pool in Inspection Shop

Source: JICA Study Team

Figure 9.13: Situation of Dilapidated Locomotives in the Morogoro Workshop Yard

9.5.3 Subjects in the Future

(1) Save of Spare Parts

1) A priority subject for TRL is to remedy the situation where it cannot implement preventive maintenance due to the shortage of spare parts, which makes the old-type locomotives terminate their service life virtually in eight years. For several years from now, however, there are no problems, as the frequency of train operation is not very high, with active locomotives increasing as new locomotives are coming and rehabilitated ones are coming back to the frontlines. Despite that, however, given the fact that the number of rolling stock increases in the future, with procured and rehabilitated locomotives, superannuated simultaneously, it is a matter of the highest priority for TRL to discuss how to have enough spare parts for maintenance services.

2) Under the circumstances where new locomotives are arriving and rehabilitated ones coming back to revenue service, TRL engineers may, fortunately, have chances to be in direct contact with those from manufacturers. On this occasion, they shall discuss measures to make sure the procurement of spare parts, while studying the technique of regular inspections within the two-year warranty period. In concrete terms, TRL shall negotiate with manufacturers and take budgetary procedures within TRL's organization and to the Tanzanian government. TRL shall secure parts on a prioritized basis, at least for new Class 90 locomotives, or the principal mainline locomotives and rehabilitated Class 88U locomotives.

3) Although TRL explains that new or rehabilitated locomotives are cheaper than spare parts, it is not conceivable that parts are more expensive than locomotives, unless they are special parts customized and manufactured on a small-lot production line. The Study Team thinks this implies that manufacturers are not cooperative for after-sales services.

   (1) As a solution to this problem, the Study Team recommends TRL to discuss a method to purchase the substitute parts from manufacturers other than the supplier of the original piece. Although it depends on the status of the development of manufacturers in Tanzania, it is an attempt to order an alternative part equivalent to the original one conveniently from a domestic part manufacturer, use it on a trial basis, and formally procure more after verification. Although it may be difficult to apply this idea to

important parts, the Study Team recommends TRL to start joint development of substitute parts from simple consumables (such as motor brushes).

(2) As TRL prepares tender documents by itself in placing orders for procurement or rehabilitation of locomotives, it may be possible for TRL to add a stable supply of spare parts for two years or over in the contract terms in the future. The supplier shall introduce similar products as alternatives if the original parts go out of production. Not to make all bidders bow out. However, a practical and reasonable warranty period shall desirably be set for that purpose.

(2) Consideration of the Standardization of Equipment and Parts

Non-unification of parts may be cited as one of the factors to have made their procurement difficult.

At the moment, TRL is procuring parts by itself. Through a competitive bidding process, the bidder who has offered the lowest price obtains the letter of award. As a result, different spare parts shall be procured from various suppliers featuring different car body/engine manufacturers, though their engine outputs, axle loads, and other basic specifications are the same.

The Study Team recommends TRL to screen one to two suppliers who would be able to supply high-quality parts constantly in the future, unify parts to improve maintainability, and maintain a structure to procure spare parts at lower costs. However, TRL shall pay attention to the transparency of procurement and perform a total cost evaluation, such as not to induce high-cost procurement unexpectedly as a result of negotiated contracts with specially-designated suppliers.

(3) Consideration of the Installation of High Maintainability Equipment

The diesel-electric locomotives currently owned by TRL are all installed with DC motors. TRL explains that DC motors are cheaper than induction motors. Nowadays, however, induction motors are the mainstream of electric railway cars from the technical viewpoint and are superior to DC motors regarding maintainability, robustness, and the ratio of outside dimensions on output (smaller outside dimensions at the same output). The Study Team recommends, therefore, for TRL to consider the procurement of induction motors while taking into account the technical progress and the market prices, continuously

9.6 Signaling System and Telecommunication

The Study Team surveyed the signal and telecommunication systems/facilities in the section between the Kilosa and Dodoma stations as detailed below.

9.6.1 Block Systems and Signals

(1) Block Systems

For the safety of train operations, there are several types of block systems. The Study Team surveyed the paper ticket block system used by TRL. Under this system, train operation over the whole section is controlled by a controller, and between stations by stationmasters. Each stationmaster communicates through block telephones (portable telephones on public telephone networks) with the stationmaster of the adjacent station (to which the train in question is proceeding) to check whether a train exists in the section up to that station. After the confirmation of the non-existence of a train, the station master issues and hands over a paper ticket to the train driver who is going to pass the station to permit entry into the section up to the adjacent station. The train driver provided with the paper ticket runs the train up to the station specified on the ticket.

The authority of stationmaster at large stations is different from that at small stations. At large stations, (i) a foreman has the power to issue the ticket on behalf of the stationmaster and (ii) a point man manipulates points, confirms their status and reports it to the foreman. At small stations, on the other hand, such procedures are all implemented by the stationmaster.

There was a tablet block system in the past, but it damaged and is now out of use.

Source: JICA Study Team

Figure 9.14: A Ticket Used under the Paper Ticket Block System

Source: JICA Study Team

Figure 9.15: Devices Used under the Tablet Block System (Now Destroyed and Out of Use)

Source: JICA Study Team

Figure 9.16: Block Telephone Sets (Out of Use with Copper Cables Broken)

(2) Signals and Points

Signals

There are semaphore signals as home and departure signals but damaged and not in use (Figure 9.17).

Source: JICA Study Team

Figure 9.17: Semaphore Signals (Destroyed and Not in Use)

Shunting Signals

There are no shunting signals

Points

All stations equipped with manually turned padlock-locking type points (Figure 9.18). To turn the point, the point man unlocks the padlock first and re-locks it again after manipulation.

Source: JICA Study Team

Figure 9.18: Manually-turned Point (Locked with a Padlock)

Interlocking System

There is no interlocking system in any station.

(3) Power Source for Signals

TRL introduced a power supply system of solar panels for signals and telecommunication devices (Figure 9.19). Due to the pilfering of telecommunication lines or breakage of cables by floods, however, the power source has not served its intended purpose thus far.

Source: JICA Study Team

Figure 9.19: Solar Energy Source Power Supply System (Not in Use)

9.6.2 Telecommunication System

(1) Trunk Telecommunication Lines

Optical fiber cables laid along the 840 km long section between the Dar es Salaam and Tabora Stations.

(2) Optical Fiber Cables

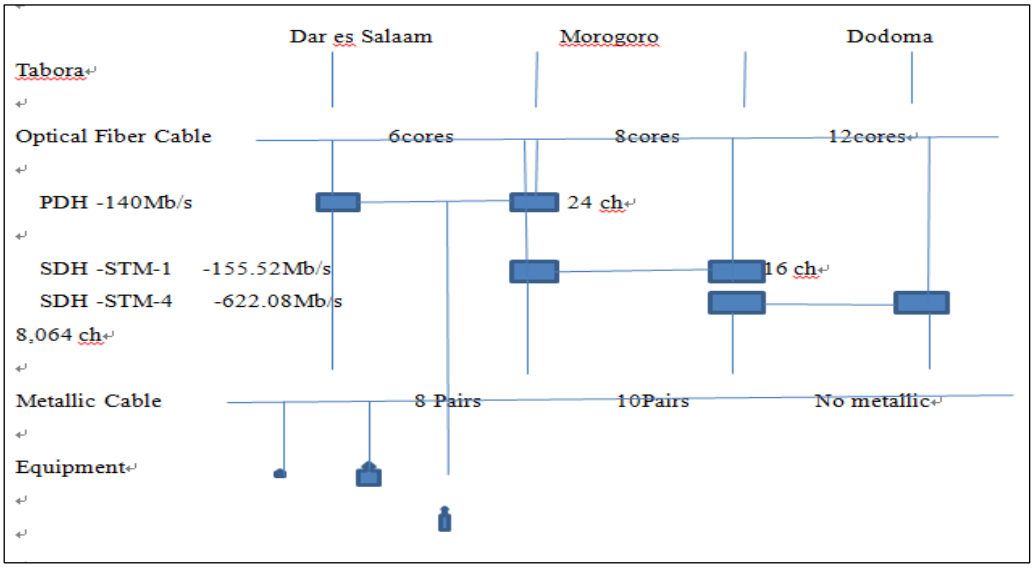
Regarding optical fiber cables, the Study Team has learned from TRL the following:

1) There is a six-core optical fiber cable between Dar es Salaam and Morogoro, with multiplexers connected to the optical fiber cables, one each for every three to four stations. Telephones at each railway station link to the copper cables extended from a multiplexer. The copper cables are victimized, however, by burglary or floods and out of use now.
2) There is eight-core optical fiber cable between Morogoro and Dodoma, of which only two cores are now active. However, TRL intended to lease the rest to outside subscribers, which has not yet been licensed, by the government. The allocation of active two core cables is the five-channel telephone circuits, with one for up-direction circuit and the other in the down-direction circuit. The copper cables are victimized, however, by burglary or floods and out of use now.
3) There is twelve-core optical fiber cable in the Dodoma and Tabora section, with a multiplexer installed at each station. Telephones at each railway station directly connect to the multiplexer without using copper cable wire. VHF wireless telecommunication units (in the 150 MHz band) are also installed to enable communication to/from relevant organizations.

Source: JICA Study Team

Figure 9.20: Multiplexer

Figure 9.21 shows a circuit diagram of the trunk transmission line:



Source: RAHCO

Figure 9.21: Diagram of Communication Line

(3) Block Telephones

TRL's stations equipped with block telephones, which are out of use, however, as copper cables are stolen or broken by floods. As a means of communication between stations, therefore, portable telephones sets for public use are deployed (Figure 9.22), with which stationmasters establish a block section between stations.

Source: JICA Study Team

Figure 9.22: A Portable Public Telephone Set (Used as a Block Telephone Set)

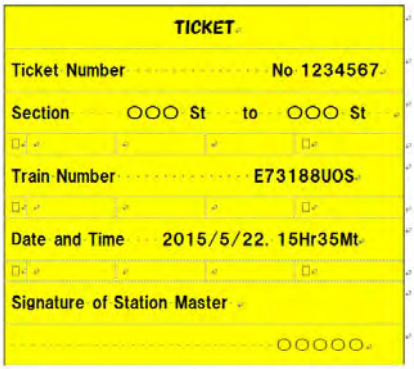
9.6.3 Signal and Telecommunication Systems in the Future (Viable Block Systems)

The Study Team has clarified through this Study that TRL's signal facilities and telecommunication lines are devastatingly robbed and damaged such that block telephones and signals can no longer serve their original purpose. In such vandalism, investment into TRL's signals and telecommunication facilities would end their futileness. It may be a far more practical way of thinking to avoid a renewal of signal and telecommunication equipment/ facilities at this juncture.

The Study Team recommends TRL, therefore, to operate trains by the following method instead, while using existing signals and telecommunication lines that have survived wrongdoings. If TRL were required to perform speedups or increase the frequency of train operation in the future, TRL should introduce high-level signal and telecommunication systems to cope with the new situation accordingly.

The Study Team recommends adoption of the paper ticket block system to run trains by following the procedures bellow.

1) To make a train depart from an adjacent station (a recipient station), the station master shall establish a block section (protected section) up to the receiving station after confirming that no trains exist in the section up to the receiving station with its stationmaster through a portable telephone set.
2) When there are no trains in the protected section, the stationmaster shall turn the relevant point where necessary, confirm its status whether it is in the normal or reverse position (closed or opened) and shall mechanically lock it.
3) To start the train, the station master shall issue a ticket (to allow entry into the protected section) and hand it over to the locomotive driver.
4) Figure 9.23 shows the sample of the ticket.



Source: JICA Study Team

Figure 9.23: An Example a Specimen of the Ticket Used under the Ticket Block System

5) The ticket consists of duplicated sheets (carbon copies).
6) The stationmaster shall prepare a recording book on his/her desk, into which he/she shall enter the train handling records.
7) The stationmaster shall keep the recording book and tickets at a safe place for three months.
8) The stationmaster shall prepare hand lamps (Figure 9.24) and spare lamps to use for departure and other signals at night.

Source: JICA Study Team

Figure 9.24: Hand Lamps

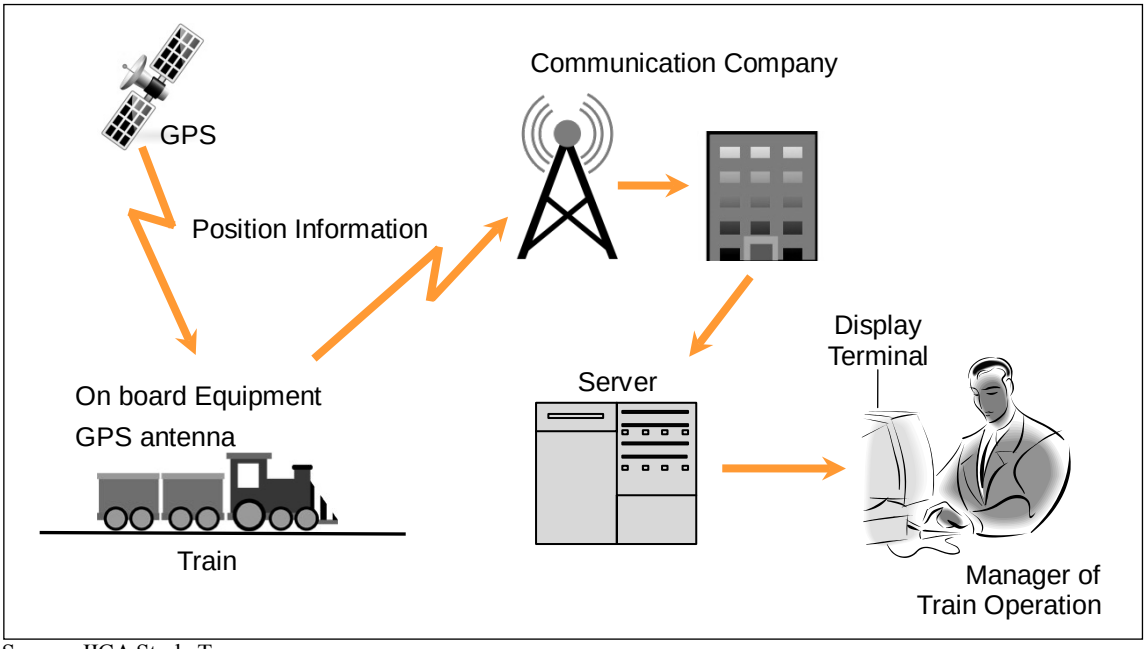
9.6.4 Ideal Train Operation Control in the Future

An ideal system for the future train operation control may be as follows:

1) The system combines a global positioning system (GPS) and the normal public portable telephone network to compose a train operation control system.
2) The driving cab of each train equips with (i) a display terminal for monitors and (ii) two antennas, one for GPS and one for the normal public portable telephone network.
3) Trains acquire their positions information through GPS and transmit it to the operation control center via the antenna for the mobile telephone network. Thus, the operation control center grasps the position of all trains on a real-time basis.
4) In case an accident or other abnormal situations have occurred, communications are made between stations and train dispatchers, between train drivers and dispatchers, and between

different stations through the portable telephone network to promptly and appropriately recover normal train operations.

Figure 9.25 gives an image of this train operation control system.



Source: JICA Study Team

Figure 9.25: Diagram of the Train Operation Control System in the Future

9.7 Stations and Related Facilities

Attempting to offer the core passenger and freight services is a meaningless endeavor without first ensuring safe and regular train operations to meet transport demand. After that is ensured, the next step is to provide improvements in users' convenience, by designing stations and terminals to allow for fluidity in the movements of passengers and freight. Furthermore, provisions shall be made to facilitate transfers to other transport modes at station plazas. The Study Team recommends that consideration is given to the improvement of equipment/facilities to guarantee mobility of physically handicapped people (barrier-free access/movement).

A subject of focus for freight terminals is the ability to control information on the location of containers, and implement a system to notify consignees of the arrival times of their freight.

Requirements for passenger and freight services frequently change according to social conditions, and the measures cited above cannot be adjusted/realized overnight. Therefore, TRL must constantly make efforts to grasp what is required for the Central Railway Line, by observing other global railways examples improving its own services step-by-step while considering cost performance at all times.

9.8 Flood Protection

9.8.1 General

The purpose of flood protection measures is to guarantee a transport capacity, approximately equal to the maximum levels seen in the past. As a first step toward this goal, Section 9.8.2

below explains an image of train operations after the implementation of the flood protection measures.

After that, Section 9.8.3 describes the policy of relocating railway facilities as a basis for flood protection works, with specifics for the objects of relocation, truck structures, tracks and station facilities, and relevant standards. Following this, Section 9.8.4 describes track relocation work, one of the largest components of the railway facilities relocating project for flood protection; Section 9.8.5 describes track strengthening after flood protection measures; Section 9.8.6 describes track materials used for facilities relocating work; and Section 9.8.7 contains some general remarks/conclusions for after the implementation of the flood protection measures.

9.8.2 Train Operation after Flood Protection

(1) Effect of Relocation of Equipment/Facilities

The line capacity between Kilosa and Gulwe, the object section for flood protection, remains unchanged even after completion of the flood protection project, as the track relocation for flood protection does not change the distances between stations in a major way (a maximum of 0.1 km, or 100 m).

As stated in Section 9.3.2, the line capacity is an index used to calculate, roughly, the number of operable trains, by using the values of (i) line utilization factor, (ii) block establishing time, and (iii) running time between stations averaged over different trains. Although it is a mere index, therefore, it shall be applied by bearing in mind the fact that some preconditions are involved.

Table 9.8 compares distances between stations and line capacities before and after the relocation of tracks from flood protection measures, with line capacities calculated under the same conditions as those in Chapter 9.3. The line capacity between Kilosa and Munisagara after relocation is 1 train/day less than before, because of the rounding factor (from 26.9 to 26.0).

Table 9.8: Distances between Stations before and after Relocation of Tracks

		Kilometrage of Starting Station (km)	Kilometrage of Arrival Station (km)	Distance between Stations (km)	Increase/ Decrease (km)	Line Capacity (trains/day)
Kilosa–Munisagara	**Before relocation**	282.7	298.8	16.1	-	27
	After relocation	282.7	298.9	16.2	+0.1	26
Munisagara–Mzaganza	**Before relocation**	298.8	311.2	12.4	-	39
	After relocation	298.9	311.3	12.4	±0	39
Mzaganza–Kidete	**Before relocation**	311.2	326.0	14.8	-	34
	After relocation	311.3	326.1	14.8	±0	34
Kidete–Godegode	**Before relocation**	326.0	349.6	23.6	-	22
	After relocation	326.1	349.7	23.6	±0	22
Godegode–Gulwe	**Before relocation**	349.6	369.4	19.8	-	36
	After relocation	349.7	369.4	19.7	-0.1	36

Source: JICA Study Team

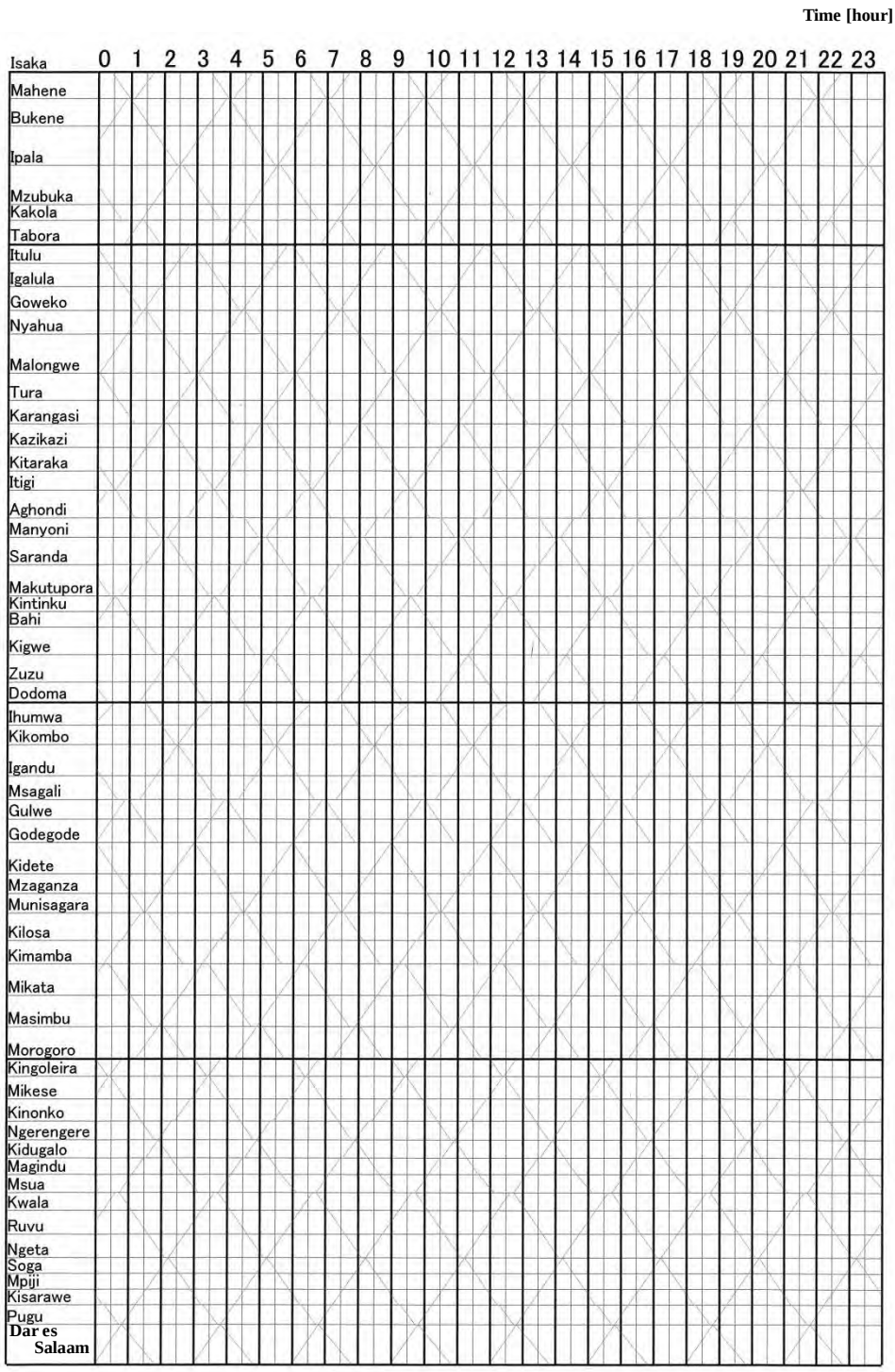
(2) Train Operation Diagram

Whereas the object section of flood protection in this Study is the Kilosa–Dodoma section, Figure 9.26 shows a train operation diagram assumed for the section between Dar es Salaam and Isaka, the area scope of TIRP plans. In drawing the train operation diagram, the Study Team set eight round-trip trains per day, in consideration of the minimum line capacity of 17 trains/day given in Table 9.3.

In this trial calculation, the Study Team set a line utilization factor 0.8 and a block establishing time 5 minutes, while adopting for calculation the train running time between stations of the maximum-speed freight train in the Tanzania Railways Corporation Working Timetable, dated July 16, 2001. For reference, five or so trains were operated in each direction in those days.

The train operation diagram is what is called a "parallel diagram", to run trains at equal three-hour intervals with a minimum dwell time of five minutes at each station. In principle, the up-train has priority for starting from/entering into stations at up- and down-train crossings. The reason for this priority comes from the fact that the demand for up trains from Dar es Salaam Port to Isaka located in an inland area is larger than that of down trains. Therefore, the punctuality of up trains is more important than that of down trains. The Study Team also assumes that down trains are more likely to transport empty containers than up trains, which naturally are of a lower priority.

This train operation diagram is applicable irrespective of whether a flood protection project is in progress, as the project does not change the line capacity. Therefore, in order to put this train operation diagram into effect, all that is required is to reinstate the currently-dormant stations as signal stations to enable two trains running in the opposite directions to cross each other at such signal stations. Additionally, the volume of freight transport capacity would potentially reach 1.3 million tons or less per year, as shown in Table 9.3 above.



Source: JICA Study Team

Figure 9.26: A Sample Timetable between Dar es Salaam and Isaka

9.8.3 Relocation Plan of Railway facility

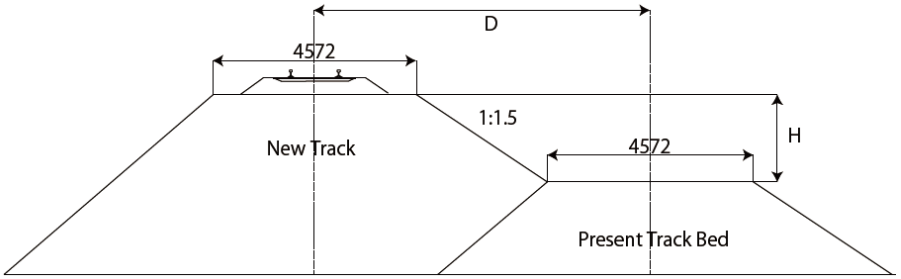
(1) Track Structure

Between Kilosa and Gulwe, 25 km of the line is to be rerouted under the flood protection project. The typical patterns of disaster are as follows:

- Pattern 1: Flood damages from the mainstream river (Kinyasungwe River).
- Pattern 2: Flood damages from the tributaries and slopes of mountains along the railway, due to inadequate cross-drainage.
- Pattern 3: Submergence of the track by the floodwaters from the mainstream and tributaries/slopes of mountains, due to inadequate drainage along the railway.

For each of the above patterns, the fundamental countermeasure is to relocate the track to a higher area where the disaster risk is lower. The concept of the relocation is to construct a higher bank along the existing track bed. When the safe elevation of the new bank is H mm higher than existing track, the distance D between the present and new track is estimated by the next equation, assuming a slope of 1.5 for the bank slope ratio and 4,572 mm for the formation level width, as shown in Figure 9.27.

D (mm) = H x 1.5 + 4,572



Source: JICA Study Team

Figure 9.27: Concept of Route Relocation

The Study Team is estimating the safety height H, and this is one of the most important points of the project. If H is assumed to be 5,000 mm, the distance between the track centers is 12,072 mm,[9] indicating that the new route runs along the mountain-side of the existing line.

(2) Railway Standards

Table 9.9 shows the proposed railway standards for the track relocating section which the Study Team deems to be appropriate. The standards comply with TRL manuals and current railway conditions.

Table 9.9: Railway Standards

Item		Remarks
Gauge (mm)	1,000	Gauge conversion not considered
Axle load (ton)	18.5	Double heading operation for steep gradients or larger hauling tonnage
Length of train composition (m)	Approx. 420	Current track layout in yard taken into account
Max. train speed (km/h)	50	Immediate target, with 80 km/h operation enabled in the future
Min. curve radius (m)	400	Adoption of line profiles to facilitate extension of transition curves
	250	Where 400 m is impractical
No. of turnout	Main: No. 10 Siding: No. 8	Mainly single and double-curve turnouts of the same type are used to avoid unsymmetrical double-curve turnouts in the same or opposite directions

Source: JICA Study Team

[9] 5,000 mm x 1.5 + 4,572 mm = 12,072 mm

Length of the Straight Line between Curves

The length of the straight line between curves shall be larger than the maximum length determined based on the safety limit (prevention of derailment caused by three-point rolling stock support) and ride comfort (in consideration of the change in cant over time and excessive centrifugal force due to cant deficiency).

Minimum Length of Curve

Trains are prone to roll at the point of entering and exiting from a circular curve, through the same process described in the previous paragraph. To prevent an accumulation of this rolling motion, it is important to ensure a circular curve longer than at least than a car length.

Cant/Superelevation

Trains running on a curve are subject to an outward centrifugal force. This (i) causes potential danger of outward overturn, (ii) affects the lateral force on the outer rail and wears on the tracks, increasing the volume of track maintenance work, and (iii) pulls passengers outward, reducing ride comfort. Therefore, tracks are to be furnished with cant on the outer rail in curved sections to prevent these effects.

In actuality, however, there is a speed difference between passenger and freight trains. This means any single cant does cannot satisfy both train speeds. To address this, the cant is set as the average speed obtained by the root-mean-square method.

For the non-relocated sections, the correction of cant is not necessary since the train speeds do not change.

Others

1) Track section length between adjoining curves or turnouts

A straight track section length equivalent to the maximum car length is necessary between adjoining curves and turnouts. Moreover, the same curve length between the adjoining straight section is required as well. The purpose of the minimum section length is to prevent the cumulative car body vibration.

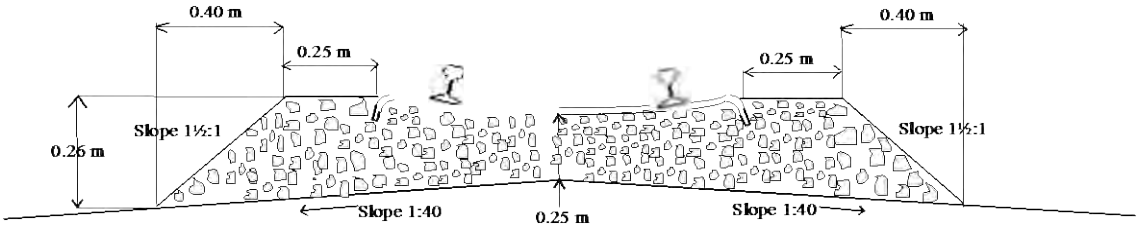
In the case that the insertion of a straight section as specified above is difficult for various constraints, such as in station yards or other places, the minimum section length is reduced to 5 m or more in length, in consideration of the car wheelbase.

2) Joints between curves, structures

Trains are normally subject to rolling at curve joints (BTC, BCC, ECC, ETC), crossings, abutments, and turnouts. The track requires a damping distance longer than the maximum car length between curves to reduce the collective car body vibration caused by such curve joints. This issue becomes serious considering the plans for speeds up to 80 km/h in the future. Therefore, it is better to consider it now, at the planning stage of track alignment.

(3) Track

Tracks are subject to be replaced in not just the re-routed sections, but sections that are presently equipped with 60 lb/yd rails as well. The new tracks shall be a meter-gauge ballasted structure composed of 80 lb/yd rails and steel sleepers as a standard. See Figure 9.28 for a track sectional drawing.



Source: TRC, Civil Engineering Manual, 1998

Figure 9.28: Track Sectional Drawing

(4) Stations

As a part of the flood protection project, some sections of railway track transfer together with stations and related facilities. The concrete objects of the relocation are:

- The facilities in service
- The facilities that have an established plan, even if they are unserviceable at this moment.

Examples of the relocated facilities/objects are as follows:

- Track (main line and refuge track)
- Station main buildings

(5) Summary

Table 9.10 summarizes railway facilities subject to relocation.

Table 9.10: Railway Facilities Subject to Relocation

	Object of Relocation		Remarks
Track structure	Section of track relocation		Length: 25.1 km (after relocation)
Track	Section of track relocation		Length: 25.1 km (after relocation)
Station facilities	Gulwe station	Station building	
		Sub-mainline for up- and down-train crossings 1 set	Effective track length: 450 m

Source: JICA Study Team

9.8.4 Relocation of Track

(1) Track Structure

Figure 9.28 and Table 9.11 summarize track structures applicable to sections subject to track relocation.

Table 9.11: Track Structure

Track structure			
	Ballasted track		
	Joint	Standard size	
	Distribution of joints	Supported joint	
	Joint supporting method	Parallel joint	
Track materials			
	Rail	Rail type	80 lb/yd over
		Length of rail	Standard size: 24.0 m or over
		Rail steel	Ordinary rail
	Rail Fastening	Composition	Double elastic fastening
		Fastening spring	Wire spring, spring crip
		Fastening method	No-screw fastening
	Sleeper	Sleeper type	Steel Sleeper
		Sleeper interval	1477 Units/km, (33 Units/24 m) A=229mm, B=610mm, C=686mm, D=748mm
	Ballast	Ballast	Crushed Stone
		Thickness of Ballast	250 mm
		Width of Ballast shoulder	250 mm
		Volume of Ballast	885.0 m^3/km

Source: TRC, Civil Engineering Manual, 1998

(2) Transport of Materials

Track materials are heavy, long, and bulky. Their bulk transportation requires appropriate vehicles and equipment for work sites, temporary storage yards, and main stock yards at the construction base. For the transportation of equipment, dedicated freight cars on the rail and trailers on the road play an active part.

The transportation of rail, sleepers, and track ballast pose some challenges. The availability of sufficient spaces for loading/unloading and equipment to be transported governs the capacity of the carriage. See Table 9.12 for methods to transport track materials.

Table 9.12: Methods to Transport Track Materials

Track material for transport	**Transport route**	**Methods to transport and unload track materials**
Rail	By a revenue service line	Unload rails from rail-transporting freight cars with a rail unloader at the main stock yard in the construction base.
		Unload rails from track motor-cars with a rail unloader at the work site.
	By land	Unload rails from trailers with a crane at the work site.
Sleeper	By a revenue service line	Unload sleepers from sleeper-transporting freight cars and track motor-cars at the main stock yard in the construction base.
	By land	Unload sleepers from trucks with a crane at the work site.
Track ballast	By a revenue service line	Transport track ballast by a ballast-transporting freight cars from the factory at the quarry to the main stock yard in the construction base and unload.
	By land	Load track ballast on dump trucks at the main stock yard in the base and transport to and unload at the work site.
		Transport track ballast from the factory at the quarry directly to the work site by dump trucks and unload.

Source: JICA Study Team

For carrying-in, storage, and loading of track materials, and storage of construction machines/tools, the process is to prepare the main stock yard in the base adjacent to the work

site and equip it with gantry cranes and other loading/unloading machines. Where necessary, a temporary storage yard is established close to the work site.

	Rail	Sleeper	Track ballast
Transport by Land	 Website: yoyogiall	 Website: nikko	 Website: matsuikido
Transport by a revenue service line	 Website: hokuju	 Website: daitetsu	 Website: mjk21

Source: JICA Study Team

Figure 9.29: Typical Equipment for Transport of Track Materials

(3) Track Construction

After constructing a track bed, ballast is manually or mechanically spread and leveled on the track bed up to the height of sleeper bottom and compacted with a vibration compactor. Next, a track panel is set up on the compacted ballast and replenishing ballast is spread to form an appropriate ballast layer section. Below, a method is explained for performing track construction work for a length of 500 m in a time period of two weeks.

Spreading/leveling ballast on the track bed to the height of sleeper bottom

Transport track ballast directly up to the construction site by dump trucks. See the method explained in sub-section (2). For a 250 m-long track construction project, ballast of 150 m^3 is required (on the assumption that ballast of 0.6 m^3 is necessary for a track length of 1 m). Transporting ballast up to a volume of 150 m^3 necessitates deploying five times a fleet of six 5 m^3 10 ton dump trucks (5 m^3/track x 6 tracks x 5 times). Spread and level the ballast unloaded with power shovels to form a ballast layer to the height of sleeper bottom and compact it with a vibrating compactor. See Table 9.13 for machines required for a 250 m-long track construction task.

Table 9.13: Important Track Maintenance Machines Required for Ballast spreading/Leveling work

Machine	Quantity	Purpose
Road-rail power shovel	2	Ballast spreading and leveling

Source: JICA Study Team

Setting up of Track Panel

After unloading sleepers to the side of formation level, uniformly arrange them on the track bed with power shovels and cranes. Use over-raise rail shifters to manually adjust spaces between sleepers. Use 360 sleepers for a track length of approximately 244 m.

After that, laterally or longitudinally move and arrange rails on the sleepers. Adjust joint gaps and fix rails with rail fasteners to set up a track panel. A 240 m-long track consists of 20 24 m-long standard-size rails on the left and right sides. See Table 9.14 for track maintenance machines required for 240 m-long track fabrication task.

Table 9.14: Major Track Maintenance Machined Required for a Track Panel Setting up

Machine/Tool	Quantity	Purpose
Road-rail power shovel	2	Unloading rails and sleepers
Attachment (gripper)	2	Unloading and arranging sleepers
Road-rail 8-t crawler crane	2	Unloading of heavy articles and shifting of track panels in lateral directions

Source: JICA Study Team

Replenishment of Ballast

After setting up a track panel, deliver replenishing ballast with road-rail power shovels. On the assumption that ballast of 0.3 m^3 is necessary for a 1 m-long track, replenish ballast of 48 m^3 for a 160 m-long track, by deploying twice a fleet of six road-rail 8 ton dump trucks, each having a capacity of 4 m^3. In parallel with ballast replenishing operation, carry ballast with road-rail power shovels; tamp the ballast with a 16-tool tie tamper and compact with a vibration compactor. See Table 9.15 for the machines used to complete the above operations in a day.

Table 9.15: Important Track Maintenance Machines used for Ballast Replenishing

Machine/Tool	Quantity	Purpose
Road-rail 8t dump truck	6	Transport of replenishing ballast
Road-rail power shovel	2	Formation of ballast section
Road-rail 16-tool tie tamper	1	Tamping of track ballast

Source: JICA Study Team

(4) Realignment of Track

There are two kinds of the realignment of the track. One is the preparing of track switchover, and the other is immediately after the switchover. The former is to tamp track ballast and realign track panels by using hand tie tampers or multi-tool road-rail power shovels while the latter to deploy multiple tie tampers and multi-tool road-rail tie tampers to adjust track irregularities caused by trains running for construction work trains and revenue service. Local track irregularities tend to occur before and after bridges and culverts, for which hand tie tampers are useful. After starting a revenue service operation, attention shall be paid to track settlements near switchover points, structures, and abutments, from the viewpoint of track maintenance. Such points require more careful tamping work than for other sections.

As newly constructed tracks are deformable by train loads, they need several times of tamping and compacting work repeatedly. Perform track inspection and measurement with a simplified track inspecting instrument to check their finishing conditions. See Table 9.16 for the machines required for track correction and ballast tamping for an approximately 500 m-long track per day.

Table 9.16: Main Machines for Realignment of Track

Machine/Tool	Quantity	Purpose
16-tool road-rail tie tamper	1	Track ballast tamping
Simplified track inspecting instrument	1	Track inspection

Source: JICA Study Team

Composition of Track Machines and Schedule

See Table 9.17 for the composition of track machines used to construct and realign a 480 m-long track, which includes the descriptions from the preceding Subsections (3) and (4), respectively. Also, see Figure 9.30 for a work schedule for an approximately 500 m-long track realignment conducted in a two week period.

Table 9.17: Composition of Main Track Machines

Machine/Tool	Quantity	Purpose
Road-rail 8-t dump truck	6	Transport of replenishing ballast
Road-rail 8-t crawler crane	2	Unloading of heavy articles and shifting of track panels in lateral directions
Road-rail power shovel (16 tool tie tamper attachment)	1	Tamping of tracks
Road-rail power shovel	2	Forming of track sections
tie tamper attachment	2	Tamping of tracks
gripper attachment	2	Arranging of sleepers
Simplified track inspecting instrument	1	Inspection of tracks

Source: JICA Study Team

Item		Details	Deployed Machine			1st Week							2nd Week						
			Name of machine	Quantity	Implementing speed per track length	M	T	W	Th	F	Sa	Su	M	T	W	Th	F	Sa	Su
Realignment of track	Spreading/leveling ballast up to the height of sleeper bottom	Transporting bottom ballast	10 t dump truck	6 sets	250m/day														
		Spreading/levelling	Road-rail power shovel	2 sets	250m/day														
		Tamping	Compacting machine	2 sets	250m/day														
	Setting up of Track Panel	Arranging sleepers	Road-rail power shovel Road-rail crane	2 sets 2 sets	244m/day														
		Arranging rails	Road-rail crane Road-rail power shovel	2 sets 2 sets	240m/day														
		Adjusting rail joint gaps																	
		Tightening fasteners																	
	Replenishing of ballast	Transport of replenishing ballast	Road-rail dump truck	6 sets	160m/day														
		Forming ballast layer sections	Road-rail power shovel	2 sets	160m/day														
Correction of track	Tamping (including compacting)		Road-rail power shovel (16-tool tie tamper)	1 set	500m/day														

Source: JICA Study Team

Figure 9.30: Work Schedule

(5) Track Switchover

After completing track construction works for the relocating section, the next step is to switch the tracks. Track switching work often reveals some problems, such as insufficiency of construction gauge or adverse effects on a train running performance due to an improper track profile caused in track connecting work. In planning a track switchover, therefore, it is important to check the site conditions in advance, guarantee sufficient working time, and prudently pay attention to recruitment of workers and procurement of tools/machines in a reliable manner.

Track Switching Operation and Train Operation Diagram

As the track switchover works require a long train interval, it often requires a change in the train operation diagrams. In particular, large-scale switchover works often require cancelation of train operations. On such occasions, notify passengers and freight consignees/shippers in advance of changes in the timetable or cancelation of train operations.

Working Time Required for Track Switchover

The work site conditions govern the working time necessary for track switchover. It is essential to implement preparatory work before the switchover. Consider dividing the switchover work into several phases and shorten the working hours to complete the track switchover work within a limited train interval.

Track Switchover Work and Low-Speed Train Operation

There are two types of slowdown patterns of train speed during a track switchover work. One pattern is to run several trains at low speeds at the switchover point and scrape out track ballast as a preparatory work before track closure. The other pattern is to run trains at reduced speeds to ensure running safety until the track exerts a sufficient strength at the switchover point after completion of a track switchover work. Discuss the timing of the lifting of the speed restriction while correcting and measuring the track deformation, as it gradually stabilizes by running trains.

9.8.5 Track Strengthening

In Tanzania, 60 lb/yd rail sections are not subject to track relocation. TRL plans to replace the 60 lb/yd rails in these sections with 80 lb/yd rails by itself. In this regard, the Study Team wishes to avail itself of this opportunity to provide the information below on what TRL should observe in promoting the 60 lb/yd rails replacing scheme.

(1) Switching to Heavy Rails

Iron sleepers currently in use for 60 lb/yd rails cannot fasten 80 lb/yd rails, as their width of rail sheet is too small. Therefore, they shall be replaced by the introduction of new rails or whole track panels.

Prior replacement of sleepers requires several repetitive works at the same points, which prolongs the period of rail replacing work and is hardly-applicable to the sections where a rail switching scheme is also planned. Therefore, the discussions below focus on the way to replace whole track panels.

Such big track renewal work can result in times where trains do not run. As cancelation of train operations is by no means appropriate from the viewpoint of customer service/satisfaction, switching to heavy rails is implemented, with daily train operation maintained under the following preconditions:

- The planned sections switching to heavy rails do not include the section of the flood protection.
- In parallel with switching to heavy rails, iron sleepers shall be replaced with new iron sleepers, with ballast layer sections corrected simultaneously.
- Switching to heavy rails with simple machines and facilities.
- Switching to heavy rails during the regular track closure times as much as possible.

The work to switch to heavy rails includes transport of materials, removal of track, laying of track, correction of track, and carrying-out of waste produced during the rail switching work. To execute the work to switch to heavy rails, discuss the method of execution while considering methods to procure materials, working environments, operation period, cost, and other factors.

(2) Transport of Materials

Methods for Transport and Unload Track Materials

Among track materials, those which are difficult to transport are rails, sleepers, and track ballast. In particular, the method to transport track ballast governs the whole period and cost of the construction work, as its quantity is enormous.

Table 9.18 summarizes different methods to transport track materials. There are two transport ways: one is with a carriage on the road, and the other is on the revenue service lines. To transport track materials by a service revenue line, use freight cars and unloaders both dedicated to material transport. As trains run on the service revenue line back and forth, in this case, the volume of ballast is governed by the capacity of freight cars and the transport time between the loading and unloading bases.

Table 9.18: Methods to Transport and Unload Track Materials

Track material for transport	Section of constructing tracks	Route of Transport	Methods to transport and unload track materials
Rail	Levee widening of an existing track	By a revenue service line	Unload rails from rail transporting freight cars with a rail unloader at the work site.
			Unload rails from track motor cars with a rail unloader.
		By land	Unload rails from trailers with a crane.
Sleeper	Levee widening of an existing track	By a revenue service line	Unload sleepers from track motor cars with a crane at the work site.
		By land	Unload sleepers from trucks with a crane at the work site.
	Separate line	By land	Unload sleepers from trucks with a crane at the work site.
Track ballast	Levee widening of an existing track	By a revenue service line	Spread ballast from ballast transporting freight cars.
		By land	Transport ballast by dump trucks from the factory at the quarry and unload at the work site.
	Separate line	By a revenue service line	Transport ballast by dedicated ballast transporting freight cars from up to the nearest station; transship to dump trucks there; forward to the work site and unload to spread.
		By land	
		By land	Transport by a dump truck from the factory at the quarry to the work site and unload to spread.

Source: JICA Study Team

After unloading rails and sleepers at the work site, place them in parallel with the existing track to facilitate fabrication of track panels.

(3) Preparation for Track Construction and Removal

The track construction process explained below consists of spreading/leveling work of bottom ballast, compaction work, and fabricating/laying work of track panel.

The meaning of "the spreading/leveling work of bottom ballast" is to spread/level ballast up to the level of the new sleeper bottom by manually or mechanically. "The compaction work" means the lifting, tamping, and compacting with a vibration compactor. "The fabricating/laying work of track panel" is the forming of track panel by manually relocating the materials that were sent to and stored in the vicinity of the work site beforehand.

After completing the preparatory work for track construction, remove the existing track after cutting it into pieces of a constant length, and move them a small distance to the side of the formation level with a crane or an over-raise rail shifter.

(4) Construction of Track

When broadly classified, there are two kinds of track constructing methods featuring different process sequences:

Track Constructing Method 1

After temporarily placing a newly fabricated track panel, lift it while spreading replenishing ballast to suffice the necessary volume and tamp it to finish.

Track Constructing Method 2

After spreading/leveling track ballast up to the height of sleeper bottom and compacting it with a vibration compactor or by other means, place the track panel on it and replenish the required volume of ballast to finish.

Select one of the above two methods according to the purpose, whether it is levee widening or not, manual or mechanical track laying, transport of materials by land or by a service revenue line, and so forth.

The work to laterally shift a track panel assumes the use of a special over-raise rail shifter for heavy articles as shown in Figure 9.31, which has a simple structure and is readily applicable to rail/turnout replacing and track maintenance work for different lines.

To transport materials and execute track construction work, large vehicles, such as those to transport track panels or for track renewal work, running on revenue service lines, are sometimes deployed. However, these vehicles are omitted from the discussions below, as they entail enormous amounts of initial investment and maintenance costs and are applicable only to the limited scope of track maintenance work.

Source : To-Ko-Sangyo Website

Figure 9.31: Special Over-Raise Rail Shifter for Heavy Articles

A unit track panel is one composed of two 24 m-rails. Assuming that a track panel has two 24 m-long 80 lb/yd rails, 70 kg steel sleepers, and 5 kg rail fasteners per sleeper, the weight of a track panel amounts to approximately 3.5 tons. As the lifting capacity of a special over-raise-rail-shifter is approximately 1.5 to 2 tons, 3-4 sets of special over-raise rail shifters shall be used to shift a 3.5-ton track panel laterally.

Table 9.19: Weight of Track Panel

Item	Quantity	Unit weight	Weight
Rail	24.0 m	40 kg/m	960 kg
Sleeper	33 pieces	70 kg/piece	2,310 kg
Fastener, pad	33 pieces	5 kg/piece	165 kg
		Total	3,435 kg

Source: JICA Study Team

After installing a track panel, refill ballast to form track ballast sections. This workload is so heavy that it governs the speed of track renewal work as a whole. After track panel laying work has progressed to the extent that construction cars are allowed to run thereon, it is efficient, from that point, to being spreading ballast by using ballast spreading cars. Figure 9.32 shows photos of typical ballast spreading cars, which can spread ballast within and outside of the track gauge.

Source: MJK Website

Figure 9.32: Typical Ballast Spreading Cars

(5) Correction of Track

After completing the construction of track, refill the ballast to correct the track irregularities. Procedures to correct the track are different depending on the selected track constructing method. In the case of track construction method 1, lift the track panel with jacks up to the specified height and tamp. In construction method 2, spread and tamp the rest of the ballast over the already spread/leveled bottom ballast, the height of which is under the sleeper bottom.

Correct the track as per the criteria stipulated in the Civil Engineering Manual 2.2.2, "Construction and Maintenance Tolerances". There are three ballast tamping methods. The first is to tamp ballast seamlessly with a multiple tie tamper; the second is to rely on manual means; the third to use road-rail power shovels attached with tamping attachments. Select one according to the volume of workload and required functions therefor. The features of these methods are described below:

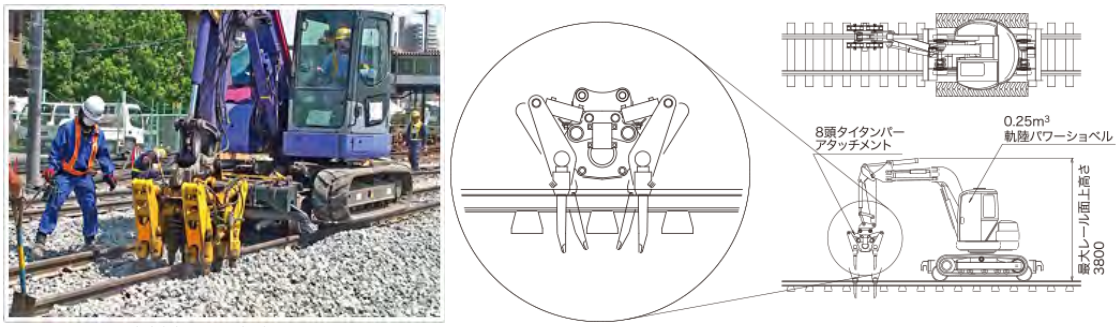
Multiple Tie Tamper

It is a machine, basically a unit of rolling stock, used to tamp track ballast seamlessly and also to correct alignment irregularities. With one dedicated to the site, even large-scale construction

work can efficiently be implemented at a high quality. However, note that as Multiple Tie Tampers run on the track itself, they must start from and return to the same point before/after track closure time, and thus their production time on sites is limited.

Road-Rail Power Shovel

It is a machine, smaller than a Multiple Tie Tamper in size, capable of running both on roads and tracks and used to tamp track ballast successively. Before tamping ballast, lift the track panel with jacks, as it does not have a lifting function. It does not have the alignment correcting function, either. It is highly mobile, however, in that it can enter and exit from a track anywhere as far as the work site is plain. This machine can also be used for track ballast excavation/adjustment, sleeper replacement and other categories of track maintenance work when fixed with an attachment dedicated to it.



Source: matsui-kidou Website

Figure 9.33: Road-Rail Power Shovel (with 8-Tool Tie Tamper Attachment)

Bucket type

16-Tool Tie Tamper

Source: matsui-kidou Website

Figure 9.34: Road-Rail Power Shovel (Exchanging Attachment)

Manual Operation

This process involves raking in track ballast under the sleepers manually with hand tie tampers. As this operation necessitates carrying-in/out of hand tampers and jacks to lift track panels, it is not suitable for long-range track correcting work, but is useful for track spot reworking operations.

(6) Track Stamping

There are two methods of track stamping. One is to stamp tracks by stamping trains, and the other is by track stabilizing cars.

Stamping Trains (Test-Run Trains)

As track ballast sometimes loosens during a track correcting work, track ballast may sink to a large extent and cause track distortion when a revenue service train runs on it the next day. To prevent this track settlement beforehand, run test trains to stamp the ballast after correcting the overall-rail-level, cross level, track gauge and alignment on the newly constructed track. As the track sinks to a large extent at the first test run, tamp it for correction. After that, repeat a stamping test run and track correction. As the required frequency of tamping is largely dependent on the track bed conditions, determine the number of required iterations by observing the changes in the settlement depth at stamping test runs.

Track Ballast Stabilizing Cars

It is useful to deploy track ballast stabilizing cars in place of trains to stamp the track. After a tamping operation, track stabilizing cars transmit vibration to the ballast through rails and sleepers, expediting the initial settlement of the ballast and stabilizing track conditions to produce the results summarized below:

Facilitates start of normal train operation:
Recovery of lateral ballast resistance force
→ Elimination of low-speed operation
→ Cutting the operation time
Extension of maintenance period:
Expediting of initial track settlement
→ Suppression of the progress of track irregularities

(7) Low-Speed Train Operation

After completing the series of heavy-rail introducing works, review whether low-speed train operation is necessary, and if required at what speed, in parallel with track irregularity correcting work while observing the progress of the track stamping operations.

Judge the progress of the track stamping operations based on the degree of track settlement at train entry. Carefully watch the sections before and after bridges or culverts, as they are particularly prone to settlement.

9.8.6 Track Materials

(1) Role of Track Materials

Considering the track maintenance work and economic efficiency, the Study Team adopted ballasted tracks (track bed tracks) composed of rails, sleepers, track beds, and other components. The Study Team explains the concept to determine the specifications based on the role of each component.

Rail

1) Role

Rails provide a safe and smooth running surface for rolling stock and shall have functions to support directly and distribute large axle/wheel loads, thereby facilitating reduced maintenance requirements and control of tracks. The section and profile of rails shall:

(i) Withstand external train loads and longitudinal loads caused by temperature changes without yielding large-degree deformation,
(ii) Not change much due to wear in service for long years,

(iii) Ensure smooth running for rolling stock, and
(iv) Have a sufficient level of durability.

In other words, it is important to discuss track structures that minimize the dynamic force caused by running trains and ensure efficient track maintenance work. The introduction of heavy track panels is helpful to raise the rigidity of tracks, as it is possible to improve the resistance of tracks against displacement due to train loads.

2) Length

Dynamic loads work at rail joints, requiring significant manpower for track maintenance. Therefore, it is desirable to minimize rail joints in number as far as possible. On the other hand, however, long rails necessitate control of rail axial force against temperature changes and affect the easiness of rail transport and workability in replacement. Despite that the introduction of long rails is helpful, rails of standard length are usually used in consideration of the track maintenance structure, where the standard length is determined to reflect environmental conditions.

Rail Fastener

1) Role

The roles of rail fasteners are:

(i) Fasten the left- and right-side rails to sleepers, thereby correctly maintaining the track gauge and resist rail creeping, and
(ii) Withstand the load and vibration on tracks in lateral directions when a train runs and transmits the force/vibration to substructures such as sleepers, track beds, and subgrades.

2) Fastening Structure and Materials

The selection of fastening structure comes from the viewpoint of ensuring the easiness of maintenance and satisfying the function of rail fasteners. In concrete terms, bolts are not used for rail fastening, with attention paid to the easiness of judgment of the rail pressing conditions by a component member (adoption of wire springs). Furthermore, prevention of vandalism/pilfering, a concern in Tanzania, is an object of consideration. Figure 9.35 illustrates a rail fastener designed with a vandalism-free profile. In this rail fastener, a projection at the tip of wire spring is hooked at a point inside the shoulder, which cannot be unhooked easily with a crowbar. Instead, a special tool is used to install or uninstall the fastener.

Source: PANDOROL's website

Figure 9.35: Rail Fastener

Sleepers

1) Role

Sleepers play a role in fixing rails, correctly maintaining the track gauge, and widely distributing the train load through the rails and onto the track bed.

2) Sleeper Types

Figure 9.36 illustrates iron sleepers. They have a hollow space under the main frame, allowing ease of transport thanks to their small volume when piled up on top of each other. They also feature a thickness smaller than that of PC sleepers that easily ensures a sufficient track bed thickness, are more lightweight than PC sleepers, law-shaped frame ends with a great withstanding force into lateral directions, and have the possibility of recycling after use. However, they have demerits in their workability and maintainability, in that the sleeper ends bent downward like a claw, precluding the ability to easily install them and insert ballast using a compacting operation. They are now widely used in TRL for the reason that they can reduce the thickness of track beds compared to other sleepers. From the viewpoint of track maintainability, it is required to discuss the possibility of PC sleepers introduced below.

Source: Website of Nippon Steel & Sumikin Texeng and Kitakyushu Innovation Gallery

Figure 9.36: Iron Sleepers

PC sleepers feature the heavyweight, stability, significant buckling resistance of track panels, the low-speed progress of track irregularities, and savings in maintenance cost. However, because of these features, they are harder to transport and require larger track bed thicknesses when compared with iron sleepers.

3) Standards for Use

The points for the selection of sleepers are maintainability responding to the degree of creeping and the lateral force in steep gradient sections. The number of sleepers depends on the categories of sleepers and rail fasteners, curve radii in the installation object section, and train running conditions.

Track Bed

1) Ballast

The places of production and transport conditions are essential in the selection of ballast. In manufacturing ballast, efforts shall be made in quality control to make element stones square and sharp to increase the inner friction of ballast when used on tracks. To manufacture and transport massive ballast stones, it in indispensable to construct ballast manufacturing plants and discuss the ballast transporting method.

2) Thickness, Cross-Sectional Profile

It is important to ensure a sufficient track bed thickness in track remodeling work while assuming deterioration of track bed ballast such as consolidation, lateral flow, penetration into subgrades, and grain refining. Also, it is important to design an appropriate sectional profile for the ballast layer for each of different curve radii in curved sections where lateral pressure tends to increase.

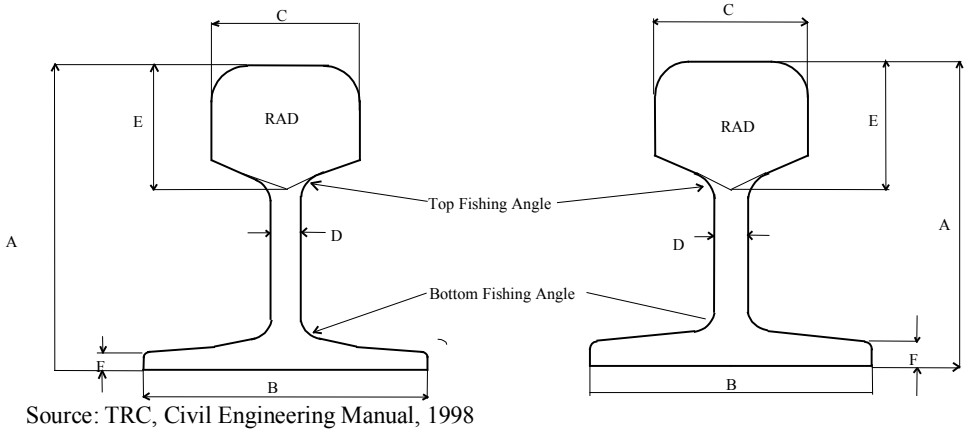
(2) Key Specifications and Standard Drawings of Track Materials

Refer to the following tables and figures for the key specifications and standard drawings of track materials.

Table 9.20: Key Specifications of Tracks

Track Structure			
	Ballasted track		
	Joint	Standard size	
	Distribution of joints	Supported joint	
	Joint supporting method	Parallel joint	
Track material			
	Rail	Rail type Length of rail Rail steel	80 lb/yd Standard size 24.0 m or over Ordinary rail
	Rail Fastening	Composition Fastening spring Fastening method	Double elastic fastening Wire spring, spring Crip No-screw fastening
	Sleeper	Sleeper type Sleeper interval	Steel Sleeper 1477 Units/km, (33 Units/24 m) A=229 mm, B=610 mm, C=686 mm, D=748 mm
	Ballast	Ballast Thickness of Ballast Width of Ballast shoulder Volume of Ballast	Crushed Stone 250 mm 250 mm 885.0 m^3/km

Source: JICA Study Team

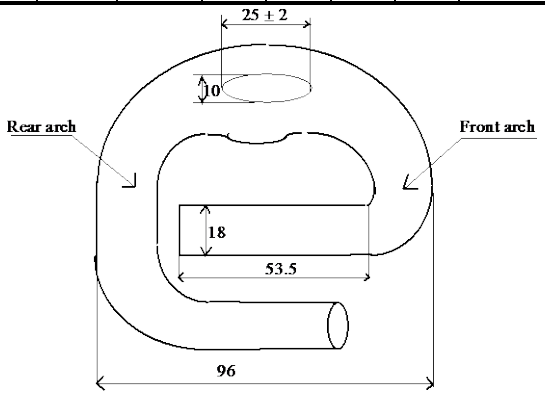


Source: TRC, Civil Engineering Manual, 1998

Figure 9.37: Sectional Drawing of Rail

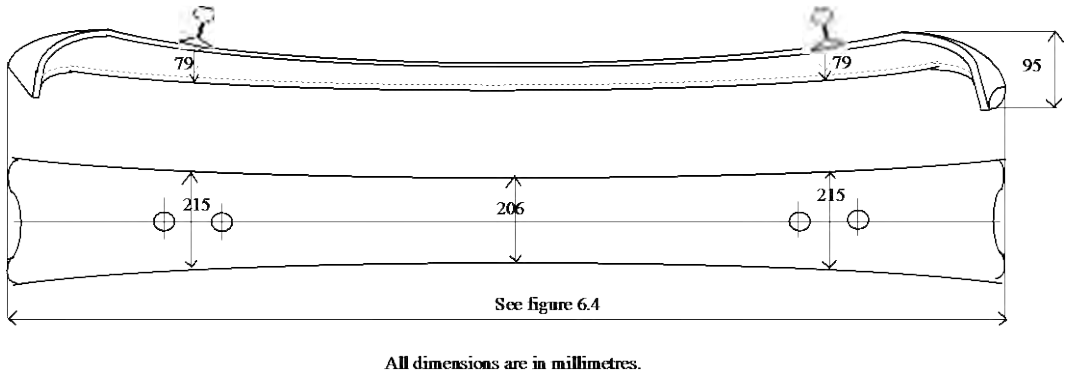
Table 9.21: Dimensions of Rail

Rail Section	Type	Dimensions in millimeters						Fishing Angle		Radius of the Table (mm)
		A	B	C	D	E	F	Top	Bottom	
80A.BS	1	133.4	117.5	63.5	13.1	42.5	25.0	1:2.75	1:2.75	304.8
80R.BS	2	133.4	122.0	63.5	13.5	40.9	19.5	1:3	1:6	229.0



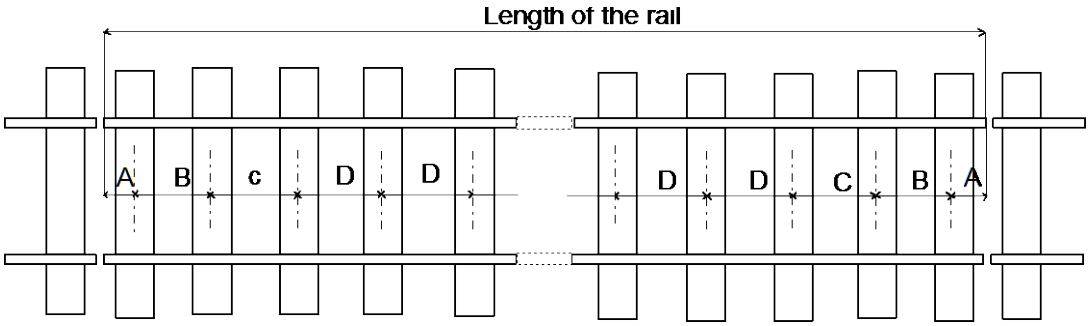
Source: TRC, Civil Engineering Manual, 1998

Figure 9.38: Example of Rail Fastener (e-Crip)



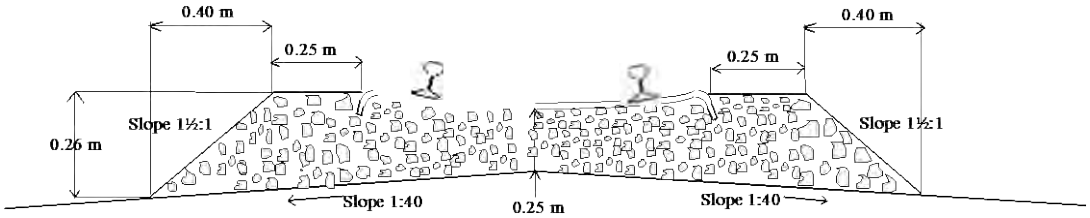
Source: TRC, Civil Engineering Manual, 1998

Figure 9.39: Example of Steel Sleeper



Source: TRC, Civil Engineering Manual, 1998

Figure 9.40: Sleeper Interval



Source: TRC, Civil Engineering Manual, 1998

Figure 9.41: Ballast Layer Sectional Profile

Table 9.22: Volume of Ballast

STANDARD CUSHION					
Type of Ballast	Type of Sleeper	Group	Rail Section	Cubic m/km	
				Jointed Track	SWR & LWR Track
Brocken Stone	Steel Sleeper	-	80 RBS 80 OBS	885.0	941,8

Source: TRC, Civil Engineering Manual, 1998

9.8.7 Conclusion

(1) Train Operation

The current line capacity of the Dar es Salaam–Isaka section is 11 trains/day, as restricted by the bottlenecked Gulwe–Kikombo section.

If the stations in that bottlenecked section reopen as signal stations irrespective of whether there are flood protection measures, the Dar es Salaam–Pugu section becomes the new bottleneck section, but there is nevertheless an overall increase in line capacity of the Dar es Salaam–Isaka section to 17 trains/day.

When 16 trains/day (6 freight trains and 2 passenger trains in each direction) run on the section, the freight transportation capacity increases to 1.3 million tons per year. If average train speed can increase to 50 km/h over the whole section in the future, the freight capacity reaches approximately 2 million tons per year. (see Table 9.3).

(2) Safety Measure

For the railway undertaking, the purpose of flood protection measures is ultimately to provide customers with safe transport opportunities. In this context, railway operators should sense dangers and stop trains at any time. Refer to the descriptions in manuals for concrete methods of how to do so. What is essential for those concerned is to abide by rules with utmost resolve. To attain this end, it is a key to repeat training and exercise.

10. Preliminary Design and Cost Estimate

<This part has been removed because of confidential information.>

11. Project Implementation and O&M Structures

11.1 Project Implementation Structure

Following the implementation arrangements for the World Bank-assisted TIRP, RAHCO will be the Executing Agency for the Project (see Section 3.2.5 for the implementation arrangements for TIRP). The organizational structure of RAHCO is described in Section 3.2.1.

As described in Section 3.2.1, RAHCO has, with only about 50 officials, insufficient technical capabilities to effectively manage a large-scale project such as TIRP and the Project. As of December 2015, for the implementation of TIRP, RAHCO was in the process of establishing a Project Implementation Team (PIT) as described in Section 3.2.5, recruiting several experts from outside of RAHCO.

In order to ensure smooth and effective implementation of the Project, it is essential to make similar arrangements to those for TIRP, and a Project Management Team (PMT) is to be established for the Project. The PMT is to be staffed with core personnel as listed in Table 11.1 who are to be provided by RAHCO and the Project.

Table 11.1: Core Personnel of Project Management Team (PMT) for the Project

Position	No of Staff	Main Responsibility
Chief of PMT	1	To be responsible for overall project management and coordination with concerned agencies.
Deputy Chief of PMT	1	To be responsible for all of the technical and financial aspects of the Project and assist Chief of PMT in overall project management.
Project Engineers (Civil Work/River Structure)	2	To supervise technical aspects of the Project and assist Deputy Chief of PMT in technical management.
Accounting Specialist	1	To undertake accounting management of the Project and assist Deputy Chief of PMT in financial management.
Procurement Specialist	1	To undertake procurement management of the Project and assist Deputy Chief of PMT in procurement management.
Assistant Project Engineers (Civil Work/ Hydrology)	2	To assist Project Engineers in supervising technical aspects of the Project.
Environmental and Social Specialist	1	To undertake environmental and social management of the Project and assist Deputy Chief of PMT in environmental and social management.
Support Staff (Driver)	1	To undertake day-to-day operation of PMT.

Source: JICA Study Team

The PMT for the Project is to undertake, but not be limited to, the following activities:

- Overall project management operations throughout the pre-construction and construction stages, including reviewing, monitoring, coordination, evaluation, modification of, and reporting concerning, project implementation
- Overall planning of the Project at the initial stage, including detailed planning of the implementation program of the Project, establishing and managing fund disbursement procedures, and establishing the organizational structure and communication channels for project implementation.
- Selection of, and contracting with, the consultants to be employed for the Project.

- Supervision of the design work and preparation of tender documents to be undertaken by the consultants employed for the Project.
- Arrangement for securing the budget from the Ministry of Works, Transport and Communications (MWTC) for any local portion of the funds required for the Project.
- Management regarding environmental and social impacts (including RAP/CRP during the detailed design) of the Project in accordance with the procedures and requirements specified in relevant laws and regulations.
- Management of tender processing and contracting for all of the contract packages of the Project, including advertising, pre-qualification of bidders, short-listing of bidders, tender call, pre-tender conference, site orientation, opening of tender, tender evaluation, contract negotiations with successful bidders, and other relevant activities.
- Overall management and monitoring of the construction works and related activities for proper control of the quality, progress and budget of the Project.
- Coordination with TIRP, funded by the World Bank.
- Reporting to, and coordination with, the agencies/entities concerned with the implementation of the Project, including JICA.
- Examination and approval regarding consultant's monthly statements of performance and contractors' monthly certificates of payment.

11.2 O&M Structure

11.2.1 Division of Roles and Responsibilities in Railway O&M

Table 11.2 shows the current and planned institutional setup for railway infrastructure management and railway services provision (which is an excerpt from Table 3.1 in Section 3.2 of this report).

Table 11.2: Current and Planned Institutional Setup for Management of Railway Infrastructure and Provision of Railway Services

Issues	Current	Transition period	Long term
Railway infrastructure			
Ownership of infrastructure assets	RAHCO	RAHCO	RAHCO
Railway infrastructure development	RAHCO	RAHCO	RAHCO
Routine infrastructure maintenance and casual renewal[1]	TRL	TRL	RAHCO[2]
Railway services			
Provide operational services for operators	TRL	TRL	RAHCO
Ownership of rolling stock	RAHCO	TRL	TRL
Provide railway freight and passenger services	TRL	TRL	TRL
Maintenance and repair of rolling stock	TRL	TRL	TRL
Procurement of new rolling stock	TRL	TRL	TRL

Notes: (1) Based on the Concession Agreement (2007), TRL is currently "responsible for the first US$ 100,000 of the cost of any restoration to such lost or damaged immovable assets and to the extent that the total cost of such restoration is less than US$ 100,000". (2) In July 2015, MOT mentioned that the transfer of this responsibility to RAHCO will be conducted by the end of 2019 when the TIRP Program is completed. However, it is still unclear who will actually conduct the maintenance work (see 3.2.6 (iii) for more details).
Source: Table 3.1 of this report

Currently, routine infrastructure maintenance is carried out by TRL. In the long term, this responsibility is planned to be transferred to RAHCO, although the timing of the transfer and the way RAHCO will conduct maintenance work are still uncertain. It is planned that designing the right maintenance organization and sustainable maintenance activities as well as a training

program for RAHCO will be conducted as part of TIRP (see Section 3.2.4). The progress of these initiatives needs to be closely updated before and during the implementation of the Project.

In the short to medium term, TRL will be responsible for routine infrastructure maintenance. As mentioned in Section 3.2.6, considering that RAHCO does not have its own in-house maintenance workforce and that there is no plan to significantly increase the size of RAHCO's workforce, it is envisaged that even after the routine maintenance responsibility is transferred to RAHCO, TRL (and a private company currently contracted out by TRL) will subsequently carry out the maintenance work on a contract basis. It is therefore realistic to assume that TRL will continue to conduct routine infrastructure maintenance in examining the scope of any technical assistance for flood protection by JICA.

The railway services will continue to be provided by TRL. As described in Sections 3.2.3 and 3.2.4, strengthening the capacity of RAHCO and TRL is essential for revitalizing the Central Railway Line before introducing new institutional arrangements, including the implementation of the open access policy. In this regard, the Study Team's concerns over the reintroduction of PPP to the railway system in Tanzania are described in Section 11.2.3.

11.2.2 Setting Up of Operation, Maintenance and Safety (OMS) Team during Construction

The Project needs to be implemented under continued railway operation. Therefore, in order to undertake train operation and infrastructure maintenance safely and efficiently during the construction stage of the Project, an Operation, Maintenance and Safety (OMS) Team is to be set up, consisting of representatives from RAHCO, TRL, the supervision consultant, and the contractors for the Project.

The OMS Team for the Project is to undertake, but not be limited to, the following activities for the section between Kilosa and Gulwe:

- Monitoring of train operations, maintenance activities, and construction works.
- Planning and implementation of safety and protection measures on the construction sites.
- Securing evacuation areas to evacuate staff/workers on the construction sites and construction equipment/machinery, etc., in case of emergency.
- Maintenance of communication equipment.

11.2.3 Concerns over Reintroduction of PPP

Considering that the railway sector of Tanzania experienced a failure in the past of a concession arrangement, the sector should take a very careful step toward any re-use of the private sector forces to provide railway services.

It is necessary to note the important lessons learned from what occurred after PPP were introduced for railways in several African countries, including Tanzania, including the following[1]:

[1] These lessons are based on the findings from a series of JICA studies on the development of economic or transport corridors in SADC countries conducted in the past several years.

- Refurbishment of railway system should be undertaken before transferring operation and maintenance works to concessionaires. Such refurbishment should be implemented with clear specifications and quality, which need to be documented explicitly.
- When deciding terms to be included in the concession agreements, the demarcation and responsibilities of contractors and concessionaires regarding maintenance should be clearly specified with details. In general cases, concessionaires are private commercial enterprises, which tend to seek maximum profit with minimum maintenance cost. Terms in the concession agreements should explicitly include the maintenance items to properly control this tendency.
- When transferring operation and maintenance works to concessionaires, the status of the railway system should be checked in detail, in the presence of contractors and concessionaires, and the conditions and qualities at the time of transfer should be clearly recorded.

11.2.4 Recommended Points on Railway O&M

Taking into account the above lessons on railway PPP and the current conditions of the railway system in Tanzania, it is recommended that the following points be considered by the Tanzanian government with respect to railway O&M:

- To improve railway infrastructure under the management by the public sector as a top priority.
- To achieve the level of rail freight tonnage during the peak times, i.e., in 2001–2004, under the current institutional setup before any re-use of PPP (including the open access policy) is implemented.
- To focus more on freight transport that will contribute to the improvement of financial performance of the railway system while placing lower priority on passenger services that would require operating subsidy.
- To strengthen the capacity of RAHCO and TRL under the current institutional setup.
- Not to rush toward complete vertical separation of the railway system, considering that even in Europe, there is no evidence indicating that vertical separation leads to better railway performance compared to vertically-integrated systems (see Box 11.1 below).

Box 11.1: Results of Selected Recent Research on Vertical Separation versus Vertical Integration in the Railway Sector

(a) J. Drew, and C.A. Nash (2011), "Vertical separation of railway infrastructure – does it always make sense?" Working Paper 594, Institute for Transport Studies, University of Leeds

- The results based on the analysis of railways in EU countries show that there is no correlation between vertical separation and the growth in rail freight traffic or rail's share of total freight traffic.
- If the key objective of vertical separation is to promote the efficiency and growth of rail freight, vertical separation may impede rail growth in some circumstances, particularly those in some Central and Eastern European countries where adequate government funding for infrastructure is not available.
- Before considering whether to make vertical separation mandatory within the EU, a much better understanding is required of the factors which determine competition, efficiency, and growth in the railway industry. On existing evidence, there is no reason to conclude that vertical separation improves rail performance.

(b) C.A. Nash, A.S. Smith, D. van de Velde, F. Mizutani, and S. Uranishi (2014), "Structural reforms in the railways: Incentive misalignment and cost implications," Research in Transportation Economics, Volume 48, pp. 16-23.

- The results based on the analysis of railways in European and East Asian OECD countries indicate that vertical separation raises costs for more densely-used railways and those with a higher proportion of freight traffic.
- It appears that the main reason for the above results is the misalignment of incentives, leading each player in the vertically separated system to seek to optimize their own costs rather than those of the system as a whole.
- There is no evidence that complete vertical separation leads to more competition.
- The findings of this research suggest that alternative railway structures will suit different railways with different patterns of usage and therefore a policy that seeks to impose complete vertical separation on all EU members would increase costs.

(c) Roland Berger (2012), "The optimal setup of a rail system – Lessons learned from outside Europe."

- This study was triggered by the debate on whether to impose complete separation on all EU members. It analyzed rail structures in the US, Canada, Japan, Russia, and China, which together account for 80% of global freight transportation by rail and 50% of passenger rail travel.
- Major railways in these countries have vertically-integrated structures that result in optimum resource allocation and efficient processes while avoiding additional costs. Integrated railways are able to act as a system integrator and help reach decisions by considering infrastructure and rolling stock jointly, based on their direct knowledge of customer requirements. As stated by several senior railway executives in these countries, key operational processes can be handled much more efficiently by integrated railways, especially when changes on short notice come into play and in case of intensely-used infrastructure. Integrated systems also avoid the additional interfaces and transaction costs of vertically-separated systems.
- Railways in these countries significantly improved their traffic volumes and personnel productivity over the last decade.
- Railways in these countries invest increasingly in assets. One reason could be that due to direct customer access, integrated railways are in an ideal position to forecast future transport needs and the required assets. They have an incentive to invest in infrastructure as they themselves are its main users.

12. Project Implementation Plan

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13. Environmental and Social Considerations

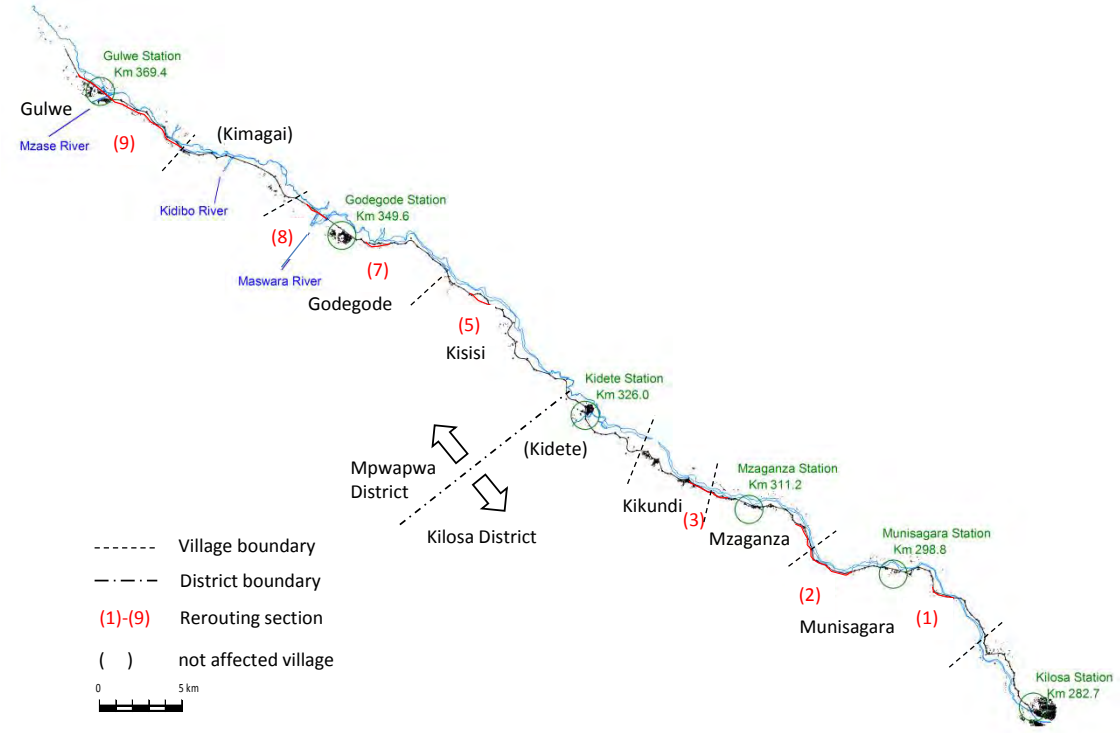
13.1 Environmental Impact Assessment (EIA)

13.1.1 Project Components Which May Affect Environment

The project components to be considered in this chapter are listed below.

(1) Rerouting

In total 25 km of the existing railway between Kilosa and Gulwe is to be relocated toward mountainside, a movement of at most five hundred meters, to avoid the impact of flooding. The rerouting sections consist of the seven sections shown in Figure 13.1; Section 9 includes the relocation of Gulwe Station for one kilometer to the west. Each rerouting section is built by embankment or cutting of the mountain slopes.



Source: JICA Study Team

Figure 13.1: Location of the Rerouting Sections

(2) Bank Protection

The riverbank is protected by installing gabion/blocks. The locations of these are presented in Subsection 10.1.9.

(3) River Training Works

At Maswara and Mzase Rivers, which are tributaries of the mainstream, the river course is straightened and defined by excavating channels together with constructing a check dam and groundsill. The details are presented in Subsection 10.1.10.

(4) Construction Access Road

The temporary construction access road will be prepared along the existing railway within the ROW.

13.1.2 Environmental and Social Conditions of the Study Area

(1) Land Cover and Land Use

Typical conditions of land cover and land use between Kilosa and Dodoma are presented in Figure 13.2 and Figure 13.3. Forest is the typical land cover around Kilosa, while bushland mixed with agricultural land are common in the western half of the Kilosa-Gulwe section. After Gulwe and toward Dodoma, the condition becomes drier. Pasturing is commonly observed at the bushland.

Forest near Kilosa

Bushland at the west half of the Kilosa-Gulwe section

Source: JICA Study Team

Figure 13.2: Typical Land Cover (Vegetation)

Agricultural land (maize) near Gulwe

Pasture at the bushland

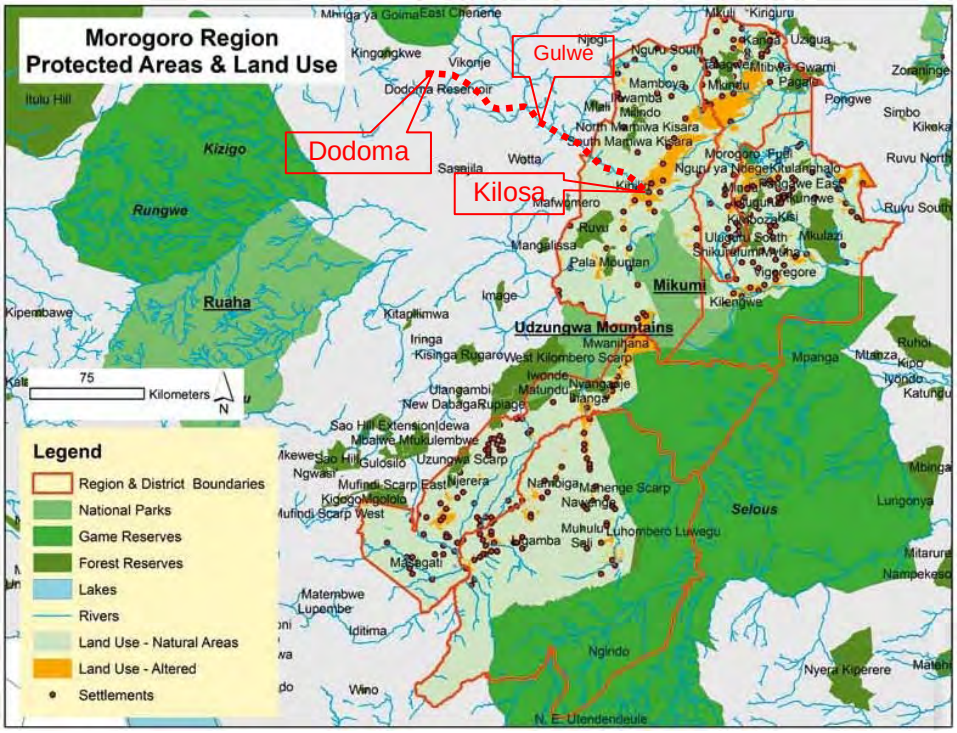
Source: JICA Study Team

Figure 13.3: Typical Land Use

(2) Protected Areas

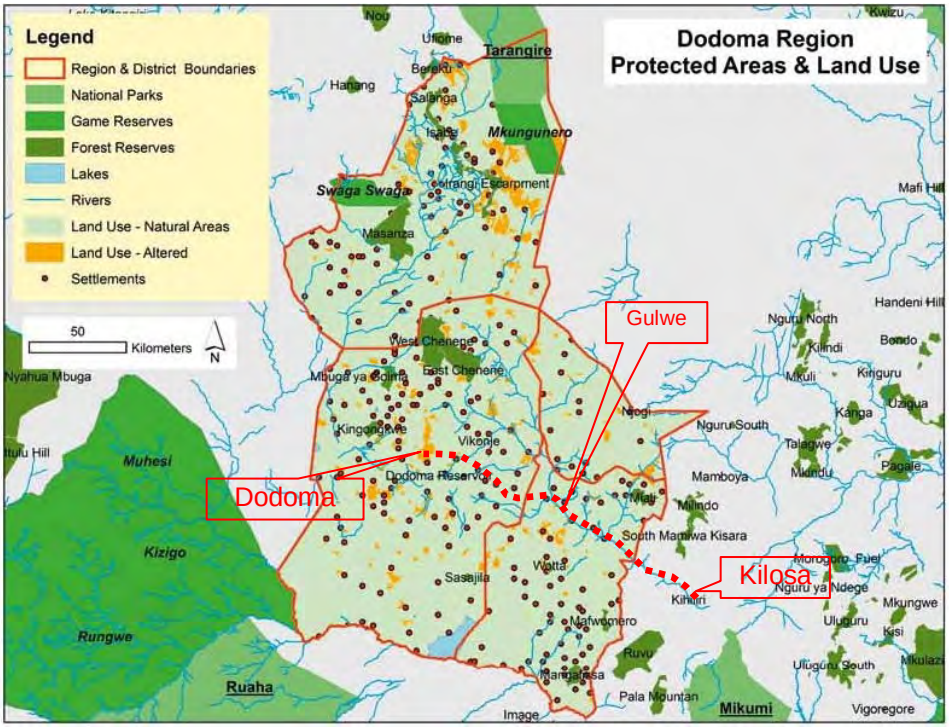
Distributions of national parks, game reserves and forest reserves in Morogoro and Dodoma region are presented in Figure 13.4 and Figure 13.5. The closest reserve to this project area is Kihiliri forest reserve located near Kilosa Station. Although the location is close to the project

area, an environmental impact to the reserve is not anticipated as the location is segregated from the railway by the river (Figure 13.6). The other reserves are located more than several kilometers away from the railway.



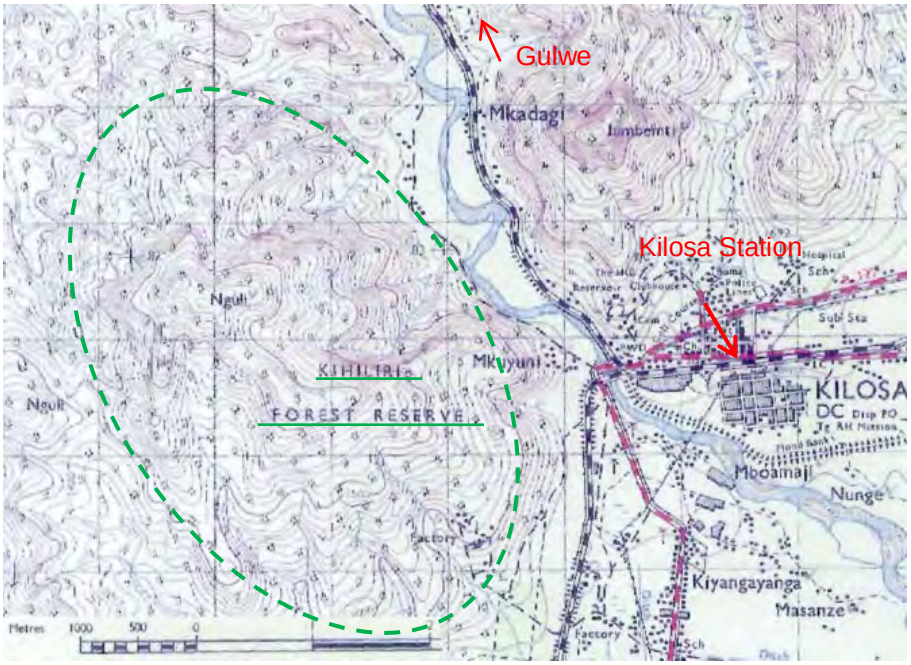
Source: Directory of Natural Resources and Land in Tanzania 2011, PAMS Foundation.

Figure 13.4: National Parks and Reserves in Morogoro Region



Source: Directory of Natural Resources and Land in Tanzania 2011, PAMS Foundation.

Figure 13.5: National Parks and Reserves in Dodoma Region



Source: Topographic map with a scale of 1 to 50,000

Figure 13.6: Location of Kihiliri Forest Reserve and the Railway

(3) Socio-economic Conditions by District

The Railway Line along the Kilosa-Dodoma section runs through the three Districts: Kilosa of the Morogoro Region, and Mpwapwa and Chamwino of the Dodoma Region. The present socio-economic conditions of each District are summarized below based on the information collected from each District Office.

General Land Usage by Districts

Kilosa District:

The District's land use consists of Agriculture (37%), Grazing (33%), Mikumi National Park (22%), Forest (5%), Built-up area and wetlands (1%).

The rail alignment runs through the two agro-ecological zones – Medium High Zone and Plains – where maize, rice, cassava, sorghum and bananas are cultivated.

Mpwapwa District:

The District's land use consists of Agriculture (31%), Grazing (35%), Game Controlled Area (19%), Forest Reserve (1.2%), Community Forest (0.9%), Settlement (4.2%) and Water Bodies (4.2%) – marsh and wetlands.

Agro-ecologically, the rail alignment, existing and proposed, lies within the Intermediate Zone (IZ) and the Low Land Zone (LLZ). Agriculture in the IZ features the cultivation of paddy, maize, sorghum and legumes, as well as dairy and traditional livestock. Agriculture in the LLZ features cultivation of dry resistance crops including millet, maize, sorghum, groundnuts, beans and tropical fruits. However, due to its temperature, the greatest part of the area is used for grazing traditional livestock.
Chamwino District:

Chamwino District has a total area of 8,856 square kilometers (km^2), out of which 4,823.066 km^2 (54.45%) is potential land for agriculture, 1864,937 km^2 (21.05%) is currently under cultivation, 1093.192 km^2 (12.34%) is used as grazing land, 813.1 km^2 (9.18%) is used as residential area, 1960.96 km^2 (22.14%) covers natural forest, 63.08 km^2 (0.71%) is used as forest reserve area and 102.1 km^2 (1.15%) is wetland. (Source: District Vulnerability Report, 2012.)

The District is characterized by two agro-ecological zones in terms of annual precipitation – a zone with 400 mm rainfall and another with 550–650 mm, with different soil features.

Key Socio-economic Features by District

Key socio-economic features by District are collected from respective District Offices. Extracted are the relevant facts in terms of employment structure, ethnic variety, poverty indicators, sources of household cash income, health situation, and availability of water, types of crop cultivated, and so on.

These facts constitute fundamental inputs to comprehend the target area's socio-economic baseline data.

Kilosa District (Extracts from District Profile, 2014):

- **Employment Structure by Sectors:** More than 80% of the District population is employed by the agriculture sector. They are engaged either at the subsistence level, growing (rice, maize, beans, cassava, and bananas) or in cultivating cash crops (sisal, sugar cane, cotton, and sunflowers). Aside from agriculture sector, office work (2.8%), livestock keeping (0.93%), fishing (0.08), plant operations (0.49%), and informal sector (15.7%) constitute other employment patterns.
- **Production of cash crop and food crops:** The District's volume of cash crops, in terms of annual yield in tons (Source: Agricultural & Livestock Dept. August 2010) is as follows: cotton (47,515), onion (13,277), sugarcane (573,294), groundnut (1,763), and coconut (4,549).

  Major food crops produced (for the year 2009/2010, in tons/year) are maize (153,939), cassava (55,543), rice (43,059), banana (27,705), sweet potato (14,799), beans (13,332) and others.
- **Livestock keeping:** Cattle, goats, sheep, pigs, and poultry represent the major livestock kept. This activity is mostly performed by Masai and Sukuma tribes who migrate to the District from other regions. Grazing is the major type of livestock keeping used by livestock keepers which in turn create social and environmental consequences with those settled farmers and cultivators. Nomad-like practices coupled with overgrazing has so far produced social conflicts among farmers and pastoralists, resulted in demarcation of a confined settlement at Twatwatwa for Masai tribes to settle.
- **Proliferation of HIV/AIDS:** According to the District Medical Office report (2010), out of a total of 16,986 persons of age above 15 screened, 1,961 persons are identified as HIV positive.
- **Water Supply:** The District population is served by shallow wells (737 schemes, 139, 985 population served), gravity water supply (4 schemes, 36,226 population served), and piped water supply (33 schemes, 158,650 population served). In particular, at Kidete Ward, villagers depend on 52 shallow wells, of which 43 are working (Source: Kilosa District Water Department, 2009).

Mpwapwa District (Extracts from District Profile, 2014):

- **Village Land Development:** As the existing rail alignment currently does, and proposed rail alignment will, traverse rural village land, it is critical to comprehend current village land use planning statuses in view of conducted surveys. In the Mpwapwa Division, 35 villages were surveyed, however none are offered certificates. (Source: Mpwapwa District Land, Natural Resources and Environment Department, 2012)
- **Main Economic Activities:** About 90% of the people in the District are engaging in agriculture and livestock rearing as their major source of income. Agriculture employs about 86% of the District's labor force population.
- **Crops produced:** During 2011/2012 season, 31,968 tons for food crops were produced. The food requirement for the period of 2012/13 is 70,460 tons and hence there is a food shortage of 38,492 tones. A total of 39,189 households had food shortages.
- **Animal Husbandry:** Livestock keepers who practice traditional animal husbandry (free range system) keep cattle (179,737), goats (148,317), sheep (56,343), donkeys (3,262), pigs (3,102), dogs (9,064), and chicken (204,923). It is estimated that the livestock sector contributes to about 45% of the total District GDP.
- **Ethnic Groups**: The dominant ethnic groups are Gogo (40%), Kaguru (16%), and Hehe (11%), in terms of total District population of 305,056 (National Population Census' Projection (2012)). Also present are a small number of pastoral groups of Wamang'ati and Wamasai, grazing at Mtera Dam and Ruaha Rivers.
- **Rural Women's Domestic Work:** Mpwapwa District's women use about 80% of their time to get essential services such as water; firewood, health services, education, milling machine, markets, shopping, and other services at a distance of 2-10 km.
- **Employment by Sector:** Agriculture and livestock activities employ about 90%, small and medium scale businesses employ 7%, small-scale industries employ 1%, and office works employs 2% of the total population.
- **Poverty Indicators:** Only 28% of Mpwapwa District residents live below the basic needs poverty line (Poverty and Human Development Report, 2005).
- **Access to Clean Drinking Water:** The proportion of households supplied with piped water in the wet season was 37%, compared to 43.9% in the dry season (The National Sample Census of Agriculture 2002/03). The well is the second main source of drinking water in Mpwapwa District, followed by springs and surface water such as river, streams, and dams. The District has 32 boreholes, 81 shallow wells (using hand pumps), and 32 water springs. The number of people served with clean water in the District has been increasing from 52.4% in 2007/08 to 60% in 2012/2013.
- **Fishery:** Fishing is not an economic activity rather than merely for domestic consumption. However, fingerlings, mainly of the Tilapia species, are the main fish type available. Fishing activities are usually undertaken in Mtera Dam in Rudi Ward. Wetlands in Mlunduzi Ward are also potential areas for ponds and fisheries.
- **Health:** The healthcare system consists of 1 hospital, 4 health centers, and 52 other facilities (48 are public, 4 owned by Parastatal, and 1 is private). 46 out of 93 villages have health facilities equal to 51% of the total villages. Only 25.5% of the total population lives within 5 km from health facilities.

- **Types of Toilets:** Almost all households in Mpwapwa District (87.3%) use traditional pit latrines, followed by those with no toilets (8.2%), improved pit latrines (1.4%), and flush toilets (1.3%) (Source: National Sample Census of Agriculture 2002/03)

Chamwino District (Extracted from District Profile, 2012):

- **Limited Dependency on Railway Service**: The Central Railway Line serves about 15.6 km in the District, which passes through Igandu and Mnase villages. However, this means of transport has some caveats, such as the infrastructure being old, and the District has limited influence on the ability to improve the railway.
- **Agriculture and Livestock Sector:** More than 90% of the District population relies on agriculture.
  Out of 563,920 hectares suitable for agricultural production only about 246,821(44%) hectares are used for crop production.
  Common crops produced include food crops such as sorghum, maize, and cassava. Cash crops grown include grapes, sunflower, groundnuts, bulrush millet, and paddy.
  Apart from agriculture, livestock keeping is ranked second as a vital economic activity in the District. In 2012 the District had an estimate of 284,749 indigenous cattle based on 2002 livestock census projection, where number of cattle was 185,659, goats was 41,384, and sheep was 9,007.

  HIV/AIDS Proliferation: HIV/AIDS is still a problem in the community and has been affecting the workforce in the District. The rate of infection dropped from 3.0% in 2007 to 2.6 % in 2013. The District Council will continue enhancing sensitization strategies to reduce the spread of HIV/AIDS and improve care of HIV victims.

  Children' Issue: The District Council is aware of impacts from increased crime rates and social problems, like street children and drug addicts.

  Water Supply: A District-wide absence of reliable water sources – permanent rivers and springs – has led the community to depend on water from boreholes, shallow wells, and rainwater harvesting. The District has 201 water supply schemes capable of providing clean and safe water to 72% people of the District. 66 villages out of 77 in the District have water committees and established water funds.

Fact-Finding through Discussions with District Council Officials

Fact-finding results are grouped by thematic topics of the JICA Study's concern, consolidating District-by-District facts identified by field data collection and interviews with responsible District Officers.

Past Dependency on Railway Services (Freight and Passengers) and Future Expectations:

Kilosa: Railway transport used to be acknowledged as cheaper, reliable, and able transport in bulk compared to road transport. Poor railway services have had some significant negative impact on the socioeconomic development of Kilosa District because of the reduced frequency of traders/middlemen coming to buy agricultural commodities (maize, rice, sunflower, and onions) and transporting via railway.

Mpwapwa: Cash crops were transported by railway in the past. Other goods transported by railway were livestock (cattle and goats).

Copper mining at Kinusi area in Gulwe also depended on railway services in the past. There is a copper processing factory in the Gulwe area which would benefit from improved railway services.

Chamwino: The railway used to be a major means of transport to Dodoma (Town) and other regions in Tanzania as there are no commuter buses in the area. Based on the production capacity (there is little or no surplus production due to rainfall scarcity) in the area, passenger trains are more important than freight trains.

Status of Village-level Land Use Planning Eligible for Development:

Kilosa: None of the villages have a land use plan established.

Mpwapwa: Villages' (in adjacency of existing alignment) land use planning status not known.

Chamwino: Igandu and Mnase are the only villages along the Gulwe-Igandu railway section in Chamwino District. Neither of these villages has a land use plan. Chamwino District has a total of 99 villages and only seven have a land use plan.

Modality of Farmers' Cooperatives Capable of Exercising Power on Railway Operation and Services:

Kilosa: There are groups of small number of farmers (named SACOS) supportive of the railway (freight) services.

Mpwapwa: There are no formal farmers' organizations, but the Mpwapwa Agricultural Society (MPWAGRISO) is emerging as supporter of smallholders.

Traditionally, the local people (ethnicity of Wagogo or Gogo), are not good farmers. They are used to zero tillage associated with shifting cultivation, which triggers soil erosion.

Chamwino: There are no cooperatives/unions in the two villages in the Project area, but there are four agricultural cooperative societies in the District.

Past Incidents of Conflict Caused by Pastoralists with a Herd of Livestock Crossing the Rail-bed Embankment and Measures against Them:

Kilosa: To mediate Masai pastoralists' grazing activity infringing farmland cultivated by settled farmers, the District Council has demarcated and organized a tract of land named TwaTwatwa Reserve (not a formal reserve) at Parakuyo Ward, Mbwande.

Mpwapwa: No report available to provide evidence of such incidents.

Chamwino: No recorded conflicts because livestock-keeping is minimal in the immediate proximity of the railway alignment.

13.1.3 Legal Framework for Environmental and Social Considerations

(1) Tanzanian Laws and Regulations

In the United Republic of Tanzania, ministries are responsible for environmental monitoring of projects under their jurisdiction. However, the Vice President's Office (VPO) has overall

responsibility for environmental policy formulation - including coordination and monitoring of National Environmental Management Council (NEMC) activities.

This section addresses the legal and regulatory conditions, which are relevant to this project.

National Policies, Act and Regulations

Table 13.1 is a summary of relevant environmental and social management policies, acts and regulations for the project. Each is aligned with the enforcement or implementation authority.

The list includes framework policies and legislation that provide the basis for more detailed regulatory instruments. Environmental management and governance in Tanzania is underpinned by two such pieces of legislation, namely the Constitution and the Environmental Management Policy (1997) and Environmental Management Act Cap 191.

Table 13.1: Summary of Relevant Policies, Laws and Regulations

NO.	POLICIES, LAWS AND REGULATIONS	AUTHORITY
	National Constitution	
1.	Constitution of the United Republic of Tanzania, Cap. 2 (1977)	Ministry of Justice and Constitutional Affairs
	Environmental and Social Management	
2.	National Environmental Policy (1997)	Department of Environment (in the Vice President's Office) and National Environmental Management Council (NEMC)
3.	Environmental Management Act, Cap. 191	
4.	Environmental Impact Assessment and Audit Regulations (2005)	NEMC
5.	Environmental Management (Air Quality Standards) Regulations (2007)	
6.	Environmental Management (Hazardous Waste Control and Management) Regulations (2009)	
7.	Environmental (Solid Waste Management) Regulations, (2009)	
8.	Environmental management (Quality Standards for Control of Noise and Vibration Pollution) Regulations (2011)	
9.	Environmental Management (Fees and Charges) Regulations (2009)	
	Land and Land Use	
10.	National Land Policy (1997)	Ministry of Lands, Housing and Human Settlement
11.	Land Act, Cap. 113 (1999)	
12.	The Land (Amendment) Act (2004)	
13.	Village Land Act (1999)	
14.	Land Use Planning Act, No. 6 (2007)	
15.	Land Acquisition Act (1967)	
16.	The National Land Use Planning Commission Act (No. 3), 1984	
17.	Land (Forms) Regulations, 2001	
18.	Land (Assessment of the Value of Land for Compensation) Regulations, 2001	
19.	Land (Compensation Claims) Regulations, 2001	
20.	Land (Management of the Land Compensation Fund) Regulations, 2001	

NO.	POLICIES, LAWS AND REGULATIONS	AUTHORITY
21.	The Village Land Regulations, 2001	Village Administration; Ministry of Land Housing and Human Settlement
	Natural Resources Management	
22.	National Water Policy (2002)	Ministry of Water
23.	Water Resources Management Act, No. 11 (2009)	
24.	Water Supply and Sanitation Act, No. 12 (2009)	
25.	Fisheries Sector Policy and Strategy (1997)	Ministry of Livestock and Fisheries Development
26.	Fisheries Act, Cap. 279 (2003)	
27.	Fisheries (Principal) Regulations (1989)	
	Health and Safety	
28.	Occupational Health and Safety Act, No. 5 (2003)	Occupational Health and Safety Authority (OSHA)
29.	Workers' Compensation Act, Cap 263 (2008)	Ministry of Labour and Employment
30.	Employment and Labour Relations Act, No. 6 (2004)	
31.	National Policy on HIV/AIDS (2001)	Prime Minister's Office
32.	HIV and AIDS (Prevention and Control) Act, No. 28 (2008)	Ministry of Health and Social Welfare
33.	TASAF III Resettlement Policy Framework, 2012	
	Archaeology and Cultural Heritage	
34.	Graves (Removal) Act, 2007	Ministry of Culture, Youth and Sports
35.	Antiquities Act No. 10 (1964)	
	Administrative / Public Laws	
36.	Local Government Laws (Miscellaneous Amendments) Act, No. 13 (2006)	Ministry of Regional Administration and Local Governments
37.	Tanzania Commission for AIDS Act, Cap. 379 (2001)	Tanzania Commission for AIDS (TACAIDS), Ministry of Health and Social Welfare
38.	Local Government (District Authorities) Act	Ministry of Regional Administration and Local Governments
39.	Local Government (Urban Authorities) Act	
40.	Road Sector Compensation and Resettlement Guidelines, 2009	Ministry of Works
41.	Guidelines	

Source: JICA Study Team

Laws and Regulations for Environmental Management Aspects

The laws and regulations listed in Table 13.2 address specific environmental and social management aspects.

Table 13.2: Laws for Key Environmental and Social Management Aspects

Management aspect	Relevant acts and regulations
Air Emissions and Ambient Air Quality	Environment Management Act, Cap 191 - Protection of the Atmosphere and Measure on Climate Change (Part V S. 74 and 75); Management of Gaseous Wastes (Part IX d).
	Environmental Management (Air Quality Standards) Regulations, (2007)
	Public Health Act, Cap. 336 (2009) - Gaseous Waste Management (Part IV d).
	Occupational Health and Safety Act, No. 5 (2003)
Solid Wastes	Environmental Management Act, Cap 191 (2004) - Management of Solid (Part IX a)
	Environmental (Solid Waste Management) Regulations, (2009)
	Public Health Act, No. 1 (2009) - Solid Waste Management (Part IV c)
Wastewater and Ambient Water Quality	Public Health (Sewerage and Drainage) Act, Cap. 336 (2009) - (Prevention of Spread of Diseases (Part III, Sub S. b, 15); Sanitation, Housing and Hygiene (Part IV: Sub. S. a - g)
	Environmental Management (Water Quality Standards) Regulations, (2007)
Soil Quality	Environmental Management (Soil Quality Standards) Regulations, (2007)
Hazardous Materials / Substances Management	Industrial and Consumer Chemicals (Management and Control) Act, No. 5 (2003)- Control of Production, Importation, Exportation, Transportation, Storage of and Dealing in Chemicals (Part III); Management of Industrial and Consumer Chemicals (Part IV)
	Environmental Management Act, Cap. 191 (2004) - Management of hazardous wastes (Part IX e)
	Environmental Management (Hazardous Waste Control and Management) Regulations (2009)
Noise Management	Environmental Management Act, Cap. 191(2004) - Environmental Quality Standards (Part X (S. 147)
	Environmental management (Quality Standards for Control of Noise and Vibration Pollution) Regulations, (2011)

Source: JICA Study Team

(2) Procedure of EIA

Legal Framework in Tanzania

Tanzanian environmental matters are governed by the Environmental Management Act, 2004, which is Act No. 20 of 2004 (hereinafter referred to as "the Act"), and its implementation is regulated by the Environmental Impact Assessment and Audit Regulations, 2005 (the Regulation). The Regulation stipulates projects to be classified into either Type A or Type B.

Type A – Project requiring a mandatory EIA:

The Project is likely to have a significant adverse environmental impacts and an in-depth study is required to determine the scale, extent, and significance of the impacts and to identify appropriate mitigation measures.

Among the list of type A projects, item 9 (iii) "Construction or new expansion to existing railway lines" can be applied to the proposed Project. Sub-item (iii) "Construction and expansion/upgrading of roads, harbors, shipyards, fishing harbors, air fields and ports, railways and pipelines" of item 14 "Building and Civil Engineering" can also be applied to the proposed Project.

Excerpted below are relevant projects of Type A.

Listed under item 9 Transport and Infrastructure are:

(i) Construction, expansion or rehabilitation of new trunk roads
(ii) Construction, expansion or rehabilitation of airports and airstrips and their ancillary facilities
(iii) Construction or new expansion to existing railway lines
(iv) Construction of new, or expansion to shipyards or harbor facilities

Listed under sub-item (iii) of item 14 Building and Civil Engineering is:

(iii) Construction and expansion/upgrading of roads, harbors, ship yards, fishing harbors, air fields and ports, railways and pipelines

Type B – Project requiring Preliminary Environmental Assessment:

The Project is likely to have some significant adverse environmental impacts, but as the magnitude of the impacts is not well-known, a preliminary environmental assessment is required to decide whether the Project can proceed without a full environmental impact assessment.

Generally, the EIA procedure for Type A project takes the following steps.

a) An application for an environmental impact assessment certificate shall be made in the format of a project brief set out in the First Schedule to the Regulation, and the applicant shall submit the application together with the prescribed fee to the Council (Article 5, the Regulation).

(1) A developer or proponent shall, depending on the nature of the project or undertaking, register in accordance with Form No. 1 specified in the Third Schedule to these Regulations and prepare a project brief stating:
(a) the nature of the project in accordance with the categories identified in the Third Schedule to the Act and the First Schedule to these Regulations;
(b) the location of the project including to the physical area that may be affected by the project's activities;
(c) the activities that shall be undertaken during the project construction, operation and decommissioning phases;
(d) the design of the project;
(e) the materials to be used, products and by-products, including waste to be generated by the project and the methods of their disposal;
(f) the potential environmental impacts of the project and the mitigation measures to be taken during and after implementation of the project;
(g) an action plan for the prevention and management of possible accidents during the project cycle;
(h) a plan to ensure the health and safety of the workers and neighboring communities;
(i) the economic and socio-cultural impacts to the local community and the nation in general;
(j) the project budget; and
(k) any other information which the Council may require.

(2) In preparing a project brief under this Regulation, the proponent or developer shall pay particular attention to other issues specified in the First Schedule to these Regulations.

(3) A project brief shall be prepared by an environmental impact assessment expert registered as such under the regulations made under the Act.

b) A proponent or developer shall submit at least ten copies of the project report to the Council or the Council's appointed agent in Form No. 1 specified in the Third Schedule to the Regulations accompanied by the prescribed fees. "Council" means the National Environment Management Council (NEMC) established under section 16 of the Act.

c) Comments on the Project Brief

(1) Where the project brief conforms to the requirements of regulation 6, the Council shall, within seven days upon receipt of the project report, submit a copy of the project brief to:
   (a) each of the relevant ministry or public institution;
   (b) the relevant local government environmental management officer; and
   (c) where more than one District is involved, to the relevant Regional Secretariats, for their written comments.

(2) Comments shall be submitted to the Council within twenty one days from the date of receipt of the project brief.

(3) On receipt of the comments or where no comments have been received the Council shall proceed to determine the project brief.

d) Screening of project brief

(1) The Council shall screen the project brief according to the screening criteria specified in the Second Schedule to these Regulations.

(2) The screening process shall be undertaken with the objective of determining whether an environmental impact assessment is to be undertaken.

e) Approval of Project Brief

(1) On determination of the project brief, the decision of the Council, together with the reasons thereof, shall be communicated to the developer or proponent within forty-five days of the submission of the project brief.

(2) Where the Council is satisfied that the project shall not have significant negative impact on the environment, or that the project brief discloses sufficient mitigation measures, the Council may proceed to recommend to the Minister to approve the project.

(3) Approval of the project or undertaking shall be made in Form 3 specified in the Third Schedule to these Regulations.

f) Decision that an Environmental Impact Statement (EIS) be prepared

(1) Where the Council finds that the project shall have a significant impact on the environment and the project report discloses no sufficient mitigation measures, it shall require the developer or proponent to:
   (a) undertake an environmental impact assessment in accordance with these Regulation; or
   (b) undertake a preliminary assessment, where more information is required to determine a screening decision.

(2) A preliminary assessment shall proceed along the following steps:
   (a) description of the project characteristics and the affected environment;
   (b) identification of impacts on the local environment; and

(c) assessment or evaluation of the significance of the impacts in terms of energy flow, transformation of matter, effects on sensitive ecosystems relative to the baseline state, and socioeconomic impacts.

(3) Where the Council finds that the project shall have no significant negative impact on the environment and the project report discloses sufficient mitigation measures, it shall not require the developer or proponent to undertake an environmental impact assessment, and may proceed to recommend to the Minister for approval of the project.

Comparison of JICA Guidelines and Tanzanian EIA

The policy framework of Tanzanian EIA was compared with the requirements of JICA Guidelines. As shown in Table 13.3, Tanzanian EIA mostly satisfies JICA Guidelines.

Table 13.3: Comparison and Gaps of JICA Guidelines and Tanzanian EIA

No.	JICA Guidelines	Tanzanian EIA	Gaps	Policy to fill the gaps in this study
1	When assessment procedures already exist in host countries, and projects are subject to such procedures, project proponents etc. must officially finish those procedures and obtain the approval of the government of the host country.	EIA procedure is required by the Environmental Management Act, 2004, to be approved by NEMC.	None	-
2	EIA reports (which may be referred to differently in different systems) must be written in the official language or in a language widely used in the country in which the project is to be implemented. When explaining projects to local residents, written materials must be provided in a language and form understandable to them	EIA reports must be accompanied with a stand-alone non-technical summary in both Kiswahili and English languages.	Language for written materials for local explanation is not stipulated by the regulation.	Materials for explanation to local residents shall be made in Kiswahili.
3	EIA reports are required to be made available to the local residents of the country in which the project is to be implemented. The EIA reports are required to be available at all times for perusal by project stakeholders such as local residents and copying must be permitted	NEMC shall grant any person who desires to consult the EIA reports and any other information submitted to NEMC access to those documents.	None	-
4	In preparing EIA reports, consultations with stakeholders, such as local residents, must take place after sufficient information has been disclosed. Records of such consultations must be prepared	Public participation and consultation are required through the procedure and the records shall be included in the EIA report.	None	-

No.	JICA Guidelines	Tanzanian EIA	Gaps	Policy to fill the gaps in this study
5	Consultations with relevant stakeholders, such as local residents, should take place if necessary throughout the preparation and implementation stages of a project. Holding consultations is highly desirable, especially when the items to be considered in the EIA are being selected, and when the draft report is being prepared	During the process of conducting an environmental impact assessment study, the developer or proponent shall in consultation with NEMC, seek the views of any person who is or is likely to be affected by the project. Consultation is taken place by the developer or proponent at scoping stage. NEMC holds public hearing before approval of the EIA report.	None	-
6	It is desirable that EIA reports cover the items enumerated in the following: -Executive summary, -Policy, legal, and administrative framework, -Project description, -Baseline data, -Environmental impacts, -Analysis of alternatives, -Environmental Management Plan (EMP), and -Consultation.	EIA report shall closely be styled and contain the following information: (i) executive summary; (ii) acknowledgement; (iii) acronyms; (iv) introduction; (v) project background and description; (vi) policy, administrative and legal framework; (vii) baseline or existing conditions; (viii) assessment of impacts and identification of alternatives; (ix) impacts management or environmental mitigation measures; (x) environmental and social management plan; (xi) environmental and social monitoring plan; (xii) resource evaluation or cost benefit analysis; (xiii) decommissioning; (xiv) summary and conclusions (xv) references; (xvi) appendices.	None	-

Source: JICA Study Team

RAHCO's Procedure for EIA

As this Project, a railways rehabilitation project, falls under type A of "construction and expansion/upgrading of roads, harbors, ship yards, fishing harbors, air fields and ports, railways and pipelines", the First Schedule of the Regulation, RAHCO, is mandated to obtain an EIA clearance from the environment authority. Therefore, the proponent agency (RAHCO) is undertaking the following actions to proceed with the project.

Step 1: Project Registration and Screening--- Already completed in March-April 2015.

(a) Developer or proponent submits a dully filled registration form and project brief to the Council as per Regulation 9;
(b) Council shall then undertake a review of the project brief in accordance with Regulation 10 and 11; and
(c) Council undertakes the screening of the proposed project in accordance with Regulation 12 and undertake the screening in accordance with any guidelines that the Minister may issue for this activity.

Step 2: Scoping--- Already completed in June-July 2015.

The developer, proponent, environmental experts or firm of experts shall undertake a scoping exercise in order to:

(a) Identify the main stakeholders that will be negatively or positively impacted by the proposed project;
(b) Identify stakeholder's main concerns regarding the proposed project;
(c) Identify main project alternatives;
(d) Identify likely impacts, data requirements, tool and techniques for impact identification, prediction and evaluation;
    (i) identify project boundaries in terms of spatial, temporal and institutional aspects;
    (ii) environmental experts or firm of experts must ensure there is adequate stakeholder participation in this and all the other stages of the environmental impact assessment; and
(e) the developer or the environmental experts or firm of experts prepare a scoping report and terms of reference for the environmental impact assessment of the proposed project and submits to the Council for approval.

Step 3: Baseline Study --- Already completed in December 2015.

(a) The environmental experts or firm of experts undertake detailed survey of the existing social, economic, physical, ecological, social-cultural and institutional environment within the project boundary area; and
(b) The consultant must ensure adequate stakeholder participation is engaged.

Step 4: Impact Assessment--- Already completed in January 2016.

(a) The consultant undertakes impact identification, impact prediction and evaluation of impact significance following a variety of appropriate techniques and approaches as specified in the guidelines issued under this Regulation;
(b) The environmental experts or firm of experts must ensure that concerns and views from stakeholders are fully taken into account during the assessment of impacts; and
(c) The environmental experts or firm of experts assess all possible alternatives and their impacts and recommends most appropriate options.

Step 5: Impact mitigation and enhancement measures --- Already completed in January 2016.

(a) environmental experts or firm of experts prepare impact mitigation measures for all negative significant impacts, either by elimination, reduction or remedial methods;
(b) environmental experts or firm of experts prepare enhancement measures for all significant positive effects arising from the project so as to increase the contribution from the project to social development and environmental conservation;
(c) environmental experts or firm of experts prepare Mitigation and Enhancement Plan for all significant negative impacts and positive effects, with details about institutional

responsibilities and costs were appropriate; and

(d) environmental experts or firm of experts prepare a Monitoring Plan and Environmental and Social Management Plan with details about institutional responsibilities, monitoring framework, parameters, indicators for monitoring and costs of monitoring were appropriate.

Step 6: Preparation of Environmental Impact Statement (EIS) --- Already completed in March 2016.

(a) environmental experts or firm of experts prepare an Environmental Impact Statement (EIS) adhering to the contents outlined in these Regulations;
(b) EIS must be accompanied with a stand-alone non-technical summary in both Kiswahili and English languages; and
(c) All technical details, including assessment methodologies, list of consulted stakeholders and their signatures, drawings and terms of references are put in the appendix.

Step 7: Review of EIS--- Ongoing as of March 2016.

(a) Council reviews the EIS adhering to the review criteria and any guidelines that may be issued under these Regulations;
(b) Council may call for a public hearing and public review of the EIS in accordance with conditions and procedures stipulated under these Regulations; and
(c) Council shall submit review report to the Minister with its recommendations and all documents used in the review for approval or disapproval.

Step 8: Environmental Monitoring and Auditing--- Will be conducted when the Project is implemented.

The Council shall conduct environmental monitoring in order to evaluate the performance of the mitigation measures following the prepared Environmental and Social Management Plan as well as the Monitoring Plan, thus:

(a) monitoring include the verification of impacts, adherence to approve plans, environmental standards and general compliance of terms and conditions set out in the Environmental Impact Assessment certificate;
(b) developer can also undertake monitoring of the implementation of the project to ensure if mitigation measures are effective;
(c) both the developer and the Council collects data that can be used in future projects and for environmental management;
(d) Council and the developer undertake environmental audits for the project;
(e) mechanisms for stakeholder participation during the monitoring and auditing process must be defined and followed through; and
(f) the auditing exercise may focus on the following areas:
    (i) implementation/enforcement audit, which takes place when the Council verifies if the mitigation measures and levels of pollution are within limits;
    (ii) performance/regulatory audit that entails identification of compliance to relevant legislation or safety standards;
    (iii) impact prediction audits checks the accuracy and efficacy of the impact prediction by comparing them with monitored impacts;
    (iv) Council collects and compiles information arising from auditing for future use; and
    (v) developer collects data from the audit and compiles information for project management and also for submission to the Council.

13.1.4 Alternatives

(1) Without Project Option

'Without project option' means no flood protection measures are formulated and no action will be taken to change the present situation of the Kilosa-Dodoma section. As transport demand is rapidly increasing, the following issues are expected to occur if "without project":

1) The railway line will continuously be affected by floods and be washed away frequently. This situation means the railway service faces serious problems for securing safe and stable transportation.
2) Once the line is washed away, the railway passengers and freight are hindered in their ability to travel until the recovery works are completed. It will affect the social and economic activities relying on the railway transport by the Central Railway Line, which is not limited to the section of Kilosa-Dodoma.
3) Because of the unreliability of the railway service, passengers and freight will be shifted to road traffic. As heavy tracks are applied for the freight, it will cause deterioration of road infrastructure, and increase risks of road accidents and freight transportation costs.
4) As the emission of carbon dioxide from the road traffic is generally larger than the railway, shifting to the road traffic will result in emissions increases.

Therefore, flood protection measures needs to be taken to improve the safety and reliability of the railway transportation, as well as to protect environmental and social conditions.

(2) Consideration of Alternative Plans

As presented in Subsection 8.6.2, Alternative A, B, and C for the flood protection measures were proposed to select the most optimal option in terms of the cost, reduction in danger of flood damages, technical difficulties, and environmental and social considerations. As the track relocation (rerouting) will affect the residential area by traversing villages when it is planned only from the engineering aspects, an additional alternative was drawn attempting to reduce the number of the affected buildings. Consequently, in total six alternatives were planned and compared: A-1, B-1, and C-1 are favoring track alignment in terms of engineering aspects, while A-2, B-2, and C-2 are those to avoid traversing residential area as much as possible.

The basic idea of Alternative A-2, B-2, and C-2 is to draw the rerouting alignment at lower elevation than Alternatives A-1, B-1, and C-1, avoiding dense residential areas. Instead of securing the high elevation above the design condition, the embankments of Alternatives A-2, B-2, and C-2 were reinforced by bank protection.

A comparison between the alternatives was presented in Subsection 8.6.2 (Table 8.40). As a result of the comparison, Alternative B-2 was selected as the optimal alternative.

13.1.5 Scoping

A scoping exercise was done for proposed Project's anticipated impacts.

Anticipated impacts are rated by A, A+, B, B+, C, C+, and D, in terms of their spatial extent, magnitude of the number of people and settlements affected, impact's duration – temporal or persistent, irreversible or reversible, etc.

The following scores are employed in rating the impacts:

- A+/−: Significant positive/negative impact is expected.
- B+/−: Positive/negative impact is expected to some extent.
- C+/−: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
- D: No impact is expected.

The result from the exercise is shown in
Table 13.4.

Based on the scoping results, Terms of Reference (TOR) for Environmental and Social Considerations are prepared as shown in Table 13.6 and Table 13.7.

Table 13.4: Summary of Scoping Result

Impact Rating	Elements
A+: Significant positive impact is expected.	*During Construction* Employment and Local Economy, Land Use and Local Resources Utilization *Railway in Service* Employment and Local Economy, Land Use and Local Resources Utilization, Existing Social Infrastructure and Social Services
A−: Significant negative impact is expected.	*Prior to Construction* Resettlement
B+: Positive impact is expected to some extent.	*Prior to Construction/During Construction* Soil Erosion, *Railway in Service* Gender, Global warming
B−: Negative impact is expected to some extent.	*During Construction* Air Quality, Water Quality, Solid Waste, Soil Erosion, Soil Contamination, Noise Vibration, Ecosystems, Water Use, Existing Social Infrastructure and Services, Infectious diseases HIV/AIDS, Working Environment, inclusive of occupational safety, Accidents *Railway in Service* Accidents, Resettlement, Solid Waste, Noise/Vibration, Ecosystems
C+/−: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)	*During Construction* Poor, Hydrology/Water Regime, Topography and Geology, Social Capital and Local Decision Making Institution, Cultural Heritages, Landscape, Children's Rights, Indigenous People *Railway in Service* Water Quality, Social Capital and Local Decision Making Institution, Cultural Heritages, Children's Rights,, Infectious Diseases, Working Environment, inclusive of Occupational health, Water Use, Poor, Landscape
D: No impact is expected.	*Prior to/During Construction* Land Subsidence, Protected Area/Forest Reserves, Trans boundary pollution *Railway in Service* Air Quality, Solid Waste, Soil Contamination, Land Subsidence, Protected Area/Forest Reserves, Hydrology/Water Regime, Topography and Geology, Trans boundary pollution

Source: JICA Study Team

Table 13.5: Scoping Result

Environmental Domain		Environmental Elements Impacted	Assessment		Reasons of Assessment
			Prior to Construction/ During Construction	Railway In Service	
Pollution	1	Air Quality	B-	D	Prior to construction/During Construction 1.1 Construction work will generate dust. 1.2 Construction equipment will emit air pollutants. Railway in service 1.3 Emission from train operation will be the same condition with the existing operation.
	2	Water Quality	B−	C−	Prior to construction/During Construction 2.1 High potential of soil runoff and/or sedimentation/siltation by the riverbank protection works and bridge/culvert construction/improvement works resulting from earthmoving and/or piling/foundation works. As a result, temporal increase in turbidity and an increase in suspended solids in the water bodies are anticipated (streams/stagnant water) at the construction sites and downstream. 2.2 Earth-moving works (cut and fill) at the hillside (proposed rerouting alignment) or inland away from the riverbanks will yield temporal soil runoff, causing water quality degradation (Mkondoa River /Kinyasungwe River) and sedimentation. Railway in service 2.3 Least possibility of surface runoff from rail embankment contaminating the Mkondoa River. 2.4 Effluents from stations and associated facilities are minimal.
	3	Soil Erosion	B−	B+	Prior to construction/During Construction 3.1 The existing alignment runs through a flood-prone area, in parallel with the frequently-flooded river systems of the Mkondoa and Kinyasungwe Rivers. The alignment lies over land sensitive to any earth-moving civil work, which has a high potential to trigger soil erosion and land degradation. Proper mitigation work needs to be devised and implemented to avoid soil erosion and sedimentation. Railway in service 3.2 Progress of flood-protection work in the entire sections will reduce soil erosion/sedimentation to a certain extent, though the incidents are anticipated to occur.
	4	Solid Waste	B−	B−	Prior to construction/During Construction 4.1 Surplus/excess soil volume generated by cut/fill is anticipated.

Environmental Domain		Environmental Elements Impacted	Assessment: Prior to Construction/ During Construction	Assessment: Railway In Service	Reasons of Assessment
					Railway in service 4.2 Hazardous/toxic waste generation by railway operation is not anticipated.
	5	Soil Contamination	B−	D	5.1 Some construction activities such as burying piles may cause soil contamination. 5.2 No significant impacts during railway in service.
	6	Noise/ Vibration	B−	B-	6.1 Construction noise will be generated by works of equipment. 6.2 Noise and vibration caused by train passing will be increased if the railway is relocated into the residential area.
	7	Land subsidence	D	D	7.1 No significant impact is anticipated as underground construction, which causes land subsidence, is not planned. 7.2 No significant impact is anticipated as drawing groundwater, which causes land subsidence, is not planned for the railway operation.
Natural Environment	8	Protected Area/Forest reserve	D	D	8.1 National Parks, Wildlife Management Areas (WMA), Forest Reserves (National Level) are not found within a 1 km-radius range of the existing rail alignment. 8.2 Districts (Kilosa, Mpwapwa, and Chamwino) have their own designation of Forest Reserves, however none with their boundaries conflicting with existing rail alignment. The Kihili Forest Reserve is situated in the vicinity of Kilosa Station. In proposing a rerouting of the alignment, potential conflicts with District Forest Reserve need to be checked.
	9	Eco-systems	B−	B−	9.1 The project site, including proposed rerouting alignment, does not encompass ecologically valuable habitats like those designated by IBA's area. 9.2 The Project site, including proposed rerouting alignment, does not encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions. 9.3 Adequate mitigation measures are to be taken to avoid conflicts with wildlife/livestock migration routes. 9.4 Proposed railway re-routing alignment may pass through primary forest in undeveloped hillside areas, resulting in loss of natural vegetation.
	10	Hydrology/ Water Regime	C−	C−	10.1 Anticipated changes in water regime in the water bodies affected by flood protection works, which may result in changes in aquatic ecosystems. 10.2 Anticipated changes in aquatic biota (fish species).

Environmental Domain		Environmental Elements Impacted	Assessment: Prior to Construction/ During Construction	Assessment: Railway In Service	Reasons of Assessment
	11	Topography and Geology	C−	D	11.1 There is a possibility that civil works, such as cutting and filling along the re-routing alignment at the hill side, will cause slope failures or landslides. 11.2 There is a possibility that soil runoff will result from cut and fill areas, waste soil disposal sites, and borrow sites.
Social Environment	12	Resettlement	A−	D	Prior to construction/During construction 12.1 No more than 40 households, at one site, are anticipated to be relocated, due to the re-routing alignment at Gulwe and the smaller number of households at Godegode. 12.2 Recovery of livelihoods of those relocated need to be secured and compensation delivered.
	13	Poor	C	C	Prior to construction/During construction 13.1 Poor or vulnerable people may be included in those to be relocated. Railway in service 13.2 The poor and vulnerable will benefit from the relocation and be able to upgrade their quality of life. On the other hand, their livelihood may be affected by resettlement if they are among that population.
	14	Indigenous People	C	C	Prior to construction/During construction 14.1 Masai people often traverse the alignment with their herds of livestock. Need to identify their grazing area to assess the impacts. Railway in service 14.2 Underpasses will be designed to allow Masai with their herds to traverse the alignment safely, reducing potential accidents and degradation of embankment.
	15	Employment and Local Economy	A+	A+	Prior to construction/During construction 15.1 Construction of rerouting sections may absorb local laborers. 15.2 Employment opportunities may generate positive impacts to the local economy.
	16	Land use and local resources utilization	A+	A+	Prior to construction/During construction 16.1 For the re-routing sections, the new alignment will pave the way for village land use transformation, leading to potential industrial development. Railway in service 16.2 The new alignment together with transformed village land use as "General Land" will accelerate development.
	17	Water Use	B−	C	Prior to construction/During construction 17.1 Residents making avail of nearby river water systems as sources of water are adversely (access to water bodies/water quality degradation) affected by

Environmental Domain		Environmental Elements Impacted	Assessment: Prior to Construction/ During Construction	Assessment: Railway In Service	Reasons of Assessment
					the flood protection works. 17.2 Project's impact on water use is temporal and local residents can enjoy previous river water usage.
	18	Existing Social infrastructure and Social services	B−	A+	Prior to construction/During construction 18.1 Flood protection works will entail increased traffic of construction machinery/heavy duty trucks on the narrow village roads, impacting village people's access to roads, resulting in degraded quality of their living environment. Railway in service 18.2 Villagers' access to social services will be improved due to improved railway service.
	19	Social capital and local decision-making institutions	C	C	Prior to construction/During construction 19.1 The new alignment due to rerouting transforms village land use into general land suitable to economic and industrial development, triggering changes in traditional social capital and local decision-making institutions. Railway in service 19.2 Neighboring communities along the newly rerouted alignment will undergo gradual changes in social capital and local decision-making institutions.
	20	Cultural Heritage	C	C	20.1 Cultural and historical heritage sites to be found in the project affected area along the railway alignment, both new and existing, are not well-explored/recorded.
	21	Landscape	C	C	Prior to construction/During construction 21.1 The new alignment, due to rerouting, that runs the hillside in the primary forest, will have visual impact for the village people living in the community nearby the new alignment. Railway in service 21.2 Local community people will be exposed to the new landscape with the improved new railway track.
	22	Gender	B−	B+	Prior to construction/During construction 22.1 Traditional rural women's work load of capturing water and care for livestock husbandry is going to be interfered during construction work in progress, in particular obstacle are access to water sources and community roads blocked by traffic by heavy-duty trucks and construction machinery. Railway in service 22.2 Local community women's domestic work is less hampered by heavy-duty vehicles' traffic.

Environmental Domain		Environmental Elements Impacted	Assessment: Prior to Construction/ During Construction	Assessment: Railway In Service	Reasons of Assessment
	23	Children's rights	C	C	Prior to construction/During construction 23.1 The Project is not deemed to impact present situation of children's rights living in the rural environment.
	24	Infectious diseases HIV/AIDS	B−	C	Prior to construction/During construction 24.1 Laborers to be engaged in construction work may come from outside may have potential to trigger HIV/AIDS proliferation in the community.
	25	Working Environment, inclusive of occupational safety	B−	C	Prior to construction/During construction 25.1 Need to care for construction workers' occupation health environment. Railway in service 25.2 No impacts on operators/laborers engaged in railway service.
Others	26	Accidents	B−	B−	Prior to construction/During construction 26.1 Need to devise countermeasures to reduce accidents during construction. Railway in service 26.2 Increased service frequency will induce higher chances of transport accidents.
	27	Trans-boundary pollution	D	D	Prior to construction/During construction 27.1 The Wami-Ruvu watershed has no internationally-connected water systems within the basin. Water pollutants shall not have a chance to migrate to surrounding countries. There are no significant sources of air-pollutants emitted from industrial establishments within the basin. Railway in service 27.2 No trans-boundary pollution impacts are anticipated during railway in service.
	28	Global warming	D	B+	Prior to construction/During construction 28.1 Emission of greenhouse gas by construction works is limited. Railway in service 28.2 Emission of greenhouse gas will be reduced by improving the railway because road transportation is expected to shift to the railway.

A+/−: Significant positive/negative impact is expected.
B+/−: Positive/negative impact is expected to some extent.
C+/−: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.
Source: JICA Study Team

Table 13.6: Survey Items and Methodology

Environmental elements	Survey items	Survey methodology
Air quality	− Ambient air quality	− Field measurement
Water quality	− Water quality of the river along the railway	− Field measurement − Sampling and analysis
Soil erosion	− Current condition of soil erosion of the riverbank	− Field observation
Solid waste	− Volume of surplus/excess soil − Type of waste and the volume generated by the railway operation	− Reviewing construction plan and method − Interview with TRL
Soil contamination	− Source of soil contamination through the construction	− Reviewing construction plan and method
Noise/vibration	− Current noise/vibration along the railway − Noise level of construction equipment	− Field measurement − Existing data collection
Eco-systems	− Fish species in the river − Terrestrial vegetation − Avifauna − Mammals − Reptiles and amphibians	− Field observation − Interview with local people − Literature survey
Hydrology/water regime	− Plan of flood protection measures which may change the river flow such as embankment and bridge pier	− Reviewing project plan
Topography and geology	− Topographic feature	− Reviewing topographic map
Resettlement	− Number of affected people and their properties	− Census and inventory survey
Poor	− Social condition of the affected people	− Interview with the affected people
Indigenous people	− Existence of indigenous tribes	− Interview with local government
Employment and local economy	− Employment opportunities and the local people's intention	− Interview and consultation with the local people
Land use and local resources utilization	− Current land use along the railway	− Interview with local government
Water use	− Domestic water source − River water use	− Interview with local people
Existing social infrastructure and social services	− Village road condition − Current railway operation − Local people's expectation on traffic infrastructure	− Field observation − Data collection from TRL − Consultation with local people
Social capital and local decision-making institutions	− Local people's intention for developing economic and industrial conditions and local decision-making institution	− Consultation with local people
Cultural heritage	− Type and location of cultural heritage	− Field observation − Interview with local people
Landscape	− Landscape condition	− Field observation
Gender	− Existing gender issues − Women's work	− Interview with local people
Children's right	− Existing children's issues − Children's work	− Interview with local people
Infectious diseases HIV/AIDS	− Prevalence of HIV/AIDS	− Data collection from local government

Environmental elements	Survey items	Survey methodology
Working environment, inclusive of occupational safety	− Working conditions of workers related to the railway	− Interview with TRL
Accidents	− Number of railway accidents and their causes	− Data collection from TRL

Source: JICA Study Team

Table 13.7: Baseline Survey Plan

Survey items	Survey Area	Outline
Natural environment		
Air quality	Around the railway track	✓ Measurement by portable outdoor monitor ✓ Parameters: NO_2, CO
Water quality	Mkondoa River (along the railway line)	✓ Two times – the dry and the wet season (June and December) ✓ Parameters: EC, pH, SS, turbidity, temperature, heavy metals, etc. ✓ Observation of stream flow condition
Fish species	Mkondoa and Kinyasungwe River (along the railway line)	✓ Collecting species by net ✓ Interview with local people nearby the riverbank
Terrestrial vegetation	Along rerouting track alignment	✓ Species identification consisting the representative vegetation
Avifauna, mammals, reptiles and amphibians	Around the track alignment including rerouting track	✓ Species identification through field observation ✓ Interview with local people ✓ Literature survey
Noise and vibration	Around the railway track	✓ Measurement at the time of train passing
Social environment		
District/ward level	Kilosa, Mupuwapwa and Chamwino Districts	✓ Secondary data collection (e.g., population, ethnicity, religion, industry, employment, livelihood, education, health condition) to compare with the primary data of village level.
Village level	Villages along the railway track of Kilosa-Dodoma	✓ Interview with the communities (e.g., population, ethnicity, religion, industry, employment, livelihood, education, health condition, means of transport, flood effects)

Source: JICA Study Team

13.1.6 Survey Results for Environmental and Social Considerations

Survey results are summarized in Table 13.8.

Table 13.8: Survey Results

Environmental elements	Survey Results
Air quality	Ambient air quality was measured at five stations between Kilosa and Gulwe in December 2015. The results showed that the ambient air quality was in good condition: the average value of NO_2 at each station was 0.0-0.05ppm (standard of US EPA:0.053 ppm), CO was 1.5-10.0 ppm (standard of US EPA: 35 ppm).

Environmental elements | **Survey Results**

(Summary of the air quality measurement)

Station	Average		Recommended air quality standard of US EPA	
	NO_2 (ppm)	CO (ppm)	NO_2 (ppm)	CO (ppm)
Kilosa	0.0	5.0	0.053	35
Munisagara	0.0	1.5		
Kidete	0.0	4.0		
Godegode	0.05	8.0		
Gulwe	0.05	10.0		

Water quality

Water quality at the rivers along the railway was examined in both the dry season (June 2015) and the wet season (November-December 2015). It was found that turbidity was very high in the Mkondoa and Kinyasungwe Rivers, which flow along the railway (101-120 NTU in the dry season, 368-1060 NTU in the wet season). This is due to the natural condition of the rivers (brown in color) carrying a great deal of sediment, especially in the wet season.

Considering this situation, turbidity generation by the construction works will not cause significant impacts to the rivers, although it is better to minimize the impacts, especially at the tributaries whose turbidity is not so high comparing with the main stream. On the other hand, leakage of oil and the other chemicals from the construction equipment and the railway operation, domestic wastewater from the construction workers, and storm water need to be managed as to not to affect the river and the water quality. (Impact #5, 6, 9, and 20 in the EIS.)

(Results of the water quality examination)

[Dry season: 7-13 June, 2015]

PARAMETERS	UNITS	Sample						TZ. STD*
		SI	S2	S3	S4	S5	S6	
Physical Parameters								
Turbidity	NTU	2.35	120	8.00	101	10.20	1.15	30
Colour	PtCo/1	9.40	300	18.60	286	26.40	7.20	50
Total Suspended Solids	mg/l	10	90	15	100	20	10	1000
Total Hardness	mg/lCaC03	360	440	212	85	40	255	600
Total Alkalinity	mg/lCaC03	230	280	148	70	45	298	N.M.
Chemical analysis								
Chlorides	mg/l	88.64	66.48	65.45	45.00	18.50	160	250
Sulphates	mg/l	71.20	24.00	10.0	28.20	12.0	84.20	400
Ortho-Phosphate	mg/l	0.04	0.02	Nil	0.02	Nil	0.05	N.M
Nitrate	mg/l	2.10	2.0	0.60	2.0	0.80	3.90	30
Nitrite	mg/l	0.10	0.05	Nil	0.06	Nil	0.10	N.M.
Ammonium	mg/l	0.10	0.01	Nil	0.01	Nil	0.50	0.50
Fluorides	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	1.5 -8.0
Bi-carbonates	mg/l	160	65	25	7S	40	210	N.M.
Carbonates	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	N.M.
Aluminium	Mg/l	0.01	Nil	Nil	Nil	Nil	Nil	0.30
Sodium	mg/l	40.00	12.00	2.00	10.30	2.S0	30	250
Potassium	mg/l	8.48	21.36	9.41	5.25	1.40	17.50	200
Magnesium	mg/l	12.47	23.24	10.47	6.0	0.60	21.40	150
Calcium	mg/l	33.64	16.82	50.46	10.50	2.80	36.20	300
Iron	mg/l	0.21	1.90	0.11	0.04	0.01	0.20	0.30
Manganese	mg/l	0.08	0.05	Nil	Nil	Nil	0.04	0.10
Copper	mg/l	Nil	Nil	Nil	0.10	0.10	0.30	1.5
Arsenic	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	0.05
Lead	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	0.10
Zinc	mg/l	0.10	0.23	0.07	0.40	Nil	0.10	5
Cyanide	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	0.10
Cadmium	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	0.05
Chromium	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	0.05
Bacteriological analysis								
Faecal Coliform	No/100	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Total coliform	No/100	Nil	Nil	Nil	Nil	Nil	Nil	Nil

*Environmental Management (Water Quality Standard) Regulations 2007

SI = Mkadage borehole; S2 = Mkondoa River at Mkadage village; S3 = Mdukwi River at Mkadage village, S4 = Mkondoa River at Munisagara village, S5 = Isima River at Munisagara village, S6=Kikundi borehole

Environmental elements **Survey Results**

[Wet season: 30 November-8 December, 2015]

PARAMETERS	UNITS	Sample				TZ. STD*
		S1	S2	S3	S4	
Physical Parameters						
Turbidity	NTU	1060	19.20	708	368	30
Colour	PtCo/l	1700	45	1260	810	50
pH	-	7.97	7.80	7.60	7.45	6.5 – 8.5
Electrical Conductivity	µS/Cm	710	138	520	490	2000
Total Suspended Solids	mg/l	410	100	280	200	1000
Total Dissolved Solids	mg/l	360	90	300	280	NIL
Total Hardness	mg/l $CaCO_3$	280	65	150	140	600
Total Alkalinity	mg/l $CaCO_3$	250	60	120	110	N.M.
Chemical analysis						
Chlorides	mg/l	85.10	19.50	60.0	56.50	250
Sulphates	mg/l	62.0	15.40	48.20	40.0	400
Ortho-Phosphate	mg/l	0.05	Nil	0.02	0.03	N.M.
Nitrate	mg/l	1.65	0.03	0.09	0.06	30
Nitrite	mg/l	0.80	Nil	0.02	Nil	N.M.
Ammonium	mg/l	Nil	Nil	Nil	Nil	0.50
Fluorides	mg/l	0.07	Nil	Nil	Nil	1.5 – 8.0
Bi-carbonates	mg/l	260	60	130	120	N.M.
Carbonates	mg/l	Nil	Nil	Nil	Nil	N.M.
Aluminium	mg/l	Nil	Nil	Nil	Nil	0.30
Sodium	mg/l	32.0	10.50	21.20	18.60	250
Potassium	mg/l	25.40	6.40	16.60	16.80	200
Magnesium	mg/l	29.0	10.20	18.0	15.0	150
Calcium	mg/l	43.50	15.0	26.0	24.60	300
Iron	mg/l	0.18	0.10	0.07	0.08	0.30
Manganese	mg/l	0.03	Nil	Nil	Nil	0.10
Copper	mg/l	Nil	Nil	Nil	Nil	1.5
Arsenic	mg/l	Nil	Nil	Nil	Nil	0.05
Lead	mg/l	Nil	Nil	Nil	Nil	0.10
Zinc	mg/l	Nil	Nil	Nil	Nil	5
Cyanide	mg/l	Nil	Nil	Nil	Nil	0.10
Cadmium	mg/l	Nil	Nil	Nil	Nil	0.05
Chromium	mg/l	Nil	Nil	Nil	Nil	0.05
Bacteriological analysis						
Faecal Coliform	No/100 mls	Nil	Nil	Nil	Nil	Nil
Total coliform	No/100 mls	30	Nil	40	20	Nil

*Environmental Management (Water Quality Standard) Regulations 2007
S1 = Mkondoa River at Munisagara village; S2 = Isima/Muvuma River at Munisagara village; S3 = Mkondoa River at Mzaganza village; S4 = Kinyasungwe River at Gulwe village

Soil erosion

Riverbank erosion is one of the major causes which damage the railway. Additionally, upstream erosion brings a great deal of sediment to the rivers and it encourages the flood damages through the sedimentation. Those facts were observed throughout the Study indicate that soil erosion is easily occurring in the project area, and it affects both infrastructure and the environment.

As the project cuts the mountain slope and fills to develop embankment, the earth-moving activities may cause soil run-off and erosion. (Impact #1 and 7 in the EIS.)

Solid waste

Surplus soil will be generated by cutting the mountain slope; however, the disposal volume will be minimized by utilizing it for filling the embankments. The minimized excess soil will be disposed at a proper site which will be agreed upon with the local government.

During the construction phase, waste oils from construction equipment and domestic waste from the construction workers will be generated. Demolition of the existing station and tracks will also generate solid waste. (Impact #6, 9, and 15 in the EIS.)

During the operation phase, it is concerned that the passengers may dispose their waste around the station. However, the volume will be limited and the current condition around the stations is kept clean by the station staffs.

Soil contamination

'Sabo Soil Cement', which will be used for constructing a check dam and ground sill at Maswara and Mzase Rivers, may cause dissolution of hexavalent chromium into the existing soil, though the possibility is generally low. The dissolution will be examined before the construction works.

Environmental elements | **Survey Results**

Noise/vibration

Although it is not an urban area, the construction noise will affect surrounding residents and fauna, such as birds. Expected range of the noise emission of the construction equipment to be used is 55 dB (vehicle)-85 dB (bulldozer). (Impact #2,10, 13, and 16 in the EIS.)
As the rerouted section does not pass through residential areas, the impacts of noise and vibration by trains will be the same with the current condition. The results of noise measurement at a train passing showed the noise level by trains was not so high comparing with international guidelines, and it will last only a short time, at most several times in one day.

(Measured Noise Level at Kilosa Station)

Condition	**Noise Level (dBA) Max. - Min.**
No train with no passengers shouting	40.2 – 44.2
No train with passengers talking/shouting/laughing	55 - 61
Train approaching without whistling	65 - 66
Stationary train	65 - 66
Train moving away from the station	65 - 66

(Guidelines for ambient noise)

	One Hour L_{Aeq} (dBA)	
	Day time 7:00-22:00	Nigh time 22:00-7:00
Residential; institutional; educational	55	45
Industrial; commercial	70	70

IFC EHS Guidelines

(Guidelines for occupational health)

Duration per day	**Noise level (dB A)**
8 hours	85

Environmental Management (Standards for the Control of Noise and Vibration Pollution) Regulations, 2011, and
IFC EHS Guidelines.

Eco-systems

The project site does not encompass ecologically-valuable habitats, such as primeval forests. Fauna and flora in the area are as follows:

Aquaticecology:
The fish found in the rivers consists of small barbs (*Barbus paludinosus*), african sharptooth catfish (*Clarias gariepinus*), tilapias (*Oreochtomis niloticus*), etc. Of these, three species are migratory fish species: *Labeo* sp., *Barbus paludinosus,* and *Anguilla* sp. Most of the fish specimen were found in large pool areas especially at the Gulwe swamp, while the river stretch had only small sized fish. Other aquatic animals reported were crocodiles (*Crocodylus niloticus*) and monitor lizards (*Varanus niloticus*). These reptiles were, however, not encountered during the survey period. None of the identified species are categorized as vulnerable, threatened, or endangered as per CITES.

As the water quality is an important living condition for those aquatic species, they will be affected if the river water is polluted by the construction and the operation of the rail, such as by oil leakage (Impact #5, 6, 9, and 20, in the EIS.).

Flora:
The vegetation of the proposed project site falls under two main Phytocorions.

Environmental elements	Survey Results
	One of them is Zambezian regional centre of endemism, characterized by drier miombo woodland, patches of flood plain grassland and riparian woodland. The other phytocorion is Somali-Masai regional centre of endemism characterized by *Acacia-Commiphora* deciduous bushland and patches of Halophytic vegetation dominated with *Tamarix nilotica* stands. Based on physiognomic characterisation within the proposed project area, seven main vegetation categories have been classified from the project area includes: *Acacia –Commiphora* deciduous bushland, Drier miombo woodland, Settlements with alien species, Cultivations, Marshland with sands, Riparian, and *Tamarix nilotica* stands**.** Around the project site, one tree species (*Cordyla densiflora*) has been identified growing in *Acacia – Commiphora* deciduous bushland at Kitete and Gulwe which is considered vulnerable under International Union for Conservation of Nature (IUCN) list. Although the construction site is not in a primary forest, railway rerouting and the access road construction will directly affect the vegetation within the site. (Impact #2 in the EIS.) <u>Amphibians and Reptiles:</u> Eleven species of amphibians were recorded between Kilosa and Gulwe. None of the species are threatened of extinction according to the IUCN list. Twenty-three species of reptiles were observed along the proposed rerouting sections and the access road. Most of the species do not appear in the IUCN list. Although those species can move away from the construction, vegetation clearance in the site and construction noise/vibration will affect the living conditions. (Impact #2 in the EIS.) <u>Avifauna:</u> 126 species of birds were recorded. Out of them, Fisher's Lovebird, or *Agapornis fischeri,* is categorized as Near Threatened (NT) according to IUCN list. However, the impacts will not be critical as it was commonly observed in the project area between Godegode and Gulwe, and not specified in the construction site. <u>Mammals:</u> 26 species of mammals were recorded in the study area through direct observation and interview with the locals. Out of the species, Leopard (*Panthera pardus*) and African Elephant (*Loxodonta africana*) were categorized Near Threatened (NT) and Vulnerable (VU) by IUCN. Presence of Leopard was mentioned by local pastoralists. African Elephant was also mentioned by the locals. However, they are not commonly observed; especially African Elephant, which is very occasionally observed and the frequency is very low. Migratory species which frequently or seasonally move through the project area were not recognized.
Hydrology/water regime	Out of the project components, the river-training works at Maswara and Mzase River will change the river course of those tributaries. The works at Maswara is to fix the river course and secure the enough cross-section area by excavating within the present flood plain (see Subsection 10.1.10). As the works are conducted in the existing flood plain, water flow which runs into Kinyasunguwe River will not be changed; therefore, the downstream hydrology will not be altered.

Environmental elements	Survey Results
	The works at Mzase are to straighten the curved river course to secure a smooth flow. The same as with the works at Maswara River, training works are conducted in the present flood plain. Therefore, the alteration of the river course will not affect downstream hydrology. The other project components, namely rerouting, bank protection and access road, will not cause hydrological changes.
Topography and geology	As the rerouting is to be conducted by cutting and filling the mountain slopes, topography around the rerouting section will be altered. Although the excavated soil will be utilized for filing the embankment, additional soil needs to be procured if the volume is not enough. In this case, it is necessary to develop new quarry near the construction site, and it will cause additional topographic change.
Resettlement	Compensation and Resettlement Plan (CRP) survey results showed that in total 952 people (201 households) will be affected by the rerouting and river-training works. Out of them, 414 people (109 household) are affected for their housing structures. (Impact #12 in the EIS)
Poor	Average household income of the affected household is about 4 million TZS/year (range of 100,000-73,440,000 TZS/year). As the average number of the household member is 4.74, average income per capita is estimated to be about 840,000 TZS/year. Comparing with the national poverty line, USD 1/capita/day which is equivalent to 730,000 TZS/capita/year, the average affected household's condition is close to be the poverty line. The project will affect those poor household by taking their agricultural land and the other properties. On the other hand, it is expected that the construction works will provide income source such as by employment of workers and procurement of materials. Additionally, the stable railway operation brought by the project will contribute to their income improvement through increase of the economic activities.
Indigenous people	In Kilosa District, various ethnic groups are living together due to the history of plantations of the colonial period, which made the laborers migrate from various parts of the country. As indigenous tribes, the Sagara and the Kaguru are living as minority; however, the lifestyle has already become similar with the others. In Mpwapwa District, the Gogo, the indigenous tribe is dominated but the others are also living together and the lifestyle is common. The Gogo are predominantly Christian. The Maasai and the Mang'ati are living in both Districts as pastoralists. They are new comers to the areas and not recognized as the indigenous. Kiswahili is commonly spoken between and within the tribes.
Employment and local economy	Through the local stakeholder meetings, expectations of the employment opportunities for the construction and the railway operation were raised by the villagers. Especially for the construction works, it is reasonable for employing local people for simple labor works such as vegetation clearance and making gabions. During operation, it is expected that increased passenger trains will provide opportunities to the locals to sell their products such as food and fruits. (Impact #31, 32, and 33 in the EIS.)
Land use and local resources utilization	As the rerouting distance at most several hundred meters from the existing railway, it will not change the land use at the project site. The construction will require construction materials such as sand, gravel and stone. Those materials need to be procured from existing quarries or a new quarry which is approved by NEMC and local authorities. (Impact #3 in the EIS)

Environmental elements	**Survey Results**
Water use	Domestic water is collected from boreholes and streams at the project site. Although the construction works may use some water, the volume will not be huge and not to affect the existing water use. On the other hand, there is a possibility to pollute water quality due to the construction and railway operation such as by oil leakage. (Impact #5, 6, 9, and 20 in the EIS.)
Existing social infrastructure and social services	Although it is not an authorized proper road, the local people are using the space along the railway as a road for their daily transport by motorbikes and bicycles. As the construction works will affect the usage, it is necessary to arrange good site management to minimize the disturbances as well as preventing accidents. (Impact #14 in the EIS.)  (Motorbikes along the railway) The project will bring reliable and stable train operation. It will directly contribute to the social transport service. (Impact #24 in the EIS.)
Social capital and local decision-making institution	The project area is in an agricultural area organized by the village government. As the rerouting distance is at most several hundred meters in the same vicinity, it will not affect the local decision-making institution.
Cultural heritage	Archaeological and cultural heritage of the project area remains relatively unknown. During the survey, archaeological site of early iron working was recorded at Mkadage in Kilosa District. Scatters of ancient settlements were observed at Munisagara Village. Additionally, a few potsherds from between the 17th and 19th centuries, and a huge scatter of ceramic materials were recorded. In Kikundi, ceramics of different age periods, ranging from the 8th to the 18th centuries, were recorded in the vicinity of the railway. (Impact #11 in the EIS.)
Landscape	The project site is between the river and the mountain slope. As the railway rerouting will create embankments with several meters height and cut the mountain slope, the landscape will be changed. However, as it is mountainous area with various topographic conditions and there are no specific views to be protected, the change will be acceptable.
Gender	Although it is a patriarchal society, there is evolution towards acceptance of women's rights; for example, each village has women council members and a women's committee. Most of the domestic works, such as fetching water, cooking, and collecting firewood tend to be carried out by women. However, the construction and the railway operation will not cause impacts to those domestic activities.
Children's right	Every village community has at least one primary school and every ward has at least one secondary school. The rate of enrolment of pupils in class is 77.3% in the Morogoro Region and 70.8% in the Dodoma Region.
Infectious diseases HIV/AIDS	The HIV prevalence rate of Tanzania is about 5% in 2013 (Ministry of Health (2014) 'Global AIDS Response Country Progress Report'). Annual new infections in the project area decreased recently: in Kilosa District, from 430 people in 2009 to 132 people in 2014; in Mpwapwa District, from 342 people in 2009 to 153 people in 2014. However, inflows of construction workers may cause the spread of infectious diseases as they will stay a certain period close to the local communities away from their own families. (Impact #18 in the EIS.)

Environmental elements	Survey Results
Working environment, inclusive of occupational safety	Construction works will involve hazardous situations, such as falling objects, moving vehicles and machines, generation of noxious fumes, working on elevated heights, exposure to welding blaze, falling in ditches, high temperature surfaces, noisy operations, etc. All these constitute occupational health and safety risks. Occupational health hazards may also be promoted by lack of procedures that mitigate negligence at work, fatigue due to understaffing and long working hours, employing wrong people on particular jobs and low morale etc. (Impact #13 and 17 in the EIS.) For the railway operation, the working condition of TRL staffs are regulated by the following regulations: − Employment and Labor Relations Act No.6, 2004 − Government Notes No.42, 2007 − Collective agreement: Agreement between management and workers of TRL. It is agreed every two years. The latest one is for 2013-2015. − Service regulation 1984 :Internal regulation − Railway Act No.4, 2002 − Public Service Act, 2003 According to TRL, accidents of TRL staff during working time are very common. Gumboots, groves, overcoats and helmets are provided to staffs working at workshops. For gang men, gumboots and grove are provided. However, the quantity of these is not enough. For the workers in workshop, in-house training to avoid accidents is carried out. For the gang men, they are trained by supervisors.
Accidents	Users of land abutting or neighboring the project site are likely to be affected by accidents during construction (traffic movements, open pits filled with water) due to lack of appropriate/sufficient signage at construction sites and timely notification. Workers are commonly exposed to health risks that are prevalent in the project area. (Impact #13 in the EIS.) During the railway operation, there are tendencies of passengers to jump on and off the train while the train is moving. Additionally, there are people, particularly children and elderly people, who may cross the railway line while the train is approaching. Another vulnerable group are motorcycle riders who at times are knocked off their vehicles at level-crossings. With the expected increase in the number of trains (both cargo and passenger trains), accidents may happen more frequently. (Impact #23 in the EIS.) Additionally, there is a risk of accidents related to the transportation of dangerous goods. Dangerous goods are frequently transported by rail, which represents a potential risk of release into the environment in the event of an accident. In intermodal containers spills and leaks may result from improper packing and the resultant shifting of loads during transport. Additionally, there is potential diesel release during fueling operations. (Impact #27 in the EIS.)

13.1.7 Impact Assessment

Results of the impact assessment are summarized in Table 13.9.

Table 13.9: Results of the Impact Assessment

Environmental Domain		Environ-mental Elements Impacted	Assessment for Scoping		Final Assessment		Reasons of the Final Assessment
			Prior to Construction/ During Construction	Railway In Service	Prior to Construction/ During Construction	Railway In Service	
	1	Air Quality	B−	D	B−	D	During Construction (same as the scoping results) Railway in service (same as the scoping results)
Pollution	2	Water Quality	B−	C−	B−	B−	During Construction Leakage of oil and the other chemicals from the construction equipment and waste water generated from the activities need to be managed not to affect the river/ground water quality. Railway in service Waste oils generated by the railway operation and the wastewater discharge from the station facilities need to be managed not to affect the river/ground water quality.
	3	Soil Erosion	B−	B+	B−	B+	During Construction As the project cuts the mountain slope and fills to develop embankment, the earth-moving activities may cause soil run-off and erosion. Railway in service (same as the scoping results)
	4	Solid Waste	B−	B−	B−	D	During Construction Waste oils from construction equipment and domestic waste from the construction workers will be generated. Demolition of the existing station and tracks will also generate solid waste. Railway in service Waste disposal by the passengers is limited. The current condition around the stations is kept clean by the station staffs.
	5	Soil Contamination	B−	D	B−	D	During Construction 'Sabo Soil Cement' which will be used for constructing check dam and ground sill may cause dissolution of

Environmental Domain		Environ-mental Elements Impacted	Assessment for Scoping		Final Assessment		Reasons of the Final Assessment
			Prior to Construction/ During Construction	Railway In Service	Prior to Construction/ During Construction	Railway In Service	
							hexavalent chromium. It will be examined before the construction works. Railway in service (same as the scoping results)
	6	Noise/ Vibration	B−	B-	B−	D	During Construction The construction noise will affect social and natural environment. Railway in service Noise from the train lasts only in short time during train passing.
	7	Land subsidence	D	D	D	D	During Construction (same as the scoping results) Railway in service (same as the scoping results)
Natural Environment	8	Protected Area/Forest reserve	D	D	D	D	No protected area/forest reserve is found at the project site.
	9	Eco-systems	B−	B−	B−	B−	The construction will directly affect the vegetation within the site. The vegetation clearance and construction noise/vibration will affect the terrestrial fauna. For the aquatic fauna, they will be affected if the river water is polluted by the construction and the operation such as by oil leakage.
	10	Hydrology/ Water Regime	C−	C−	D	D	The river-training works at Maswara and Mzase Rivers will change the river course; however, it will not affect downstream hydrology because they are conducted within the present flood plain.
	11	Topography and Geology	C−	D	B−	D	During Construction Developing a new quarry for filling embankment will cause another topographic change. Railway in service No activities is expected which causes topographic/geological change.
Social Environment	12	Resettlement	A−	D	A−	D	Prior to Construction 952 people (201 households) will be affected for their land/housing structures.

Environmental Domain		Environ-mental Elements Impacted	Assessment for Scoping		Final Assessment		Reasons of the Final Assessment
			Prior to Construction/ During Construction	Railway In Service	Prior to Construction/ During Construction	Railway In Service	
	13	Poor	C	C	B-/+	B+	Prior to/During Construction The project will affect the poor households by taking their properties. On the other hand, it is expected that the construction works will provide income source such as such as by employment of workers and procurement of materials. Railway in service The stable railway operation brought by the project will contribute to the people's income improvement through an increase of economic activity.
	14	Indigenous People	C	C	D	D	There are various tribes in the project area. Some of them are indigenous; however, the lifestyle has become similar with the others.
	15	Employment and Local Economy	A+	A+	A+	A+	(same as the scoping results)
	16	Land use and local resources utilization	A+	A+	B-	D	During Construction The construction will not change land use. It is necessary to procure construction materials from registered quarries. Railway in service The railway operation will not change land use.
	17	Water Use	B−	C	B-	B-	Although water volume will not be affected by the construction and the operation of the railway, it is necessary to prevent water pollution caused by oil leakage and others.
	18	Existing Social infrastructure and Social services	B−	A+	B-	A+	During Construction The construction work will affect the informal local road along the railway. Railway in service The railway operation will become reliable and stable.
	19	Social capital and local decision-making institutions	C	C	D	D	As the rerouting distance is maximally within several hundred meters in the same village, it will not affect the local decision-making institution.

Environmental Domain		Environ-mental Elements Impacted	Assessment for Scoping		Final Assessment		Reasons of the Final Assessment
			Prior to Construction/ During Construction	Railway In Service	Prior to Construction/ During Construction	Railway In Service	
	20	Cultural Heritage	C	C	B-	D	During Construction Some archaeological materials were found through the survey, especially in Kilosa District. The construction may affect those things. Railway in service As the materials are buried in the ground, railway operation will not affect them.
	21	Landscape	C	C	D	D	Landscape will be changed because of the embankment and cutting mountain slope; however, it will be acceptable as it is mountainous area and no specific views to be protected.
	22	Gender	B−	B+	D	D	The construction and the railway operation will not cause impacts to the domestic activities by women.
	23	Children's rights	C	C	D	D	The construction and the railway operation will not cause impacts specified for children.
	24	Infectious diseases HIV/AIDS	B−	C	B-	D	During Construction Inflow of the construction workers may cause spread of the infectious diseases as they will stay certain period close to the local communities away from their own families. Railway in service Risk of the spread of diseases is low because the railway passengers will not stay long at the project site except residents.
	25	Working Environment, inclusive of occupational safety	B−	C	B-	B-	During Construction Occupational health and safety risks need to be considered for construction workers. Railway in service There are risks of an increase of accidents affecting TRL staff due to the increase of train operations.
Others	26	Accidents	B−	B−	B-	B-	During Construction There are risks of accidents for local people. Railway in service Train accidents affecting local people may be increased due to the increase of train operations.

Environmental Domain		Environ-mental Elements Impacted	Assessment for Scoping		Final Assessment		Reasons of the Final Assessment
			Prior to Construction/ During Construction	Railway In Service	Prior to Construction/ During Construction	Railway In Service	
	27	Trans-boundary pollution	D	D	D	D	(same as the scoping results)
	28	Global warming	D	B+	D	B+	During Construction (same as the scoping results) Railway in service (same as the scoping results)

A+/−: Significant positive/negative impact is expected. B+/−: Positive/negative impact is expected to some extent.
C+/−: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses) D: No impact is expected.
Source: JICA Study Team

13.1.8 Mitigation Measures

Negative impacts which were evaluated as A, B, and C in the above section were presented in the Environmental Impact Statement (EIS) as Impact #1-27. The correspondence relations are tabulated in Table 13.10.

Table 13.11 presents mitigation measures and the Environmental/Social Management Programme (ESMP) describe in the EIS.

Implementation responsibility of the ESMP is solely under the project proponent, RAHCO. RAHCO shall supervise and monitor all components implemented by the Contractor. RAHCO shall provide the necessary supervisory oversight to ensure the mitigation measures are implemented.

RAHCO shall designate an Environmental Control Officer (ECO) who takes responsible for oversight of environmental compliance. The ECO shall serve in a day-to-day supervisory role during the entire construction period. The ECO shall have the capacity to coordinate the implementation of the various activities in the ESMP and ensure all RAHCO's Health Safety and Environment (HSE) management requirements are met by all aspects of the project. The ECO shall be the main contact person on all environmental and social matters related to the project (shall maintain contacts with officials in the various relevant Ministries, Departments and agencies both central and within Local Government Authorities and the RAHCO).

The Contractor shall ensure that those mitigation measures that are to be implemented during mobilization and construction are attended to. The Contractor shall designate among its staff/appoint an officer to act as Environmental Liaison Officer (ELO), and he/she will be responsible to ensure the environmental and social management mitigation measures are implemented during the contract period.

Table 13.10: Correspondence Relation Between Above Section and the EIS

Impacts in the above section			EIS	
No.	**items**	**Rating**	**No.**	**Impact description**
Prior to construction/during construction				
1	Air quality	B-	Impact #4 and #8	Impaired air quality & contribution to climate change due to release of dust, greenhouse gases and other noxious air pollutants
2	Water quality	B-	Impact #5	Release of oils and fuels in the aquatic environment
			Impact #6	Contamination of surface and ground water with demolition debris
			Impact #9	Impaired land and water qualities and contained resources from discharge of pollutants (wastes, oily substances, etc.)
3	Soil erosion	B-	Impact#1	Land disturbances/soil erosion at offsite locations - sources of construction materials - (sand, ballast, concrete blocks, aggregates, and stones)
			Impact #7	Land disturbances/soil erosion
4	Solid waste	B-	Impact #6	Contamination of surface and ground water with demolition debris
			Impact #9	Impaired land and water qualities and contained resources from discharge of pollutants (waste, oily substances, etc.)
			Impact #15	Loss of aesthetics due to haphazard disposal of demolition waste
5	Soil contamination	B-	-	(Although it is not specified in the EIS, implementation of the examination will be secured in the detailed design stage.)
6	Noise/vibration	B-	Impact #2	Loss/damage/disturbance of indigenous vegetation and contained biodiversity species
			Impact #10	Temporary disturbances/flight of fauna from noise, gaseous and dust emissions
			Impact #13	Construction health and safety hazards
			Impact #16	Nuisance and disturbances from noise/ vibrations (exceeding allowable level for the zone)
9	Ecosystem (Aquatic ecology)	B-	Impact #5,6,9	(Impacts from water pollution)
	(Terrestrial flora and fauna)	B-	Impact #2	Loss/damage/disturbance of indigenous vegetation and contained biodiversity species
11	Topography and geology	B-	-	(EIA for new quarry development will be conducted if necessary.)
12	Resettlement	A-	Impact #12	Change or modification of population and its quality of life due to land take
13	Poor	B-	Impact #12	Change or modification of population and its quality of life due to land take
16	Land use and local resource utilization	B-	Impact #3	Depletion at point source
17	Water use	B-	Impact #5,6,9	(Impacts from water pollution)

Impacts in the above section			EIS	
No.	**items**	**Rating**	**No.**	**Impact description**
18	Existing social infrastructure and services	B-	Impact #14	Temporary disruption of socioeconomic activities
20	Cultural heritage	B-	Impact #11	Destruction of archaeological and cultural heritage resources
24	Infectious disease HIV/AIDS	B-	Impact #18	Public HSS risks: traffic accidents, risks of human-human transmission of diseases (STD, HIV, etc.), Infections from putrescible wastes with disease pathogens
25	Working environment, inclusive of occupational safety	B-	Impact#13	Construction health and safety hazards
			Impact #17	Occupational HSS risks (Serious injuries, Disturbances/nuisance and discomfort, Fatalities, Sickness and ill-health, Negligence due to fatigue, Loss of morale
26	Accidents	B-	Imact#13	Construction health and safety hazards
Railway in service				
2	Water quality	B-	Impact #20	Release of oils and fuels in the aquatic environment
9	Ecosystem (Aquatic ecology)	B-	Impact #20	(Impacts from water pollution)
17	Water use	B-	Impact #20	(Impacts from water pollution)
25	Working environment, inclusive of occupational safety	B-	Impact #22	Occupational and Public health and safety during operation
26	Accidents	B-	Impact #23	Potential loss of lives and property as a result of falling off from moving train, collision with train at road crossing as a result of increased train frequencies
			Impact #27	Impairment of environmental quality due to accidental events

Source: JICA Study Team

Table 13.11: Mitigation Measures and the Environmental/Social Management Program

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
DESIGN AND MOBILISATION PHASE					
Natural Resource Receptor	Impact #1: Land disturbances/soil erosion at onsite and offsite location	In order to mitigate land degradation onsite and offsite the contractor shall, through the entire mobilisation phase, implement the following measures: ▪ Implement soil erosion control and land rehabilitation measures at all project sites and offsite locations ▪ Ensure strict control of trucks, vehicles as well as equipment and machinery to ensure that they operate only within the project area ▪ Limit excavations area needed for construction works, construct temporary drainage grooves and sedimentation ponds for surface runoff collection and compact the disturbed areas soon after construction. ▪ Compact the disturbed areas soon after construction. ▪ Whenever possible development activities shall be implemented when the agents of erosion (i.e., rain and wind) are not active. ▪ RAHCO will monitor areas of exposed soil during periods of heavy rainfall throughout the project development phase.	All disturbed land is rehabilitated	RAHCO	25,000,000
Natural Resource Receptor	Impact #2: Loss/damage/disturbance of indigenous vegetation and contained biodiversity species	In order to mitigate loss, damage, disturbance of indigenous flora and fauna, through the entire project phases, RAHCO shall ensure the following measures are implemented: ***Vegetation*** ▪ Develop and Implement a Flora and Vegetation Conservation and Soil Restoration Plan – which shall include: conduct pre-construction floristic conservation survey; identification and re-planting of the species to be conserved in similar alternative habitats; collection of their seeds and bulbs and establishment of small-scale nurseries and ex- situ and in situ conservation measures. ▪ Train the workers and construction site managers in avoiding cutting of trees and bushes along the RoW and destruction of soils on large areas ***Fauna*** Examine at each section: ▪ breeding areas of special wildlife and invertebrates in water objects ▪ presence of small mammals; ▪ presence of the nests of protected birds; ▪ presence of colonies of bats in the trees to be cut; and ▪ whether the individual section of a big mammal falls within the construction zone.	As minimum impact as possible	RAHCO	50,000,000

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
		Mitigation of noise The Contractor shall implement the following measures: ▪ Maintaining machinery and equipment in good running conditions and avoiding sudden loud noise ▪ Establish and enforce good site management ▪ Develop and observe best practice - methods of working ▪ Restrict hours of working during day light at the settlements; ▪ Exercise efficient material handling ▪ Define access routes to the site with the smallest number of properties in proximity ▪ Keep trucks and vehicle movements to a minimum possible			
Material efficiency and waste receptor	Impact #3: Depletion at point source	▪ RAHCO shall ensure that the construction materials such as sand, gravel, natural stones, ballast are procured from registered quarry and sand mining firms, whose projects have undergone satisfactory environmental assessment/audit and received NEMC/District Council approval. ▪ RAHCO shall impress the Contractor to avoid over procurement of construction materials ▪ RAHCO shall impress the Contractor to avoid wastage, damage or loss (through run-off, wind, etc.) of materials at the construction site	Resources are used as per requirement	RAHCO	0
Air quality and climate change receptor	Impact #4: Impaired air quality & contribution to climate change due to release of dust, greenhouse gases and other noxious air pollutants	In order to mitigate the impairment of climate change, throughout the project cycle, the Contractor, RAHCO will continuously implement the following measures: ▪ Use of best practice management techniques during extraction, loading and transporting raw materials. ▪ Use efficient trucks and vehicles ▪ Train driver-training to minimize emissions (e.g., prevention of over revving, shut off engines when vehicles not in use). ▪ Regular (monthly) servicing of engines ▪ Avoiding idling of engines ▪ Ensure efficient equipment operations and maintenance measures to minimize emissions. ▪ Institute proper planning of transportation of materials to ensure that vehicle fills are increased in order to reduce the number of trips done or the number of vehicles on the road.	Environmental Management (Air Quality Standards) Regulations, 2007	RAHCO	100,000,000 per year
Water resources receptor	Impact #5: Release of oils and fuels in the aquatic environment	In order to protect the receiving environment against fuels the Contractor and RAHCO shall implement the following measure: ▪ Fuels and lubricants shall be stored only at designated areas. ▪ Storage of fuel and lubricants shall be kept at least 30m from the edge of the	Environmental Management (water Quality Standards)	RAHCO	Covered under impact #4

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
		surface waters, e.g., rivers ▪ Refuelling and lubrication of equipment shall be restricted to areas at least 30m away from the edge of the surface waters ▪ Perform all routine equipment maintenance at least 30 meter away from the edge of the rivers and recover and dispose of wastes in an appropriate manner. ▪ Fixed fuel dispensing locations will be provided with secondary containment to capture fuel from leaks, drips, and overfills. ▪ A supply of sorbent and barrier materials sufficient to allow the rapid containment and recovery of spills shall be maintained at construction site ▪ Ensure that all equipment is free of leaks prior to use on the Project and prior to entering or working in or near the water bodies. ▪ Conduct regular maintenance and inspections of the equipment to reduce the potential for spills or leaks. ▪ Rubber-tired vehicles (trucks) shall refuel at commercial fuel stations. Tracked machinery (e.g., backhoes, bulldozers) shall be refuelled and lubricated on the construction site.	Regulations, 2007		
Water resources receptor	Impact #6: Contamination of surface and ground waters with demolition debris and soils	In order to mitigate impacts of demolition waste the Contractor together with RAHCO shall be guided by the waste management guidelines as follows:[1] ▪ Prevent the generation of hazardous waste; ▪ Where elimination is not possible apply means and techniques to reduce the quantity of hazardous waste generated; ▪ Minimize amount of waste for disposal by recycling, reuse and/or recovery. This includes the recovery of energy which may be available from the waste. ▪ Treat waste to stabilize, immobilize, contain or destroy hazardous properties. ▪ Dispose of residues with minimum environmental impact. ▪ Appropriately contain, isolate and store hazardous waste for which no acceptable treatment or disposal option is currently available. Other specific measures that will be implemented are: ***Inert Construction Materials:*** These materials shall be used for construction of embankments, acoustic barriers or as filling materials on rural roads. **Non-hazardous Waste:** ▪ Concrete waste will be disposed in similar manner as inert wastes. ▪ Metal waste shall be disposed separately for reuse and recycling.	All waste are handled accord to respective regulations	RAHCO	10,000,000

[1] Environmental Management (Hazardous Waste Management) Regulations, 2008

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
		Hazardous Waste: ▪ Hazardous wastes will be collected and transported to Dar es Salaam for their final disposal. ▪ Uncontrolled incineration will not be allowed. ▪ Before removal of wastes from the site, the quantity (volume) and size of wastes; the name of waste collector/disposal agent and the name of the place of their final disposal/measure shall be specified. This issue shall be controlled by site manager ▪ The technical personnel shall be trained and informed about the appropriate regulations for handling hazardous waste i.e., Environment Management (Hazardous Waste Control and Management) Regulations, 2008 ▪ After demolition the place shall be restored to the pre-construction state.			
CONSTRUCTION PHASE					
Land resources receptor	Impact #7: Land disturbances/soil erosion	In addition to mitigation measures listed under impact #1 following measures will also be implemented: ▪ RAHCO shall make land management and soil erosion control a requirement in the bidding document; ▪ RAHCO shall develop management plans for its existing quarry sites, and new sources of construction materials. ▪ Contractors will be required to control soil erosion and rehabilitate disturbed land; RAHCO shall provide oversight supervision and monitoring during and after project implementation. ▪ Contractor shall identify erosion prone areas, identify permanent erosion control measures (applicable for a particular site) and plan construction works and sites to limit quantity of material likely to be eroded and transported into the nearby rivers. ▪ Deliberately the Contractor will cover exposed soils with grass and other appropriate species as soon as possible and temporarily will bind exposed soil and redirect flows from heavy runoff areas that threaten to erode or result in substantial surface runoff to adjacent water courses. ***Topsoil removal, disposal and piling*** ▪ First of all the topsoil and then subsoil shall be cut and piled (stocked) separately on specially selected area for their purposeful use. ▪ The stocked topsoil should not be mixed up with unfertile soils, stones, etc. It should be prevented from washing to preserve the structure, fertility and seeds base of the topsoil. ▪ Topsoil will be stored in the form of stockpiles having the height up to 2 m and	All site with erosion tendencies	RAHCO	The cost of implementing these measures are part of the project implementation. They will be included in bill of quantities

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
		slope inclination up to 30-35°. ▪ Erosion of stockpile surface shall be provided through compacting surfaces to the level having no threat of development of anaerobic processes. ▪ The Contractor shall stop topsoil removal and stocking operations if topsoil is saturated with water. ▪ Stocked soil shall be protected from washing, therefore, it is necessary to arrange drainage [system] in the bottom of the storage. ▪ Stocking of removed topsoil outside the RoW, shall be avoided as far as possible. If this is not possible appropriate sites shall be identified and used in accordance with the current Tanzania Laws (e.g., Village Land Act, 1999)			
		Erosion control Following erosion control measures shall be implemented: ▪ Arrangement of berms, stone mounds and gabions will be required at the cut slopes and in the bottom of the slopes. ▪ Cut topsoil shall not be used for construction of berms within the RoW. ▪ At the location of cult slopes and ravine crossings where the excavation works are to be carried out, water collecting and conveyance canals shall be built to regulate the flows of surface waters. ▪ At the ends of water conveyance canals the settlers shall be arranged (pits, sand sacks) to prevent damage of areas adjacent to RoW with water. ▪ Phyto-amelioration measures shall be implemented to stabilize the edges of slopes and cut slopes if required. ▪ It is particularly important to protect the removed and stocked topsoil from erosion processes – as follow. ✓ Stocked topsoil shall be drained. ✓ To control erosion processes at the edge of the cut slope, phyto-amelioration measures shall be implemented on the slope. ✓ For regulation of surface waters, berms and water canals shall be arranged at the edge of the slope that will be connected to natural water courses to avoid development of lateral erosion. ***Soil reinstatement measures*** ▪ After completion of excavation works and laying the rails the soil reinstatement activities shall be implemented in the areas adjacent to the embankment. ▪ The reinstatement works shall be carried out in favourable meteorological (dry) conditions and in the shortest possible time. ▪ During implementation of soil reinstatement works mechanical and physical-	All site with erosion tendencies	RAHCO	The cost of implementing these measures are part of the project implementation. They will be included in bill of quantities

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
		chemical characteristics of soils shall be taken into account. ▪ Soils shall be reinstated at least to its initial state for the purpose of observation of the principles of environmental safety and preservation of the recreational value of landscapes.			
		▪ Reinstatement works to be carried out within the framework soil quality management; therefore the following will be required: ✓ preservation of landscapes and their recreational value; ✓ reinstatement-conservation of the areas modified as a result of construction activities to their initial visual-aesthetic state as much as possible; ✓ the construction shall not cause negative impact on the environment of the railway route and the RoW; ✓ implementation of slope stabilization and designing activities at the crossings of the railway with ravines; ✓ reinstatement of the private land parcels located in the vicinity of the railway bypass to their initial state, conservation of their fertility and natural characteristics; ✓ implementation of erosion control measures along and in the vicinity of the railway. Other mitigation measure include: ▪ ***Training of workers and construction site managers*** to avoid, along other impacts, destruction-trampling and mechanical damage of soils by construction machinery in the areas adjacent to the construction sites.	All site with erosion tendencies	RAHCO	The cost of implementing these measures are part of the project implementation. They will be included in bill of quantities
Air quality and climate change receptor	Impact #8: Impaired air quality & contribution to climate change due to release of dust (including fugitive (unavoidable, residual), greenhouse gases and other noxious air pollutants	Mitigation measures listed under Impact #4 apply.		RAHCO	Covered under Impact #4

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
Water resources receptor and Land Resources Receptor	Impact #9: Impaired land and water qualities and contained resources from discharge of pollutants (wastes, oily substances etc.)	In addition to mitigation listed under Impact #5 and Impact #6 , the Contractor and RAHCO shall implement following additional measures: ▪ Develop and implement project-specific Waste Management Procedure/Plan (i) identify what type of solid or liquid wastes and categories of wastes the project will generate or handle (biodegradable/organic wastes; packaging materials; non-biodegradable (metallic, plastic), and hazardous wastes i.e., fuels, oils, lubricants, vehicle/machinery fluids etc.); (ii) identify ways to reduce the volume of waste by reusing or recycling initiatives (iii) establish technological interventions to capture and removal unwanted materials and sand before entering the water ways i.e., bar screens, sand traps and grit chambers. The following are specific waste management procedures to be implemented: ▪ During earthworks, i.e., excavation, digging pits, quarrying, etc. Contractor shall ensure the top soil is pilled aside at one place, then after finishing the earthwork the top soil shall be used to fill any bare land surfaces around the site. ▪ Plastic and glass bottles (about 9 kg per day) shall be collected into litter bins, and transported to plastic recyclers. ▪ At completion of each day, site shall be left clean and tidy; debris, scrap and spill materials removed. ▪ Biodegradable waste of about 900 kg per day consisting of mainly paper, etc. from offices and open workshop will be disposed by burying ▪ Batteries will be sent to YUASA in Dar es Salaam for recycling ▪ No waste oil will be disposed at the site during construction. Fuel, oils and lubricants (300kg per day) on average from construction machinery and equipment from maintenance workshops, fuelling points etc. will be collected for use in furnaces ▪ Demolition debris will be used during construction as construction aids or distributed to community project and filling of rural roads. Following specific measures shall be implemented where applicable: ***Inert Construction Materials:*** measures listed under impact #6 apply The Contractor and RAHCO shall implement following additional measures to mitigate water pollution from vehicle related activities: ▪ vehicle fuelling stations (in case of their existence at the construction stage) shall be embanked to prevent spread of fuel and pollution of the surrounding area in case of accidental spills; ▪ vehicle wash areas within the garages shall be embanked. For wastewater	Environmental Management (Waste Management) Regulations, 2008	RAHCO	50,000,000

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
		treatment a primitive treatment facility in the form of concrete covered two-step ditches to prevent discharge of untreated waters in ravines and rivers; ▪ washing of vehicles in river and other surface water object shall not be allowed; ▪ layers of soil polluted by fuel and lubricants spilled from construction machinery shall be removed and transported to the place agreed with the Vice President's Office (VPO), Division of Environment (DoE), Department Natural Resources in advance; ▪ when painting metal constructions, especially metal bridges, tin or other covers shall be placed under the sections to be painted to avoid spill of paints into the surface water objects; ▪ Crossing of the planned railway with water bodies shall be designed in a manner to avoid penetration of pollutants in water bodies. Other wastes ▪ places for toilets within the construction camps shall be selected with consideration of the groundwater levels. ▪ Cesspools shall be covered with cement solution to avoid pollution of groundwater with faeces. ▪ Cesspools shall be emptied on a regular basis in accordance with the number of workers living in the construction camp. ▪ construction waste shall be piled at a distance of at least 50 m from the riverbeds of rivers and ravines prior to disposal to the specially allocated dumpsites; ▪ temporary barriers shall be arranged at the small ravines and gullies to avoid movement of increased volumes of solid materials from the RoW to large ravines and rivers at the construction stage; ▪ the design of shall ensure protection of the groundwater and the river water from pollution			
		Non-hazardous Waste - *mitigation measures listed under impact #6 apply* ▪ Construction camps will be provided with toilet/shower facilities connected to a regularly empting septic tank; ▪ Special waste bins and waste collection system will be introduced to ensure disposal of wastes at landfills; ▪ The concrete wastewater will be collected, processed through a sedimentation tank and neutralized, usually with gaseous CO_2, before their disposal; ▪ Vegetation wastes generated from site clearance during construction can be left on the site only in exceptional cases. They will be transported to the suitable waste management facility;	Environmental Management (Solid Waste Management) Regulations, 2009 Environmental Management (Hazardous	RAHCO	

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
		Hazardous Waste – mitigation measures listed under impact #6 apply ▪ Reserves of potential polluters will be stored on special insulating bedding and fenced by a berm made of the similar material to retain the polluter in an amount of 10% more than stored. ▪ During operation all stationary construction machinery operating on diesel and petrol will be equipped with a special container to collect leaking fuel for disposal. ▪ Main equipment and vehicles will be fuelled on special insulating bedding wherever possible. ▪ A special attention will be paid to prevention of fuel spills. Special collectors will be installed at the points of potential leakage. Absorbents will be used as well. Fuel will be transported by specially designed fuel trucks. ▪ Collection, treatment and transportation of waste wastes generate at the construction site will be implemented in accordance with the general plan of waste management. ▪ Wastes shall be collected on a daily basis. Waste bins labelled with special signs will be placed on specially allocated points for collection and further disposal of wastes.	Waste Control and Management) Regulations 2008		
Natural environment & biodiversity receptor	Impact #10: Temporary disturbances/flight of aquatic fauna from noise emission	In addition to mitigation listed under Impact # 2, the Contractor and RAHCO shall implement following additional measures: ▪ During the construction phase small supporting enterprises, construction camps, parking and maintenance areas shall be arranged at a considerable distance from the settlements. ▪ If protected species are found, special measures to minimize their disturbance during reproduction and breeding periods will be develop and implemented; ▪ Arrange fences to prevent animals from falling into the trenches. Before filling the trenches make sure that there is no animal there. In general, it will be sufficient to place wooden boards in trenches that will be used by animals for escaping; ▪ Keep old trees near the RoW during the construction works; ▪ After completion of construction works the water courses and forest strips shall be recovered, topsoil shall be reinstated and re-cultivated, shrubbery shall be planted along the RoW. Pipes laid in gorges will play the role of so-called “Green Bridges” for animals.	Environmental Management (Noise and Vibration) Regulations, 2008	RAHCO	The costs are covered under impact #2

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
SOCIAL IMPACTS					
SITE SELECTION, MOBILISATION AND CONTSRUCTION PHASES					
Acrcheology and Cultural Heritage Receptor	Impact #11 Destruction of archaeological and cultural heritage resources	▪ During implementation of earthworks at the project sites and adjacent areas permanent inspection/monitoring of the archaeologist shall be done ▪ The results of inspection will be reflected in the construction progress report ▪ If cultural/archaeological heritage is discovered or the grounds for assuming its existence are revealed during construction works, RAHCO (or/and its Contractor) is legally bound to stop the activities that bear the risk of damaging cultural heritage and inform in writing the Director of Archaeology and Cultural Resources in the Division for Antiquities, Ministry of Natural Resources and Tourism . The Director has to verify the discovered cultural heritage or the grounds for supporting the discovery and inform RAHCO 9or /and its Contractor) about the verification results in writing no later than in 2 weeks offer receipt of the notification.	Antiquities Act No 10 of 1964	RAHCO	Part of construction costs
Community wellbeing receptor	Impact #12: Change or modification of population and its quality of life due to land take	In order to mitigate impact associated with land take and land use change RAHCO shall implement the following measures, before project implementation begins; ▪ The Project Affected People will be compensated as proposed in the Resettlement Action Plan (RAP) ▪ Ensure user participation at the planning, design, and implementation stages of the project. Consultations with. ▪ Ensure women and other vulnerable groups are not disadvantaged by the project. ▪ Encourage the PAPs to join Village Community Bank (VICOBA) as a way of protecting their money. ***Loss of land and property*** ▪ To minimize the negative effects of the relocation of affected communities RAHCO shall develop a Resettlement and Compensation Plan. RAHCO has developed a preliminary Project Resettlement Framework containing possible mitigation measures ▪ Consultations with the PAPs on the developed relocation program shall be continuously be made. Information on timeframe of the relocation program should be provides. In addition, railway staff should be trained on relocation program if appropriate. ▪ Consultations should be conducted not only with the people that are subject of displacement but also with the host community members. The affected community members should be involved in the decision-making process related to the resettlement process: compensation packages, resettlement assistance,	All PAPs to be compensated for their land and property before the project kicks off	RAHCO	The estimated costs are contained in the CRP

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
		suitability of proposed resettlement sites and the proposed timing. ▪ In terms of mitigation and reduction of negative impacts from disruption of social relationships and networks while considering resettlement opportunities priority should be given to those areas where the possible resettlement of the whole community/settlement exists. ▪ To address in a timely manner specific concerns that will be raised during the resettlement process Grievance Mechanism should be established at an early stage as possible.			
CONSTRUCTION PHASE					
Welfare, Health & Well-being receptor	Impact 13: Construction health and safety hazards	In order to mitigate these impacts RAHCO should oblige construction company through contractual terms to conduct the following activities: ▪ To develop and implement *Public health and Safety and Construction Health and Safety Plans* - these should address the dust and noise issues. ▪ Where possible erect special fences; provide adequate sheeting of vehicle, ensure loads up until tipping point when moving around the site; use of dust filters on fixed plant and machinery. ▪ The workers should be provided with and require wearing protective special masks especially those workers who are involved in the implementation of dust generating works. ▪ Where possible avoid conduction works during night-time ▪ Develop and implement Grievance Mechanism through which local residents and workers could bring their concerns on the noise and dust caused to the construction. Additional measures include: ▪ Avoid and minimize the pollution and ensure environmental safety of workers and the population all construction equipment is maintained in good running conditions. ▪ Develop and implement Construction Site Management Plan: which will regular watering of relevant sites, especially in dry and windy weather, regular washing of construction machinery and their wheels and use of closed waste containers to ensure additional protection from unpleasant smell ▪ Use of diesel engines in closed spaces shall be restricted within depots and maintenance areas, exhaust mufflers shall be installed on internal boilers and proper ventilation of closed spaces shall be ensured.	OSHA Regulations	RAHCO	20,000,000

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
Community wellbeing receptor	Impact #14: Temporary disruption of socioeconomic activities	During construction the Contractor shall implement the following measures to mitigate disruption of other socioeconomic activities: ▪ Establish and enforce good site management to limit the construction activities as close as possible to the construction site ▪ Develop and observe best practice - methods of working – e.g., avoid unnecessary noise ▪ Restrict hours of working during day light; ▪ Exercise efficient material handling to minimise vehicle movement ▪ Define access routes to the site, and try to avoid the large port area ▪ Keep trucks and vehicle movements to a minimum possible	As minimum as possible	RAHCO	Part of contract sum
Landscape & Visual Amenity receptor	Impact #15: Loss of aesthetics due to haphazard disposal of demolition waste	▪ Mitigation measures listed under Impacts #6 & 9 apply			
Natural environment and habitants receptor	Impact #16: Nuisance and disturbances from noise/vibrations (exceeding allowable level for people comfort) due to construction activities	▪ Mitigation measures listed under Impact #10 apply			
Community wellbeing receptor	Impact #17: Occupational Health and Security and Safety (HSS) risks	In order to mitigate Occupational and Health safety Hazards the Contractor and RAHCO shall implement the following measures: ▪ Avoid use of faulty equipment, tools and risk practices: Standards and operations and equipment: lifting, electrical isolation/installation, working at heights, manual handling, fitness for work, hand tools, housekeeping, building and office, vehicle and driving, hazardous substances, etc. ▪ Employ trained /qualified and competent Personnel. ▪ Provide appropriate equipment and working condition. ▪ Provide PPEs (to workers and visitors) and enforce their use. ▪ Put in place fall-prevention systems for people working at elevated sites. ▪ Install Signage: post warning signs with appropriate text (local language) and graphics. ▪ Observe standard working hours (8 hours per day) ▪ Secure equipment properly and demarcate any hazardous areas. ▪ Enforce best code of practices at the work place: Observe internationally acceptable Performance Standards on health/safety requirements.	OSHA Regulations	RAHCO	Part of contract sum

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]

		▪ Institute procedures and guidelines, work procedures, inspections and maintenance system,
		▪ Implement in-house health and safety manual /guidelines
		▪ Avoid inadequacies in water and sanitation provisions
		  ▪ The demolition and construction work shall be contracted to class one contractor to avoid unnecessary health risks.
		  ▪ OSHA guidelines on workers safety shall be implemented
		▪ Raise awareness on construction hazards to construction workers.
		  ▪ Use water sprinklers to suppress dust during construction
		▪ Post warning signs with appropriate text (local language) and graphics.
		▪ Workers Code of Conduct with the Community Liaison Plan will be developed and implemented – this will provide rules of conduct while conflict situations; emphasizing cultural characteristics of the local communities if migrants from different cultures enter the area shall be developed. Moreover, workers should be trained in order to ensure that they behave according to the developed Workers Code of Conduct.			

Community wellbeing receptor	Impact #18: Public HSS risks: traffic accidents, Risks of human-human transmission of diseases (STD, HIV, etc.) Infections from putrescible wastes with disease pathogens	In order to mitigate public health and safety hazards, the Contractor and RAHCO shall implement the following measures: ▪ Cooperate with local Civil Society Organizations (CSOs)/public health offices in programmes for reduction/eradication of the diseases and establish worker's health protection procedures (e.g., make available free condoms to workers) ▪ Enforce surveillance measures, e.g., yellow fever vaccination, potential Ebola infection, etc. ▪ Enforce speed limit for vehicles ▪ The construction area shall be isolated with special fences from the settled areas; clear signs should be posted at the entrance to the construction area to ensure that community members will avoid entrance of this area and will be more cautious when passing the construction site Other measures include: ▪ *Public Health and Safety Plan* shall be developed and implemented to mitigate the impacts of the movement of heavy equipment on existing local roads. ▪ *Construction Traffic Management Plan* shall be developed which will allow re-routing of the truck traffic from residential streets or using local roads with fewest homes for transportation of construction materials. ▪ Develop and implement a Grievance Mechanism to facilitate early notifications of any concern from the public	No injuries to the public	RAHCO	Part of contract sum

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
	Impact #19: Vandalism of structures/equipment, theft of materials and portable items during construction	In order to mitigate vandalism tendencies RAHCO shall implement the following measures: ▪ Strengthen patrol of project construction sites and routes ▪ Strengthen security on construction sites	No theft or vandalism	RAHCO	Part of contract sum
RAILWAY OPERATION					
Water resources receptor	Impact #20: Release of oils and fuels in the aquatic environment	In order to protect the receiving environment against oils and fuels during operation TRL shall implement the following measure: ▪ Fuels and lubricants shall be stored only at designated areas. ▪ Storage of fuel and lubricants shall be kept at least 30m from the edge of the surface waters, e.g., rivers ▪ Refuelling and lubrication of equipment shall be restricted to areas at least 30 m away from the edge of the surface waters ▪ Perform all routine equipment maintenance at least 30 meter away from the edge of the rivers and recover and dispose of wastes in an appropriate manner. ▪ Fixed fuel dispensing locations will be provided with secondary containment to capture fuel from leaks, drips, and overfills. ▪ A supply of sorbent and barrier materials sufficient to allow the rapid containment and recovery of spills shall be maintained at construction site ▪ Conduct regular maintenance and inspections of the locomotives to reduce the potential for spills or leaks.	Environmnetal Management (Water Quality Standard) Regulations 2007	TRL	Normal Operation and Maintenance of TRL
Air quality receptor	Impact #21: Impairment of local air quality	Mitigation measures listed under Impact #4 & 8 apply Other mitigation measures include: ▪ Proper maintenance of trains, rails and wheels; ▪ Speed of trains may be restricted when passing the sensitive areas; ▪ Supporting structures may be constructed along the railway track which will play a role of acoustic screens.	Environmental management (Standards for Control noise and vibration pollution) Regulations 2011	RAHCO	100,000,000 per year
Welfare, Health & Well-being receptor	Impact #22: Occupational and Public health and safety during operation	In addition to mitigation measures under Impact #17, TRL shall implement the following measures to reduce risks of worker accidents during rail operations: ▪ Develop and implement a *Safety Program* in accordance with the international norms. ▪ Ensure that every manager and worker receives training before they perform any work on the line, and are provided refresher training at least every year thereafter. This applies to temporary workers as well.	OSHA Regulations	TRL	20,000,000 per year

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
		▪ Train workers in personal track safety procedures ▪ Block train traffic on lines where maintenance is occurring (green zone working) or if blocking the line is not possible use an automatic warning system ▪ Segregation of stabling, marshalling and maintenance areas from running lines. ▪ Railway workers should schedule rest periods at regular intervals and during the night to the extent feasible, to maximize the effectiveness of rest breaks and in accordance with international standards and good practices for work time in order to avoid fatigue of workers and accidents invoked by this.			
Welfare, Health & Well-being receptor	Impact #23: Potential loss of lives and property as a result of falling off from moving train, collision with train at road crossing as a result of increased train frequencies	To avoid, minimize and control the risks associated with railway operation including railway crossings the RAHCO and TRL shall implement the following measures: ▪ Use of bridges or tunnels is recommended. ▪ If level crossings are unavoidable, signals shall be installed and their regular inspection/maintenance provided. ▪ Increase the security at all railway stations ▪ Continuously provide awareness campaign to inform passengers on the dangers of boarding or disembarking train while the train is moving. ▪ TRL will develop and implement a *Safety Program* in accordance with the international norms. Underpasses or level crossings should be developed based on the consultations with the public and representatives of local government. ▪ Post visible warning signs at potential points of entry to track areas. ▪ Fencing or other barriers should be installed at station ends and other locations to prevent access to tracks by unauthorized persons. ▪ Stations should be designed in such a way to ensure that the authorized route is safe, clearly indicated and easy to use. ▪ In addition awareness raising campaign should be conducted in the area for the local public to provide them relevant information and increase their awareness on the risks of trespassing.	OSHA Regulations Zero accident	TRL RAHCO	20,000,000 per year
Welfare, Health & Well-being receptor	Impact #24: Additional pressure and demands on local social services and resources (increase water users, toilet users)	RAHCO shall implement the following measures ▪ Ensure there enough toilets and washrooms at all stations ▪ Ensure availability of clean water at all stations ▪ Construct passenger waiting room ▪ Provide areas for canteen operation	Adequate numbers and quantities	TRL RAHCO	100,000,000

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
Welfare, Health & Well-being receptor	Impact #25: Vandalism of structures/equipment, theft of materials and portable items	In order to mitigate vandalism tendencies RAHCO shall implement the following measures: ▪ Strengthen patrol of the railway infrastructure ▪ Work with village leadership to get their cooperation to guard the infrastructure ▪ Strengthen community outreach and Corporate Socio Responsibility programmes			
NATURAL, ACCIDENTAL AND ANTHROPOGENIC EVENTS					
Water and land resources receptor	Impact #26: Physical damage of project structures and disruption of railway operations and schedules due to natural causes	This project is aimed at mitigating recurrent flood risk as such efforts should be made to implement it In order to protect the environment from natural or accidental events RAHCO shall implement the following mitigation measures: ▪ RAHCO should develop a disaster management program. The main tasks of this programme are: ✓ Introduction and systematic use of methods for analyzing, evaluating and predicting the risks of disasters in practice; ✓ Improve the management and coordination activities for the reduction of disaster risk and increase the resilience of sites of critical infrastructure; ✓ Establishment of an early warning system and notification of disasters; ✓ Improving the quality of management, organization and technical provision of the single rescue system; ✓ Development of systems for seismic surveys and monitoring of water basins and rivers; ✓ Improving the system for training of managerial staff for disaster response; ✓ Public education using modern technologies and media to form a culture of safe life activity.	Minimum or no damage	RAHCO	Const are included in the project costs. For additional measures 50,000,000 for developing a disaster management programme
Natural Environment & Biodiversity receptor	Impact #27: Impairment of environmental quality due to accidental events	RAHCO in collaboration with TRL shall implement the following measures: ▪ Carry out continuous research and monitoring to determine the reasons for and reduce the risk of freight train derailment – e.g., the probability that a train will be involved in a derailment is a function of the quality of track, the length of train, and exposure in terms of distance travelled etc. ▪ Implement rail operational safety procedures aimed at reducing the likelihood of train collisions, such as a positive train control (PTC) system. ▪ Conduct regular inspection and maintenance of rail lines and facilities to ensure track stability and integrity in accordance with national and international safety standards. ▪ Implement an overall safety management program that is equivalent to			

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
		internationally recognized railway safety operations. For example, the Safety Management System published by the Safety Management in Railways group of the International Union of Railways (IUR). **Accidents related to the transportation of dangerous goods** ▪ TRL should develop and implement a system for the proper screening, acceptance and transport of dangerous goods. ▪ RAHCO should develop spill prevention and control, and emergency preparedness and response plans and ensure its implementation. ***Vegetation*** ▪ TRL and RAHCO should develop and implement a system to rehabilitate areas of damaged vegetation as a result of railway accidents (oil spills, destruction of the soil horizon, etc.) along with implementation of the Emergency Response Plan. ▪ Conduct regular training of the relevant employees for preparedness and timely and effective response to emergency situations.			
Natural Environment & Biodiversity receptor	Impact # 28: Impairment of railway operations as a result of flooding of Gombe Dam	RAHCO shall continuously liaise with operator of the Gombe Dam to ensure that the dam is effectively managed to ensure it does not flood beyond its boundaries	The flood does not extend beyond the boundaries of the dam	RAHCO	5,000,000 per year
Social Impacts					
Welfare, Health & Well-being receptor	Impact #29: Increased train frequencies and therefore smoothen passenger and cargo movement	In order to enhance the benefits that will result from the implementation of this project TRL and RAHCO shall ▪ Invest in other infrastructure and operational requirements such as procuring more wagons and more engines, improving welfare of workers etc.	At least one passenger train per day to operate from Dar es Salaam and One from Kigoma and Mwanza	RAHCO TRL	
Built environment receptor	Impact #30: Protection of roads from heavy cargo as is the current practice	In order to improve the usage of railway system to transport cargo instead of roads the following mitigation measure should be considered: ▪ Tanzania should make it mandatory to transport heavy cargo with railway system instead of using road			
Welfare, Health & Well-being receptor	Impact #31: Increased income to local suppliers	In order to enhance the benefits that may result from procurement of construction materials and other services from local business people the following measures may be implemented:			

Receptor	Project Aspect/ Potential Direct Impacts	Mitigation Measures/Management Program	Target Level/ Standard	Responsi-bility	Estimated Cost [TZS]
		▪ RAHCO and TRL will develop a plan aiming at providing opportunities, where possible, for procurement contracts with local companies in the context of all areas of service requirement during construction and operation			
Welfare, Health & Well-being receptor	Impact #32: Employment opportunities	In order to enhance the employment benefits the following measures may be implemented: ▪ RAHCO and TRL will develop and implement a Local Workforce Recruitment Plan aiming at providing opportunities for employment of local workforce. ▪ Information with regard to construction recruitment will be comprehensively and timely communicated to the local community members by contractors.			
	Impact #33: Increased income and improved or livelihoods as result of increased agricultural production, trading activities, and movement of people within the region and bordering countries	Measures under Impact #29 will apply.			
	Impact #34: Improved comfort of passengers as a result of increased train frequencies	Measures under Impact #29 will apply.			
Landscape & Visual Amenity receptor	Impact #35: Improved quality of the landscape features and appearance of the river embankments	▪ River embankment protection will be implemented as planned			
Natural Environment & Biodiversity receptor	Impact # 36: Improved flood management emanating from proper operation of the Gombe Dam	▪ Mitigation measures under Impacts # 28 apply			

Source: Environmental Impact Statement

13.1.9 Monitoring Plan

Table 13.12 shows the Environmental/Social Monitoring Program (ESMoP).

The project proponent, RAHCO, has sole responsibility on implementation of the ESMoP. RAHCO shall supervise and monitor components of the monitoring plan and keep records of the monitoring outcome.

Table 13.12: Environmental/Social Monitoring Program

Potential Impact	Parameter to be monitored	Monitoring frequency	Monitoring areas	Measurement units	Target level or standard	Responsible party	Estimated Cost TZS
Mobilisation							
Impact #1: Land disturbances/soil erosion at onsite and offsite location	Rills and gullies (visual observation of soil erosion) Sediments in receiving water bodies	Once every six months	Project site	None mg/l	No erosion None	RAHCO	10,000,000 per year
Impact #2: Loss/damage/disturbance of indigenous vegetation and contained biodiversity species	Types of vegetation being cleared Existence of endemic /protected species Area being cleared	Continuously during mobilisation and construction phase	Entire project site	Numbers	No endemic/ protected species cleared Clearance should be restricted to project corridor	Contractor	Part of contract costs
Impact #3: Depletion at point source	Procurement records	Monthly during construction	Point of sourcing and Project site	all procurements from licensed operator	No material from unlicensed supplier, No new borrow pit	RAHCO Environmental Manager	200,000 per month
Impact #4: Impaired air quality & contribution to climate change due to release of dust, greenhouse gases and other noxious air pollutants	CO, NOx, dust	Once every six month	Construction site	mg/l, ppm	NOx = 150 µg/ Nm^3 for 24-hours average value[2] CO = Daily average of hourly values shall not exceed 10mg/kg and average of hourly values in eight consecutive hours shall not exceed 20 mg/kg. Dust (measured as PM10) = 150µg/m^3	Contractor ELO ECO	1,000,000 per month

[2] Environmental Management (air Quality Standard)Regulation of 2007

Potential Impact	Parameter to be monitored	Monitoring frequency	Monitoring areas	Measurement units	Target level or standard	Responsible party	Estimated Cost TZS
					measured over 24hour average[3]		
Impact #5: Release of oils and fuels in the aquatic environment	Oil contents	Once every six month	Surface water bodies	mg/l	10[4]	RAHCO	500,000 per year
Impact #6: Contamination of surface waters with demolition debris and soils	All types of waste including ▪ Heaps of soils ▪ Plastics wastes ▪ Glass wastes ▪ Turbidity ▪ Suspended solids in receiving water bodies ▪ BOD	Continuous throughout the project cycle	Project site	None NTU mg/l mg/l	No haphazard disposal of waste 300[4] 100 [4] 30 [4]	RAHCO Environmental Manager	500,000per month
Construction							
Impact #7: Land disturbances/soil erosion	Rills and gullies Sediments in receiving water bodies	Once every six months during construction	Project site	None mg/l	No erosion None	RAHCO	2,000,000 per year
Impact #8: Impaired air quality & contribution to climate change due to release of dust (including fugitive (unavoidable, residual), greenhouse gases and other noxious air pollutants	CO, NOx, dust	Once every year during construction	Construction site	mg/l, ppm	NOx = 150 µg/ Nm^3 for 24-hours average value[5] CO = Daily average of hourly values shall not exceed 10mg/kg and average of hourly values in eight consecutive hours shall not	Contractor ELO ECO	1,000,000 per month

[3] USA National Air Quality Standard
[4] Environmental Management (Water Quality Standards) Regulations, 2007
[5] TBS - Ambient air quality

Potential Impact	Parameter to be monitored	Monitoring frequency	Monitoring areas	Measurement units	Target level or standard	Responsible party	Estimated Cost TZS
					exceed 20 mg/kg. Dust (measured as PM10) = 150µg/m^3 measured over 24hour average[6]		
Impact #9: Impaired land and water qualities and contained resources from discharge of pollutants (wastes, oily substances etc.)	Oil contents All types of waste including ▪ Heaps of soils ▪ Plastics wastes ▪ Glass wastes ▪ Turbidity ▪ Suspended solids in receiving water bodies ▪ BOD	Once every year during construction	Surface water bodies	mg/l NTU mg/l mg/l	10[7] 300[31] 100 [31] 30 [31]	RAHCO	1,000,000 per year
Impact #10: Temporary disturbances/flight of aquatic fauna from noise emission	Noise levels	Once month after commencement of construction	Project site	dB	<85 dB[8]	RAHCO Environmental Manager	1,000,000
Impact #11: Destruction of archeological and Cultural heritage resources	No. of discoveries	Continuously	Project site	Number	All discoveries should be reported	RAHCO Contractor	12,000,000 per year
Impact #12: Change or modification of population and its quality of life due to land take	Existing of land related conflicts Types of land use	Continuously	All villages along the project corridor	Number of conflicts	Zero	RAHCO	500,000 per six months
Impact #13: Construction health and safety hazards	▪ Personnel health records ▪ Noise levels ▪ Concentration of pollutants such as	Once every year	Project site	None dB ppm numbers	 Noise = <85dB Dust = Not to exceed	RAHCO OHS Officer	5,000,000 per year

[6] USA National Air Quality Standard
[7] Environmental Management (Water Quality Standards) Regulations 2007
[8] Environmental Management (Noise and Vibration Management and Control) Regulations of 2007

Potential Impact	Parameter to be monitored	Monitoring frequency	Monitoring areas	Measurement units	Target level or standard	Responsible party	Estimated Cost TZS
	dust in the working environment ▪ Number injuries				250 mg/Nm^3 (24h mean value)[9] Zero injuries		
Impact #14: Temporary disruption of socioeconomic activities	Existence of complaints	Continuously during construction	Entire project site	Number of complaints	As minimum as possible	Contractor RAHCO	Included in impact #11
Impact #15: Loss of aesthetics due to haphazard disposal of demolition waste	All types of waste including ▪ Heaps of soils ▪ Plastics wastes ▪ Glass wastes ▪ Turbidity ▪ Suspended solids in receiving water bodies ▪ BOD	Continuous throughout the project cycle	Project site	None NTU mg/l mg/l	No haphazard disposal of waste 300[31] 100 [31] 30 [31]	RAHCO Environmental Manager	500,000per month
Impact #16: Nuisance and disturbances from noise/vibrations (exceeding allowable level for people comfort) due to construction activities	Noise levels	Once month after commencement of construction	Project site	dB	<85 dB[10]	RAHCO Environmental Manager	Covered under #10
Impact #17: Occupational Health and Security and Safety (HSS) risks	Incidences of breach of health and safety	Continuously	Project area	Number of incidence	Zero	RAHCO	3,000,000 per year
Impact #18: Public HSS risks: traffic accidents, Risks of human-human transmission of diseases (STD, HIV, etc.) Infections from putrescible wastes with disease pathogens	STDs HIV/AIDS infections Cholera	At the beginning of the project and once every year	hospital/dispensary	Number of people infected	No or as minimum infectious cases	District Medical Officer	2,000,000 per year

[9] Environmental Management (Air Quality Standard) Regulation of 2007
[10] Environmental Management (Noise and Vibration Management and Control) Regulations of 2007

Potential Impact	Parameter to be monitored	Monitoring frequency	Monitoring areas	Measurement units	Target level or standard	Responsible party	Estimated Cost TZS
Impact #19: Vandalism of structures/equipment, theft of materials and portable items during construction	Destroyed infrastructure and loss of equipment	Continuously during construction phase	Construction site and stores	Number of theft incidences	No or minimum vandalism cases	RAHCO	10,000,000
Railway Operation							
Impact #20: Release of oils and fuels in the aquatic environment	Oil contents	Once every six month	Surface water bodies	mg/l	10[11]	RAHCO	
Impact #21: Impairment of local air quality	CO, NOx, dust	Once every six month	Construction site	mg/l, ppm	NOx = 150 µg/ Nm^3 for 24-hours average value[12] CO = Daily average of hourly values shall not exceed 10mg/kg and average of hourly values in eight consecutive hours shall not exceed 20 mg/kg. Dust (measured as PM10) = 150µg/m^3 measured over 24hour average[13]	Contractor ELO ECO	1,000,000 per month
Impact #22: Occupational and Public health and safety	▪ Personnel health records ▪ Noise levels ▪ Concentration of pollutants such as dust in the working	Once every year	Project site	None dB ppm numbers	Noise = <85dB Dust = Not to exceed 250 mg/Nm^3 (24h mean value)[14]	RAHCO OHS Officer	

[11] Environmental Management (Water Quality Standards) Regulations, 2007
[12] Environmental Management (Air Quality Standard) Regulation of 2007
[13] USA National Air Quality Standard
[14] Environmental Management (Air Quality Standard) Regulations of 2007

Potential Impact	Parameter to be monitored	Monitoring frequency	Monitoring areas	Measurement units	Target level or standard	Responsible party	Estimated Cost TZS
	environment ▪ Number injuries				Zero injuries		
Impact #23: Potential loss of lives and property as a result of falling off from moving train, collision with train at road crossing as a result of increased train frequencies	Reported cases of such injuries	Once every month	Railway stations	Number	Zero	TRL RAHCO	500,000 per year
Impact #24: Additional pressure and demands on local social services and resources (increase water users, toilet users)	Number of toilets at each station Incidences of open defecations	Once at the beginning of operation and then one year and availability of clean water Continuously	Railway stations	Number of functioning toilets Clean water Signs of open defecation	As many as possible No open defecation	TRL RAHCO	500,000 per year
Impact #25: Vandalism of structures/equipment, theft of materials and portable items	Reported cases of vandals	Continuously	Entire project	Reported cases	No or minimum vandalism cases	TRL RAHCO	500,000 per year
Impact #26: Physical damage of project structures and disruption of railway operations and schedules due to natural causes	Physical strength of impacted structure Visual monitoring of soil erosion along the unpaved project areas and river banks	Once every year	Project site	None	No structure weakness	Contractor RAHCO	5,0000,000 per year
Impact #27: Impairment of environmental quality due to accidental event	Vegetation Oil contamination	Immediately after accident and once every six months	Site of accident	Decontaminated soils and plants mg/l	10[15]	TRL	5,000,000 per year
Impact # 28: Impairment of railway operations as a result of flooding of Gombe Dam	Flooding tendencies	Continuously during rainy season	Gombe Dam Area	Visual	Floods should not extend beyond the dam boundaries	RAHCO	5,000,000 per year

[15] Environmental Management (Water Quality Standards) Regulations, 2007

Potential Impact	Parameter to be monitored	Monitoring frequency	Monitoring areas	Measurement units	Target level or standard	Responsible party	Estimated Cost TZS
Impact #29: Increased train frequencies and therefore smoothen passenger and cargo movement	Train frequencies	Once every year	TRL Head Quarters	Number	At least one passenger train per day	TRL	0
Impact #30: Protection of roads from heavy cargo as is the current practice	Cargo tonnage transported by train	Once every year	TRL Head Quarters	Tonnage	At least 80% of cargo is reported by train by 2019	TRL	0
Impact #31: Increased income to local suppliers	Supplies and services received from the residents	Monthly	Procurement supply list	Number of supplies and services from the residents	As many supplies and services from the residents	Procurement manager	0
Impact #32: Employment opportunities	Number of residents employed	Every year	Employed employees	Number of employees	As many tenant employees as possible	RAHCO	0
Impact # 33: Increased income and improved or livelihoods as result of increased agricultural production, trading activities, and movement of people within the region and bordering countries	Incomes of local people in the project area	Once every year	Affected villages	Per capita income	National per capita income average	RAHCO	10,000,000 per year
Impact # 34: Improved comfort of passengers as a result of increased train frequencies	Passenger perception	Once (six months after commissioning of the project sections)	Affected villages	Perception	Positive perception	RAHCO	5,000,000
Impact # 35: Improved quality of the landscape features and appearance of the river embankments	Landscape	Once after completing the construction work	The project area	Visual appearance	Attractive visual appearance	RAHCO	2,000,000
Impact # 36: Improved flood management emanating from proper operation of the Gombe Dam	Flooding tendencies	Continuously during rainy season	Dam area	Over flooding	No flooding beyond the border of the dam	RAHCOO	5,000,000 per year

Source: Environmental Impact Statement

13.1.10 Stakeholder Meetings for EIA

(1) The First Meeting

Outline

In accordance with the Environmental Management Act and JICA Guidelines, the first series of stakeholder meetings were held in the villages along the railway in the study area. The meetings aimed to involve local communities at an early stage such as to collect necessary information for the EIA study and encourage local participation into the mitigation measures for possible environmental and social impacts.

The meeting was held in six villages in the Kilosa–Gulwe section and three villages in the extended project section to Dodoma (Table 13.13). In the Kilosa–Gulwe section, the meetings basically consisted of two sessions: the first was for village leaders and the second was for the village assembly. Participants in the first session included about 20–30 representatives in each village including village council members, ward officers, elders, religious leaders, women committee members, members of youth groups, security officers, political leaders, and so on. After the first session, the results were presented in the village assembly, in which about 100 villagers participated at each meeting to collect comments from the villagers.

The schedule of the village assembly was informed through village leaders and networks among villagers. As representatives from women's committee were invited for each village leader's meeting, participation of women was secured in all of the meetings and the village assemblies.

Table 13.13: Outline of the First Stakeholder Meetings (8–12 June 2015)

		Village information			Number of participants	
Date	Village name (Ward and District name)	km post	Status of the station	Accessibility by car	Leaders' meeting	Village assembly
8 June	Mkadage (Magomeni, Kilosa)	286	No station	No access	47	
9 June	Munisagara (Msanze, Kilosa)	298	Closed	No access	25	72
	Mzaganza (Kidete, Kilosa)	311	Closed	No access		140
10 June	Kikundi (Kidete, Kilosa)	316	No station	No access	24	80
	Godegode (Godegode, Mpwapwa)	349	Closed	Available	25	98
11 June	Gulwe (Gulwe, Mpwapwa)	366	Operational	Available	31	87
12 June	Musagali (Chunyu, Mpwapwa)	382	Closed	Available	18	-
	Igandu (Igandu, Chamwino)	402	Closed	Available	21	-
	Ihumwa (Mtumba, Dodoma)	439	Closed	Available	20	-

Note: Village assemblies were not planned in Musagali, Igandu and Ihumwa as they are out of the main project area.
Source: JICA Study Team

Results

The possible positive and negative impacts by the project were raised by the participants responding to the facilitator's question (Table 13.14). As a positive impact, expectations for job opportunities for the construction works and railway operation were raised at almost every village. On the other hand, some negative concerning was also raised such as compensation for resettlement and sexual disease/HIV effects. Those concerns were addressed in the mitigation plan in the EIA.

Apart from the project impacts, participants expressed various requests related to the project; for example, flood protection for agricultural land in addition to the railway, and improvement of train service and road infrastructure (Table 13.15). Although most of them are out of the scope of this project, their requests shall be noted for possible future plans.

Table 13.14: Positive and Negative Impacts Raised in the Meetings

Subjects	Raised Issues	Response
Positive impacts	1) Job opportunities for construction and train operation. It should be prioritized to the local villagers.	The contractor is to be coordinate with the local government closely and prioritize the job opportunities to the villagers considering equal distribution through the village government.
	2) Improvement of the railway service for transporting agricultural products.	-
	3) Protection of the agricultural land and people's properties from flood, not only the railway.	The project aims to protect the railway, not the agricultural land and people's properties.
	4) Economic growth of the villages/villagers.	-
Negative impacts	5) House relocation and land acquisition. It should be compensated properly.	Addressed in the CRP.
	6) Sexual diseases such as HIV and marriage destruction caused by inflow of construction workers. Education is necessary for both community and workers.	Addressed in the mitigation plan.
	7) OHS (Occupational Health and Safety)/ worker's insurance	Addressed in the mitigation plan.
	8) Students may leave their studies to seek employment.	Addressed in the mitigation plan.
	9) Environmental degradation such as deforestation and pollution such as dust.	Addressed in the mitigation plan.
	10) It is concerned that the culvert improvement might affect downstream agricultural land by the increased flood flow (Igandu).	To be addressed in the culvert improvement planning at Igandu.

Source: JICA Study Team

Table 13.15: Requests to RAHCO/the Government and TRL

Topics	Requests	Villages	Response
Flood protection measures	1) Kidete Dam should be renovated as the first priority for protecting both agricultural land and the railway from flood.	Mkadage, Mzaganza Kikundi	Flood flow prevention shall be addressed in future project such as watershed management project.
	2) Flood flow from Kibakwe should be prevented for the same reason as above.	Godegode	
	3) Flood flow from Kimagai and Kidete Dams should be prevented for the same reason as above.	Gulwe	
	4) Flood flow from Bujuku and Maschilo should be considered	Musagali	
	5) Number of culvert under the railway needs to be increased to discharge flood flow from agriculture land (near Musagali Station).	Musagali	To be addressed in the future improvement plan.
Irrigation	6) Reserving water is necessary at the same time with flood protection.	Musagali	To be noted for the future development.
Train services/ operations	7) Existing station to be operated and rehabilitated.	Munisagara, Mzaganza Godegode, Musagali Igandu	To be noted for TRL.

Topics	Requests	Villages	Response
	8) A station to be built in the village.	Mkadage, Kikundi	To be noted for the future development.
	9) Trolley or small train to be operated for local transportation.	Mkadage, Mzaganza	To be noted for TRL.
	10) Train operation to be regulated more strictly for safety control. (e.g., speed limitation, sounding phone more frequently)	Munisagara, Igandu	To be noted for TRL.
	11) Communication system needs to be improved to find the flood disaster points on the railway.	Musagali	To be noted for TRL.
Side road	12) The road along the railway to be improved for securing safety and local transportation.	Mkadage, Munisagara Mzaganza, Kikundi	To be discussed the possibilities.
	13) Temporary road for construction to be utilized for local transportation after the construction.	Mzaganza	
	14) After relocating the railway, the existing railway location to be utilized for a local road. Existing bridge and culvert to be maintained after the relocation.	Munisagara, Kikundi	
Crossing road	15) Roads to cross the railway (with livestock) to be built.	Mkadage, Munisagara Mzaganza, Igandu Ihumwa	Underpass is to be planned in this study for the section of railway embankment.
	16) The existing culvert needs to be improved not only for flood protection but also for crossing the railway.	Igandu	

Source: JICA Study Team

(2) The Second Meeting

Outline

The second series of the meetings were held in order to provide feedback of the EIA results to the local stakeholders. The meetings were held at five villages with participants from six villages which would be affected by the project, especially by the railway rerouting. It was called for the village leaders as shown in Table 13.16 including women leaders.

Table 13.16: Outline of the Second Stakeholder Meetings (22–24 February 2016)

Date	Village name (Ward and District name)	Participants	Number of participants	
			Total	(Women)
22 Feb.	Munisagara (Msanze, Kilosa)	Village Executive Officer (VEO), village chairman, village council members, sub-village leaders	18	(5)
	Mzaganza (Kidete, Kilosa)	VEO, village chairman, village council members, sub-village leaders, secretary of political party, teacher	16	(3)
23Feb.	Kikundi (Kidete, Kilosa)	Ward Executive Officer(WEO), VEO, village chairman, village council members, sub-village leaders, elder	12	(2)
24 Feb.	Gulwe (Gulwe, Mpwapwa)	WEO, ward councilor, VEO, village chairman, village council members, sub-village leaders, village land officers, teacher, nurse, TRL staff	20	(8)
	Godegode (Godegode, Mpwapwa) Kisisi (Godegode, Mpwapwa)	WEO, VEO, village chairman, village council members, sub-village leaders, village health officer, party leader, elders	20	(7)

Source: JICA Study Team

Results

During the meetings, the entrusted consultant explained the major points of the ESMP including responses to the comments at the first meetings. After that, the participants made questions/comments and the consultant and RAHCO answered (Table 13.17). Through the meetings, the results of the ESMP were well accepted and the understandings on the project were encouraged among the participants. It was agreed by the participants to explain the meeting results to the other villagers.

Table 13.17: Questions/Comments and Response in the Meeting

Questions/Comments	Response
1) The service of local shuttle trains (pick-up train - locally known as "punguza") should be re-established to serve communities located away from the existing main railway stations and who haven't any other means of reliable transport. (Munisagara)	The plans will be put in place to resume the services of the shuttle train during operation phase.
2) It is concerned that heavy truck and equipment will be used during construction phase and will cause environmental degradation particularly to the existing flora and fauna. (Kikundi)	Appropriate mitigation measures have been put in place to mitigate all environmental impacts including degradation of existing flora and fauna in the project area.
3) Is the EMP applied for the existing construction work for the flood damage this year? (Kikundi)	The proposed EMP is for the JICA project.
4) Is it possible for constructing a school and a dispensary at the relocation site? (Kikundi)	As far as they are not affected, the new facilities are not planned.
5) Is the 30 m distance away from the water source enough to avoid water pollution by the construction works specified in the EMP? Is it legal? (Kikundi)	It is legally acceptable and seems to be enough.
6) Pathway for livestock keepers is requested for crossing the new track. (Gulwe)	Culverts will be prepared with enough size for livestock to cross the rail.

Questions/Comments	Response
7) Is there any physical properties left for village use after project construction phase? (Gulwe)	The camp site might be left for village use at the end of construction phase, but this will be discussed and agreed at the end of project implementation. Also livelihood restoration shall be provided to the affect people.
8) Flood measure at Mzase River is necessary. (Gulwe)	Already planned.
9) Will the village land be compensated if it is affected? (Gulwe)	Yes it will.
10) There might be conflict between Contractor and village government on issue of payment of village levy for construction materials. (Gulwe)	Contractor shall abide and follow all local government by-laws and regulation including the payment of all relevant levy. Contractor shall also source construction materials at authorized areas in order to avoid conflicts with local communities and environmental degradation.
11) Road damage by the heavy construction materials is concerned. (Gulwe)	Construction access road will be prepared. If the village road is damaged, the contractor is to be responsible for repairing.
12) Is there any regulation for paying tax for the material procurement? (Gulwe)	Is should be consulted with the local government in accordance with the regulation.
13) It is necessary to collaborate between contractor and the local people in order to secure the environmental and social management. (Gulwe)	-
14) The construction access road is requested to be left for public use. (Godegode/Kisisi)	It will be left.
15) Pollution of water source by the construction is concerned. (Godegode/Kisisi)	It will be managed by the EMP and EMoP.
16) There is water scarcity in Godegode village, thus requested the Contractor to be engaged to build water well as compensation for taking construction materials within the village area. (Godegode/Kisisi)	The village government should discuss and see the possibility of this matter with the Contractor prior to commencement of the construction works.
17) Accident is concerned because of the shortage of medical facilities and staffs. (Godegode/Kisisi)	Safety management plan will be prepared to prevent accidents.

Source: JICA Study Team

Meeting with village leaders
In the first meeting

Village assembly
In the first meeting

Meeting with village leaders
In the second meeting

Source: JICA Study Team

Figure 13.7: Stakeholder Meetings for the EIA

13.2 Compensation and Resettlement Plan

13.2.1 Necessity of Resettlement

The following project components will cause resettlement.

(1) Rerouting

In accordance with the Railway Act (2002), "railway strip" which means ROW is defined as land adjacent to the railway track reserved to facilitate future development of rail infrastructure. In this strip, a person shall not erect any building or structure or execute any works without written permission of RAHCO. The act also defines the width of the strip as fifteen meters in urban area and thirty meters in rural area from the center line of the track. Based on the act, it is necessary to acquire the land for thirty meters of both sides of the newly rerouted railway tracks.

As explained in Subsection 8.6.2 and 13.1.4, the rerouting course was selected to minimize the house relocation by comparing Alternative A-1, B-1, and C-1 versus A-2, B-2, and C-2. However, not all of the residential areas were avoidable and the agricultural land would be affected.

(2) River-Training Works

Excavating a new channel at Maswara River will directly affect the agricultural land in the flood plain. However, no house relocation is required.

Training works at Mzase River will not affect either agricultural land or housing structures as the location is bare land and not used for any such purpose.

13.2.2 Legal Framework for Compensation and Resettlement

The Tanzanian legal framework for land acquisition and Compensation and Resettlement Plan (hereinafter referred to as "CRP") is summarized in Table 13.18.

Table 13.18: Tanzanian Legal Framework for Land Acquisition and Resettlement

Types	Name of policies/laws
National Policies	National Land Policy, 1997
	National Environmental Policy, 1997
	National Human Resettlement Development Policy, 2000
	TASAF III Resettlement Policy Framework, 2012
Legal Framework	The Land Act, 1999
	The Land (Amendment) Act, 2004
	The Village Land Act, 1999
	The Land Acquisition Act, 1967
	The National Land Use Planning Commission Act (No. 3), 1984
	Urban Planning Act, 2007
	Graves (Removal) Act, 2007
	Local Government (District Authorities) Act
	Local Government (Urban Authorities) Act
	Land (Forms) Regulations, 2001
	Land (Assessment of the Value of Land for Compensation) Regulations, 2001
	Land (Compensation Claims) Regulations, 2001
	Land (Management of the Land Compensation Fund) Regulations, 2001
	The Village Land Regulations, 2001
Guidelines	Road Sector Compensation and Resettlement Guidelines, 2009

Source: JICA's Tanzanian Environmental and Social Consideration Profile, Sept. 2011, with updated revisions by JICA Study Team

(1) Summary of Relevant Policies and Regulations for Social Considerations in Tanzania

Tanzanian main laws and regulations on land acquisition and compensation and resettlement plan procedures, can be summarized as below.

The Land Acquisition Act, 1967

The Land Acquisition Act, 1967 is the principal legislation insofar as land acquisition is concerned. The provisions of Section (1) draw attention to the requirements of the Constitution: *"Subject to the provision of this Act, where any land is acquired by the President under Section 3, the Minister shall on behalf of the Government pay in respect, thereof, out of moneys provided for the purpose of the Parliament; such compensation as may be argued upon or determined in accordance with the provision of this Act."*

The most common instruments which the state has and can apply to access land are: negotiations and persuasion, legalized force, and compulsory acquisition. The latter is normally effected through the power of "eminent domain". This gives the state powers to expropriate private property for public use without necessarily seeking the owners' consent. However, this is subject to payment of fair and prompt compensation. Compulsory land acquisition involves four key steps, namely: (i) planning and the decision to acquire land, (ii) legal preliminaries, including getting statutory authority and serving notices, (iii) field investigations, including valuation, and (iv) payment of compensation to those being dispossessed.

Normally it is the local or central government that initiates the process of land acquisition for public use. Valuation of land and other improvements therein is done either by the government or by private companies, but the central government must give approval. While dispossessed households are entitled to fair and prompt compensation, the allocation of alternative land for resettlement is not a right, but is instead at the discretion of the government or any other institution involved in the acquisition of land for public use. In the Tanzanian context, the provision of alternative land in an appropriate location seems to be a key pre-condition not only for restoring land occupiers to the situation they were in before the acquisition of their land for public use, but also for promoting sustainable use of environmental resources on which the survival of urban settlers depends.

The Land Act (No. 6), 1999

The current basic law in effect in relation to land can be identified as the Land Act (No. 6), 1999, excluding village land management, settlement of disputes and related matters. The Act relates to land-use planning processes, land-use management, and guidance to landownership in Tanzania. The law vests all land in the name of the President, empowering him to grant occupancy rights to individuals, legal persons and territorial communities. The President is and empowered to revoke the "Right of Occupancy" of any landholder for the "public/national interest" should the need arise. The President can acquire land for public use and benefit, for instance, to resettle people from densely populated areas to sparsely populated areas, and so forth. The President can also acquire land for other national projects, like railway infrastructure. However, the law declares the value attached to any piece of land and as such any land rights transfer is subject for compensation.

Under the Government Standing Order on expropriation for public utility, the holder of a Right of Occupancy is guaranteed a free enjoyment of the land and is entitled to compensation if dispossessed by the Government for public use. In many cases, whilst the holders agree to leave their land, they are not happy with the amount and delay of the compensation. Often, for example, improvements that they have made to the land are omitted or underrated. The

expropriation should match the price that improvements could fetch if sold in the open market. Replacement value (defined as the cost of putting up a structure equivalent to the evaluated one) makes allowances for age, state of repair, and economic obsolescence.

The Village Land Act (No. 7), 1999[16]

This Act was enacted for the purpose of regulating administration and management of land in villages. Under the provisions of the Act, the Village Council[17] is responsible for the management of village land, taking respect of balance in land use, other natural resources development, and environmental preservation, by upholding the principle of sustainable development.

The Land (Assessment of the Value of Land for Compensation) Regulations, 2001

The regulation outlines that the basis for assessment of the value of any land and un-exhausted improvement for the purpose of compensation shall be its market value:

(a) The asset evaluation related to land and accommodated properties, shall be based on market value.
(b) The market value of land and accommodated properties, shall be set up based on comparative proof, of equivalent land's recent actual selling price, by income approach, or by replacement cost method.
(c) In terms of payment by the government or by the local authority in charge, the land and all the remaining value identified, must be confirmed by the administrative auditor or by the competent representative in charge.
(d) If compensation is not paid promptly, and payment of interest rate may become an additional obligation, then the government or the local authority in charge must be held accountable in bearing such cost.
(e) In order to evaluate the interest rate of the compensation payment, "prompt payment of compensation" stated in above item, shall mean, within 6 months, after the subjected land acquisition or after expiration of its land right.
(f) If in case, within 6 months, after the subjected land acquisition or after expiration of its land right, the compensation is not paid, then payment of the interest rate, by adopting the commercial banks' fixed deposit standard rate, until the compensation payment period, shall additionally be paid.

The Land (Allocation Committee) Regulations, 2001

This regulation established a Land Allocation Committee in every District and Urban Authority as well as in the Ministry Headquarters. Allocation of identified resettlement sites to PAPs would ideally be done by the five District's District Land Allocation Committee.

The Land (Compensation Claims) Regulations, 2001

The Regulation sets out the rights and entitlement for one to claim compensation against the Government or local government or any public institution under the Act. The below categorized groups are entitled to put up such a claim:

(a) Based on Article 5 of the Land Act (hereinafter referred to as "the Act"), land title holder of general land transferred into village land, or protected land; based on Article 22 of the

[16] Extract from and reference to, Working Paper no. 82 –Cities and Fragile States- Land Acquisition for Public Use: Emerging Conflicts and their Socio-Political Implications, Wilbard Kombe, ARDHI University, Oct. 2010
[17] Based on article 25 of the Local Government (District Authorities) Act, 1982, all villages are obligated to set up each Village Council.

Act, land title holder of land, subjected for compulsory land acquisition upon order by the President for the purpose of public use; or based on Article 54 of the Act, land title holder whose land rights are subjected for expiration.

(b) Based on Article 7 of the Act, title holder of awarded customary occupancy rights of the land registered as hazardous land.

(c) Land title holder based on customary occupancy rights, whose subjected land are to be occupied by a third person.

(d) Land title holder awarded or transferred customary occupancy rights, whom have had withdrawn his/her rights based on Article 54 of the Act.

(e) Land title holder of urban area and its surrounding area, whom have had acquired land under order by the President based on Article 60 of the Act.

The Land Management Officer appointed from the Commissioner, or Officer who has competent right, upon implementation of the land acquisition procedure, shall put up a notification at the public bulletin board, and at the same time, notify to all the land title holders, based on below mandated style:

(a) Notify to the land title holders to be subjected for compensation

(b) To request the subjected land title holders to submit a request of compensation

(c) To request the subjected land title holders to attend at the inspection place at the appointed date and time for its assessment

The Land Management Officer or the Officer with the competent power shall conduct the assessment on the compensation amount, required for payment (based on Valuation Form 1 provided by MLHHSD). The Officer in charge shall then draft a compensation payment schedule, and along with the request for compensation form, submit the forms to the Land Compensation Fund (hereinafter referred to as "the Fund") established under the Act.

(a) The Fund based on the compensation schedule drafted by the Land Management Officer or the Officer with the competent right, must decide within 30 days prior to compensation payment schedule, on the relevancy of the payment.

(b) This regulation applies to all the compensation applications and/or claims to the government, local government, public organizations, and public institutions.

(c) Compensation based on Article 156 of the Act, does not apply to non-governmental organizations or individual entitled with public easement rights.

The payment shall be in monetary payment form. Although in principle, compensation should be in monetary payment form, according to decision by the government, compensation can be provided in the form of all the following, or any of its combination.

(a) In the form of land, equivalent in quality, scale of area and potential productivity, to the land to be lost

(b) In the form of building, equivalent in quality, scale of area, and purpose of usage, to the building to be lost

(c) Plants and nursery trees

(d) Crops and basic food

(2) Social Consideration Related Authorities in Tanzania

Historically, the Ministry of Lands was established as the Department of Lands, and later changed into a full ministry, which changed its name according to its functions at that specific

period in time. The current name is Ministry of Lands, Housing and Human Settlements Development encompass core sector Departments which are: Land Administration, Survey and Mapping, Physical Planning and Housing. Core sector units are Registration of Titles, Property Valuation, and District Land and Housing Tribunal. The mandate of the ministry is to facilitate an effective management of land and human settlements development services for the betterment of social and economic well-being of Tanzanian society.

MLHHSD is the sole Ministry in charge of certifying approval of the CRP Report, and if there is no problem with its content, it usually takes merely approximately a week in obtaining approval after submission to the section in charge.

(3) Land Acquisition and Compensation and Resettlement Plan (CRP) Procedure in Tanzania

In reference to the Road Sector Compensation and Resettlement Guideline, 2009, the following steps are taken to fulfill Compensation and Resettlement Plan (CRP) procedural requirements in Tanzania.

Initial (Reconnaissance) Survey

(a) During initial surveys and field trips (on site surveys) undertaken for the EIA Study, discussions should be held with the District administrations to inform about the project and activities, and to ask them what the social impacts of the project are likely to be.
(b) District authorities are often well aware of locations where displacement of people are likely to occur, and can therefore be able to arrange meetings with the ward and village administrations. At the meeting, below items (c) to (g) should be discussed.
(c) The subjected route and its length, possible realignments, municipal rights of way.
(d) The type of improvement works.
(e) Likelihood of persons being displaced or in some way affected by the construction works.
(f) The criteria adopted for eligibility for compensation and resettlement (including possible cut-off-date).
(g) Total project time, from planning to completion, including indication of the time required for the C & R process.

The Ward and Village Administration's Role

(a) Identifying the PAPs and confirming their eligibility.
(b) Identifying and providing land for the relocation of houses and buildings.
(c) Providing assistance to PAPs during the resettlement process and monitoring the progress of the CRP, in particular the status of the resettled persons.
(d) Assisting the formation of a Compensation and Resettlement Implementation Sub-Committee.
(e) To assist the PAP Census and Survey Team, to set up meetings with the local communities.

The PAP Census and Socio-Economic Survey

(a) After alignment has been confirmed, and PAP surveys are about to begin, meetings have to be held again with the District, ward and village administrations to re-affirm above issues and in more detail including below (b) to (d).
(b) Setting of cut-off-date, usually given at the date of completion of the PAP census.
(c) Physical identification of the possible relocation areas within the village or ward.

(d) Prevailing land tenure and transfer systems in the areas to where resettlers may be relocated.

(e) The purpose of the PAP census is to identify each and every project affected party (people as well as private and public institutions). Information collected during the census is typically recorded **Valuation Form 1** provided by the Ministry of Lands.

(f) As a minimum, the following information should be collected during the socio-economic survey, for preparing a **socio-economic profile**; to be able to plan the types of facilities required, as well as the kind of assistance required for the PAPs.

- Household head and Structure
- Household size
- Gender structure
- Age structure
- Ethnicity and religion
- Migratory status
- Occupations of the PAPs
- Income and expenditure
- Education levels
- Health status
- Vulnerable groups; requiring special assistance

Land/ Property Assessment Survey

Information on the property and assets is also collected on Valuation Form 1, including:

(a) Type of property
(b) Details of construction
(c) Accommodation characteristics
(d) Condition of the property
(e) Purpose/use of property
(f) Area of affected buildings/structures (built-up-area)
(g) Types of crops grown
(h) Area of cultivated land affected
(i) Total area of land

Note 1: Though the Form does not explicitly ask for it, information on trees, fences and/or boundary walls, wells, should be included in the survey of assets.
Note 2: The Valuation Form 1 must be signed by the PAP, a representative of the local administration and the land valuer/surveyor.

Consultations with the Authorities and the PAPs

Based on the Road Sector Compensation and Resettlement Guidelines, 2009, consultations with the related Authorities should be held at least in three stages.

The first is during the Initial (Reconnaissance) Survey stage of SIA, also corresponding with the scoping stage of the EIA procedure. Above explained contents of the survey, for example project outline and assumed impacts based on rapid assessment, should be informed to the District, Ward and Village Administrations, as well as for asking in advance, assistance in formation of the Compensation and Resettlement Implementation Sub-Committee, to monitor the CRP process, identification and eligibility, status of the PAPs, to identify and provide the land for the relocation of houses and buildings, and to assistance the PAPs during the resettlement process.

For the PAP Census (and Socio-Economic Survey to be held concurrently) preparation, so that the surveying team will be able to hold the first meetings with the local communities, these

meetings should also be arranged by the local Administrations, upon request from the Implementing Sub-Committee. Since a number of critical issues will be discussed here, it is important that there is good representation from local communities at this meeting.

It is important to keep a consultation log, and to have a record of all the consultations. Minutes of the consultations should therefore be drawn up and signed by the local community leaders present, as well as by an official representative from the District, ward or village.

When the Sub-Committee surveying team undertakes the PAP Census and Socio-Economic Survey, information disclosure to the communities, such as an outline of the project, etc. (details described in page 55 of Road Sector Compensation and Resettlement Guideline) must be informed, and the District, Ward and Village Administrations are committed to assist in the CRP process, also (so that the community will recognize that it is an official process).

After the PAP Census, Socio-Economic Survey, and Socio-Economic Profile are compiled, consultations with local Administration, yet again must be held. The agenda for the consultations shall be: (a) to have the Administrations to approve the list of PAPs, and (b) reconfirm on areas to where affected households can be relocated, (c) confirm that the village, ward, District and town Administrations are aware of their specific responsibilities regarding the monitoring of the compensation and resettlement process (please refer to p. 54 of Road Sector Compensation and Resettlement Guideline for further details), (d) discuss and develop grievance redress mechanism that will be most appropriate for the affected communities, and (e) determine existing social networks and social support systems that can help persons affected by the project, and ways in which support can be given.

(4) JICA's Policies on Resettlement

The key principle of JICA policies on involuntary resettlement is summarized below.

I. Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.
II. When, population displacement is unavoidable, effective measures to minimize the impact and to compensate for losses should be taken.
III. People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels.
IV. Compensation must be based on the full replacement cost as much as possible.
V. Compensation and other kinds of assistance must be provided prior to displacement.
VI. For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. It is desirable that the resettlement action plan include elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A.
VII. In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.
VIII. Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans.
IX. Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

Above principles are complemented by World Bank OP 4.12, since it is stated in JICA Guideline that "JICA confirms that projects do not deviate significantly from the World Bank's Safeguard Policies". Additional key principle based on World Bank OP 4.12 is as follows.

X. Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits.
XI. Eligibility of Benefits include, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying.
XII. Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.
XIII. Provide support for the transition period (between displacement and livelihood restoration.
XIV. Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc.
XV. For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared.

In addition to the above core principles on the JICA policy, it also laid emphasis on a detailed resettlement policy inclusive of all the above points; project specific resettlement plan; institutional framework for implementation; monitoring and evaluation mechanism; time schedule for implementation; and, detailed Financial Plan etc.

(5) Comparison of JICA Guidelines and Tanzanian Related Policies

Harmonization of Tanzanian Compensation and Resettlement policies with international donor policies, such with as the World Bank Operational Policy, O.P. 4.12 on Involuntary Resettlement, of which, basically speaking, the JICA Environmental and Social Consideration Guideline (April 2010 version) follows suit, is gradually in progress, as taken up in the contents of the National Human Resettlement Development Policy, 2000 and TASAF III Resettlement Policy Framework, 2011 (Draft).

Table 13.19 summarizes the abovementioned gap. However, current works are still based on past laws and regulations, from around 2008. Therefore, further revisions are needed.

Table 13.19: Comparison and Gaps of JICA Guidelines and Tanzanian Policies

No.	Resettlement and compensation Aspect	JICA Guidelines (A)	Resettlement Policy of Tanzania (B)	Gaps (C) between JICA (A) and Tanzania (B)	Resettlement Policy under the Project (D)
1.	Avoidance	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. (JICA GL)	Literally the same	None	Adopt both
2.	Impact minimization	When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken. (JICA GL)	Literally the same	None	Adopt both
3.	Livelihoods restoration	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels. (JICA GL).	Landowners, with or without formal legal rights, are entitled to full, fair and prompt compensation. They also get disturbance allowance, transport allowance, accommodation allowance and loss of profit if they were in actual occupation of the acquired property. There are no legal provisions requiring the government to restore livelihoods or to provide assistance towards the restoration of such livelihoods.	Payment of compensation for loss of assets, allowances and other relocation assistance to restore/improve livelihoods.	Full, fair and prompt compensation; as well as disturbance allowance, transport allowance, accommodation allowance and loss of profit should satisfy both JICA GL and Tanzanian requirements.
4.	Calculation of compensation and valuation	Compensation must be based on the full replacement cost as much as possible. (JICA GL)	The basis for assessment any land and unexhausted improvement for purposes of compensation is the market value of such land. The market value is arrived at by the use of comparative method evidenced by actual recent sales of similar properties; or by the use of the income approach, or replacement cost method, where the property is of special nature and not saleable.	Literally none as the Tanzanian approach attempts to achieve full replacement cost by using replacement cost method.	Adopt both

No.	Resettlement and compensation Aspect	JICA Guidelines (A)	Resettlement Policy of Tanzania (B)	Gaps (C) between JICA (A) and Tanzania (B)	Resettlement Policy under the Project (D)
5.	Timing of compensation payments	Compensation and other kinds of assistance must be provided prior to displacement. (JICA GL)	Tanzanian law requires that compensation be full, fair and prompt. "Prompt" means it should be paid within six months, failure to do so results in an interest rate equivalent to the average rate offered by commercial banks on fixed deposits.	In terms of timing, both Tanzanian laws and JICA GL require that compensation be paid promptly. However, the practice in Tanzania, compensation is hardly paid promptly, and delays are not rectified by paying the interest rate as required by the law.	Compensation and other kinds of assistance must be provided prior to displacement.
6.	Requirement for preparation of RAPs	For projects that entail large-scale involuntary resettlement, resettlement action plans (RAPs) must be prepared and made available to the public. (JICA GL)	Literally the same. The Land Act allows displaced persons to fill in forms requiring that their land be valued, and giving their own opinion as to what their assets are worth.	Literally none	Adopt both
7.	Consultation	In preparing a RAP, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance (JICA GL)	Several Tanzanian land laws have provisions insisting on the urgency for consultation with project affected persons.	Literally none	Adopt both
8.		When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people. (JICA GL)	The Land Act allows displaced persons to fill in forms requiring that their land be valued, and giving their own opinion as to what their assets are worth.	Literally none	Adopt both
9.	Participation	Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans. (JICA GL)	As above. And PAPs are to be informed about their options and rights, offered choices/alternatives, but also given chance to choose their preferences.	Literally none	Adopt both
10	Grievance mechanisms	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities. (JICA GL)	In practice the government tries to resolve grievances through public meetings of the affected persons.	None	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

No.	Resettlement and compensation Aspect	JICA Guidelines (A)	Resettlement Policy of Tanzania (B)	Gaps (C) between JICA (A) and Tanzania (B)	Resettlement Policy under the Project (D)
11.	Identification of project affected persons (PAPs)	Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits. (WB OP4.12 Para.6)	The entitlement cut-off date refers to the time when the assessment of persons and their properties in the area is carried out, i.e., the time when the project area has been identified and when the socio-economic study is taking place. Thereafter, no new cases of affected people will be considered. Persons who encroach the area after the socio-economic study (census and valuation) are not eligible for compensation or any form of resettlement assistance.	Literally none	It will be important to set a cut-off date early on in the RAP preparation process in order to avoid speculation and spurious claims. An appropriate cut-off date will possibly be the time when the location of project is identified on the ground and when the baseline survey and socio-economic study is undertaken.
12.	Eligibility criteria	Eligibility of benefits includes: the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying. (WB OP4.12 Para.15)	The *Land Acquisition Act*, the *Land Act* 1999 and the Village *Land Act* 1999 have it clearly that landowners, with or without formal legal rights, are entitled to full, fair and prompt compensation.	There is no gap between JICA GL and Tanzania laws as far as those with formal legal rights and those without formal legal rights but have a claim to land and assets are concerned.	As long as ownership can be proved compensation is payable.
13.	Land-based resettlement	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. (WB OP4.12 Para.11)	Tanzanian laws do not provide for relocation and resettlement. However, there are a few cases where the government has provided both compensation and alternative land, but this has been done at its discretion. In general however, the government feels that it has discharged its duty once compensation is paid, and it is up to the displaced persons to resettle and re-establish themselves elsewhere.	Occasionally, in a discretionary manner, an alternative land is awarded.	Ensure full replacement cost as much as possible; and where possible provide alternative land.

No.	Resettlement and compensation Aspect	JICA Guidelines (A)	Resettlement Policy of Tanzania (B)	Gaps (C) between JICA (A) and Tanzania (B)	Resettlement Policy under the Project (D)
14.	Transition period support	Provide support for the transition period (between displacement and livelihood restoration). (WB OP4.12 Para.6)	Tanzanian law provides for transport allowance for 12 tons of luggage for up to 12 km from the acquired land, provided the displaced person was living on that land. In lieu of housing accommodation allowance is made in the form of rent for 36 months.	Literally none	Ensure full replacement cost as much as possible to the extent that PAPs could withstand challenges of transition period.
15.	Vulnerable groups	Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc. (WB OP4.12 Para.8)	There are no specific provisions that require the government to pay special attention to vulnerable groups or indigenous peoples.	Vulnerable groups are treated as other PAPs.	Particular attention to be paid to the needs of the vulnerable groups.
16.	Abbreviated resettlement plan	For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared. (WB OP4.12 Para.25)	No specific provisions on preparation of RAPs based on the number of people to be involuntarily resettled.	Literally none	RAP to be prepared irrespective of the number of PAPs.

Source: Input by the JICA Study Team, using JICA template for Gap Analysis.

(6) Objectives of the CRP in This Study

As land acquisition and house relocation are unavoidable due to the project, a Compensation and Resettlement Plan (CRP) which corresponds to the Resettlement Action Plan (RAP) in the World Bank (WB) Safeguard Policies (Operational Policy (OP) 4.12) shall be prepared in accordance with the JICA Guidelines for Environmental and Social Considerations.

In Tanzania, valuation of affected land/assets for compensation is carried out after the detailed design stage, when all proposed project activities are approved by the relevant authorities. As it is still in the feasibility study stage, the valuation of affected land/assets is conducted as a **preliminary valuation** at this point. Objectives of the CRP in this study which includes the preliminary valuation are listed as follows. The results of the valuation in this survey need to be updated at the detailed design stage.

The objectives of the CRP in this study are to:

- Clarify compensation policy for this project which fulfills both Tanzanian law and JICA Guidelines/the WB OP 4.12;
- Identify social impacts at the early stage and prepare appropriate mitigation measures, including compensation;
- Obtain consensus of the affected peoples in the early stage and incorporate their views to the mitigation measures; and
- Estimate compensation amount for preparing the project budget.

As the initial step for preparing the CRP, the framework of the CRP is drafted as follows.

13.2.3 Framework of the CRP

(1) Key Principles

The key principles of the compensation and resettlement policy are as flows:

(i) Involuntary resettlement and loss of means of livelihood are to be **avoided** whenever feasible, or **minimized**, by identifying possible alternative project designs that have the least adverse impact on the communities in the project area.

(ii) Where displacement of households is unavoidable, all PAPs (including communities) losing assets, livelihoods, or resources will be **fully compensated** and assisted so that they can improve, or at least restore, their former economic and social conditions.

(iii) Compensation and rehabilitation support will be provided to any PAPs, that is, any person or household or business which on account of project implementation would have his, her or their:

- Standard of living adversely affected;
- Right, title or interest in any house, interest in, or right to use, any land (including premises), agricultural and grazing land, commercial properties, tenancy, or right in annual or perennial crops and trees or any other fixed or moveable assets, acquired or possessed, temporarily or permanently;
- Income earning opportunities, business, occupation, work or place of residence or habitat adversely affected temporarily or permanently; or
- Social and cultural activities and relationships affected or any other losses that may be identified during the process of resettlement planning.

(iv) All affected people will be eligible for compensation and rehabilitation assistance, **irrespective of tenure status**, social or economic standing, and any such factors that may

discriminate against achievement of the objectives outlined above. Lack of legal rights to the assets lost or adversely affected tenure status and social or economic status will not bar the PAPs from entitlements to such compensation and rehabilitation measures or resettlement objectives. All PAPs residing, working, doing business and/or cultivating land within the project impacted areas **as of the date of the latest census** and inventory of lost assets (IOL), are entitled to compensation for their lost assets (land and/or non-land assets), at replacement cost, if available, and restoration of incomes and businesses, and will be provided with rehabilitation measures sufficient to assist them to improve or at least maintain their pre-project living standards, income-earning capacity, and production levels.

(v) PAPs that **lose only part of their physical assets** will not be left with a portion that will be inadequate to sustain their current standard of living. The minimum size of remaining land and structures will be agreed during the resettlement planning process.

(vi) People **temporarily affected** are to be considered PAPs and resettlement plans will address the issue of temporary acquisition.

(vii) Payment for land and/or non-land assets will be based on the principle of **replacement cost**.

(viii) Compensation for PAPs dependent on agricultural activities will be **land-based** wherever possible. Land-based strategies may include the provision of replacement land, ensuring greater security of tenure, and/or upgrading livelihoods of people without legal land titles. If replacement land is not available, other strategies may be built around opportunities for re-training, skill development, wage employment, or self-employment, including access to credit. Solely cash-based compensation will be avoided as an option if possible, as this may not address losses that are not easily quantified, such as access to services and traditional rights, and may eventually lead to those populations being worse off than without the project.

(ix) Replacement lands, if the preferred option of PAPs, should be **within the immediate vicinity** of the affected lands wherever possible and be of **comparable productive capacity and potential**. As a second option, sites should be identified that minimize the social disruption of those affected; such lands should also have access to services and facilities similar to those available in the lands affected.

(x) The resettlement plan must consider the needs of those most **vulnerable** to the adverse impacts of resettlement (including the poor, those without legal title to land, ethnic minorities, women, children, the elderly, and the disabled) and ensure they are considered in resettlement planning and mitigation measures identified. Assistance should be provided to help them improve their socio-economic status.

(xi) PAPs will be **involved** in the process of developing and implementing resettlement plans.

(xii) PAPs and their communities will be **consulted** about the project, the rights and options available to them, proposed mitigation measures for adverse effects, and, to the extent possible, be involved in the decisions that are made concerning their resettlement.

(xiii) **Displacement does not occur before provision of compensation and of other assistance** required for relocation. Sufficient civic infrastructure must be provided at the resettlement site prior to relocation. Acquisition of assets, payment of compensation, and the resettlement and start of the livelihood rehabilitation activities of PAPs, will be completed prior to any construction activities, except when a court of law orders so in expropriation cases. Livelihood restoration measures must also be in place but not necessarily completed prior to construction activities, as these may be ongoing activities.

(xiv) **Organization and administrative arrangements** for the effective preparation and implementation of the resettlement plan will be identified and in place prior to the commencement of the process; this will include the provision of adequate human resources for supervision, consultation, and monitoring of land acquisition and rehabilitation activities.

(xv) Appropriate reporting (including auditing and redress functions) and **monitoring and evaluation mechanisms** will be identified and set in place as part of the resettlement management system.

(2) Principle of Valuation for Compensation

All affected land and non-land assets needs to be valuated for compensation based on the **full replacement cost,** in accordance with the JICA Guidelines/WB OP4.12. "Replacement cost" refers to the entire amount required to acquire the asset, with equal value to the affected asset, at the present time, covering the market value of the asset as well as the cost of any registration and transfer taxes.

Tanzanian laws also stipulate valuation in market value and compensation to include allowances, which cover costs for acquiring alternative assets for land and buildings/structures. However, some disparities with JICA Guidelines/WB OP4.12 are found as follows:

(i) In Tanzania, the market value of buildings/structures is valuated factoring in depreciation, while WB OP4.12 requires valuation **without depreciation**.

(ii) In Tanzania, non-land assets owned by encroachers who does not have legal right to land cannot be compensated while WB OP4.12 recognize them as eligible for the compensation.

(iii) In Tanzania, compensation is paid principally by cash, while JICA Guidelines/WB OP4.12 strongly prefer '**land-based**' replacement, especially when the PAP's livelihood is dependent on land and a large portion of the land (greater than 20%) is affected.

Considering the disparities, the following principles shall be applied for this project to comply with JICA Guidelines/WB OP4.12.

(i) The valuation of non-land assets including buildings/structures owned by PAPs with land right for compensation shall basically follow Tanzanian laws including allowances. In addition, community support will be provided and covered by the loan. The requests on the community support from the affected community are described in Table 13.45.

(ii) The number and status of assets without land which are in the existing ROW and which might be in the proposed ROW are described in Table 13.32 and Table 13.33. Resettlement policy for those assets will be applied as described in Table 13.33.

(iii) Land-for-land replacement shall be prioritized over cash compensation, especially when the PAP's livelihood is based on the land and greater than 20% of the land asset will be affected. If a land-for-land replacement is not feasible, LRP shall be provided to restore the livelihood without the land asset.

For valuation of assets in replacement cost, the following definition of replacement cost by Resettlement Guidelines, 2009, developed by the Ministry of Infrastructure Development, is noted as the basic principle for this project:

- For agricultural land, it is the pre-project or pre-displacement, whichever is higher, market value of land of equal productive potential or use located in the vicinity of the

affected land, plus the cost of preparing the land to levels similar to those of the affected land, plus the cost of any registration and transfer taxes.

- For land in urban areas (residential area), it is the pre-displacement market value of land of equal size and use, with similar or improved public infrastructure facilities and services and located in the vicinity of the affected land, plus the cost of any registration and transfer taxes.
- For houses and other structures, it is the market cost of the materials to build a replacement structure with an area and quality similar to or better than those of the affected structure, or to repair a partially affected structure, plus the cost of transporting building materials to the construction site, plus the cost of any labor and contractors' fees, plus the cost of any registration and transfer taxes.

Regarding the allowances to be included in compensation, the Road Sector Compensation and Resettlement Guidelines are summarized as follows:

- **Disturbance allowance** based on the principle of "the value of the Estate multiplied by the rate of interest prevailing and payable to fixed deposits by commercial banks".
- **Transport allowance,** which is the actual cost of transporting twelve tons of luggage by rail or road within 20 km from the point of displacement.
- **Accommodation allowance** based on market rent for 36 months. These can be determined based on actual rents stated by property owners, although further investigation may be necessary to verify reliability.
- **Loss of rental income restoration**, based on loss of rental income for 36 months rent per tenant.
- **Loss of profits** is calculated on the basis of net monthly profits of the business carried out on the land, for a period of 36 months.
- **Loss of wages**, equivalent to payment in lieu of wages while rebuilding.

In addition, costs associated with the acquisition of the subject land; and any loss or capital expenditure incurred to the development of the subject land must be included in the valuation.

The PAP is eligible to obtain hard copy of the valuation form which will be recorded during the census/valuation survey to confirm his/her valuated properties.

(3) Policy for Vulnerable People

There are no specific provisions that require paying special attention to vulnerable people in Tanzanian laws for compensation and resettlement. However, Road Sector Compensation and Resettlement Guidelines list the following people who require special assistance – physical and moral – during the compensation or relocation process:

- Old people (>65 years)
- Women heads of households
- Widows
- Single mothers
- Orphans
- Physically and mentally challenged
- The infirmed.

(4) Livelihood Restoration Program

There are no legal provisions for restoring livelihoods or providing assistance towards the restoration of such livelihoods in Tanzania. However, considering that the project may severely affect their livelihood in the cases of lost agricultural land or other means of income, the project shall consider preparing the Livelihood Restoration Program (LRP) for those affected people.

The details of the LRP are prepared after the census/socio-economic survey, based on the affected people's needs and requests.

(5) Entitlement Matrix

The entitlements for compensation and rehabilitation assistance for this project are developed and presented in Table 13.11 below:

Table 13.20: Entitlement Matrix

Types of Asset	Types of Impact	Person(s) Affected	Compensation/Entitlement/Benefits
Agricultural land	**Loss of land under cultivation** Greater than 20% of land holding lost	Title holder [Both statutory and customary]	(a) • Land-for-land replacement where feasible, or compensation in cash for the entire landholding according to the PAP's choice. Land-for-land replacement will be in terms of a new parcel of land of equivalent size and productivity with a secure tenure status at an available location which is acceptable to the PAP. • Tax for transferring the land to the PAP, registration fee, and other costs for obtaining the land shall be compensated. • If the livelihood is affected by losing agricultural land, the PAP is entitled to be compensated for the loss or join the Livelihood Restoration Program. • Compensation for land users will be paid through land owners based on their contracts. Land owners/land users are allowed harvesting crops that are within the affected area. The deadline for the harvest shall be discussed and determined with the PAP during the Detailed Design stage.
		Land user (Tenant/lease holder)	(b) • In case the livelihood is affected by losing agricultural land, the PAP is entitled to join the Livelihood Restoration Program.
		Encroacher	(c) • The PAP is allowed harvesting crops that are within the affected area. The deadline for the harvest shall be discussed and determined with the PAP during the Detailed Design stage. • If the livelihood is affected by losing agricultural land, the PAP is entitled to join the Livelihood Restoration Program..
		Vulnerable title holder	(d) Same with (a) plus: • Process for obtaining and registering alternative land shall be assisted. • Assistance for securing the livelihood depending on the PAP's situation.
		Vulnerable land user (Tenant/lease holder)	(e) Same with (b) plus: • Assistance for securing the livelihood depending on the PAP's situation.
	Less than 20% of land holding affected	Title holder [Both statutory and customary]	(f) • Cash compensation for affected land equivalent to replacement value OR alternative land of equivalent size and productivity with a secure tenure status at an available location which is acceptable to the PAPs where feasible. • Tax for transferring the land to the PAP, registration fee, and other costs for obtaining the land shall be compensated. • If the livelihood is affected by losing agricultural land, the PAP is entitled to be compensated for the loss or join the Livelihood Restoration Program. • Compensation for land users will be paid through land owners based on their contracts. Land

Types of Asset	Types of Impact	Person(s) Affected		Compensation/Entitlement/Benefits
				owners/land users are allowed harvesting crops that are within the affected area. The deadline for the harvest shall be discussed and determined with the PAP during the Detailed Design stage.
		Land user (Tenant/lease holder)	(g)	• In case the livelihood is affected by losing agricultural land, the PAP is entitled to join the Livelihood Restoration Program.
		Encroacher	(h)	Same with (c).
		Vulnerable title holder	(i)	Same with (f) plus: • Process for obtaining and registering alternative land shall be assisted. • Assistance for securing the livelihood depending on the PAP's situation.
		Vulnerable land user (Tenant/lease holder)	(j)	Same with (g) plus: • Assistance for securing the livelihood depending on the PAP's situation.
	Loss of land under cultivation by public/ community	Public/community	(k)	• Cash compensation for affected land equivalent to replacement value.
Commercial land	**Loss used for business** The remaining assets become insufficient for business purposes	Title holder	(l)	Same with (a) plus: • Opportunity cost compensation equivalent to 2 months net income based on tax records for previous year (or tax records from comparable business, or estimates) • Compensation for land users will be paid through land owners based on their contracts.
		Land user (Tenant/lease holder)	(m)	• In case the livelihood is affected by losing agricultural land, the PAP is entitled to join the Livelihood Restoration Program.
	The business can be continued by the remaining assets	Title holder	(n)	Same with (f) plus: • Opportunity cost compensation equivalent to 5% of net annual income based on tax records for previous year (or tax records from comparable business, or estimates where such records do not exist). • Compensation for land users will be paid through land owners based on their contracts.
Residential land	**Loss of residential land either partially or entirely**	Title holder	(o)	• Land-for-land replacement or compensation in cash according to the PAP's choice. • Land-for-land replacement shall be of minimum plot of acceptable size under the relevant law(s) or a plot of equivalent size, whichever is larger, in either the community or a nearby resettlement area with adequate physical and social infrastructure systems. • When the affected holding is larger than the relocation plot, cash compensation to cover the

Types of Asset	Types of Impact	Person(s) Affected	Compensation/Entitlement/Benefits	
				difference in value. • Tax for transferring the land to the PAP, registration fee, and other costs for obtaining the land shall be compensated.
		Vulnerable title holder	(p)	Same with (o) plus: • Process for obtaining and registering alternative land shall be assisted.
	Loss of residential land used by public/ community	Public/community	(q)	• Cash compensation for affected land equivalent to replacement value.
The other type of land	Loss of the other type of public land (e.g., forest, pastureland)	Public/community	(r)	• Cash compensation for affected land equivalent to replacement value.
Buildings and structures	Entire structures are affected	Owner	(s)	• Cash compensation for entire structure and other fixed assets with depreciation following Tanzanian laws, including allowances. • Relocation allowances which include those for disturbance, transportation, accommodation and loss of income during relocation.
		Renter	(t)	• Relocation allowances which include those for disturbance, transportation, accommodation and loss of income during relocation.
		Squatter/informal dweller	(u)	▪ The policy described in the Table 13.33 will be applied.
		Vulnerable owner	(v)	Same with (s) plus: • Process for obtaining alternative structure shall be assisted. • Assistance for securing the livelihood depending on the PAP's situation.
	Entire public structures are affected	Public/community	(w)	• Cash compensation for entire structure and other fixed assets, or alternative structure of equal or better size and quality in an available location which is acceptable to the PAP. • Relocation allowances which include those for disturbance, transportation and accommodation.
	Structures are partially affected Remaining structures are	Owner	(x)	• Cash compensation for affected building and other fixed assets • Cash assistance to cover costs of restoration of the remaining structure • Disturbance compensation equivalent to applicable rental costs or time that will take to finish construction work.

Types of Asset	Types of Impact	Person(s) Affected	Compensation/Entitlement/Benefits	
	viable for continued use			
Standing crops	Crops affected by land acquisition or temporary acquisition	Owner of crops	(y)	• PAP allowed harvesting crops if fully matured OR cash compensation of the crops equivalent to the market value for the mature and harvested crop.
Trees	Trees lost	Owner of trees	(z)	• Cash compensation based on type, age and productive value of affected trees.
Cultural properties	Loss of graves, archaeological sites	Owner of graves, Community	(aa)	• Compensation based on the relevant law (Graves (Removal) Act, 1969; Antiquities Act, 1964)

Source: JICA Study Team

(6) Cut-off Date

The "cut-off date" refers to the date prior to which the occupation or use of the project area makes the occupants/users eligible to the entitlement. Establishment of a cut-off date is intended to prevent the influx of ineligible non-residents who might erroneously or inadequately get benefits from the project entitlement.

In Tanzania, the cut-off date is usually set as the date of completion of the census survey which is conducted together with asset valuation for compensation. As the survey in this study is for preliminary valuation without official approval by the Ministry of Lands, Housing and Human Settlements Development (MLHHSD), the official cut-off date is to be set at the time of the official survey after the detailed design stage. In order to prevent an influx of ineligible people to the project area before the official cut-off date, the cooperation of the local governments is to be asked to not to allow any individuals/groups to occupy or use the project area after the date of the completion of the census survey in this study. As the project area is village land under management of village government, the village government has enough power to restrict the land transaction and occupation before the official cut-off date. In this context, the date of the completion of the census survey in this study is recognized as 'preliminary' cut-off date prior to the official cut-off date.

(7) Institution Arrangements for the CRP Implementation

After the detailed design is completed and when the CRP is updated, it is appropriate to set up a Compensation and Resettlement Implementation Committee. The Committee will consist of representatives from RAHCO and local governments, including village leaders as representatives of affected community. Basic responsibilities of the relevant agencies for implementing the CRP are proposed in Table 13.21.

Table 13.21: Responsibilities of Relevant Agencies for Implementing the CRP

Agency		Responsibility
MLHHSD		• Approval of the CRP, including valuation results for compensation. • Ensuring that compensation is paid or resettlement is undertaken as agreed.
Committee	**RAHCO**	• **Overall responsibility for implementing the CRP, including compensation payment and LRP.**
	Regional government	• Facilitating and assisting local governments.
	District government, Ward government, and Village government.	• Consultation with affected people, • Arrangement of plots for resettlement, • Assisting mobilization, • Assisting LRP implementation, • Receiving grievances from affected villagers.
Consultant/NGO* commissioned by RAHCO		• Coordinating with relevant agencies for proceeding with the activities, • Preparing plots/structures for resettlement coordinating with RAHCO and the contractor, • Assisting vulnerable affected people, • Implementation of LRP, • Recording progress of the CRP implementation, • Monitoring and evaluating the process.

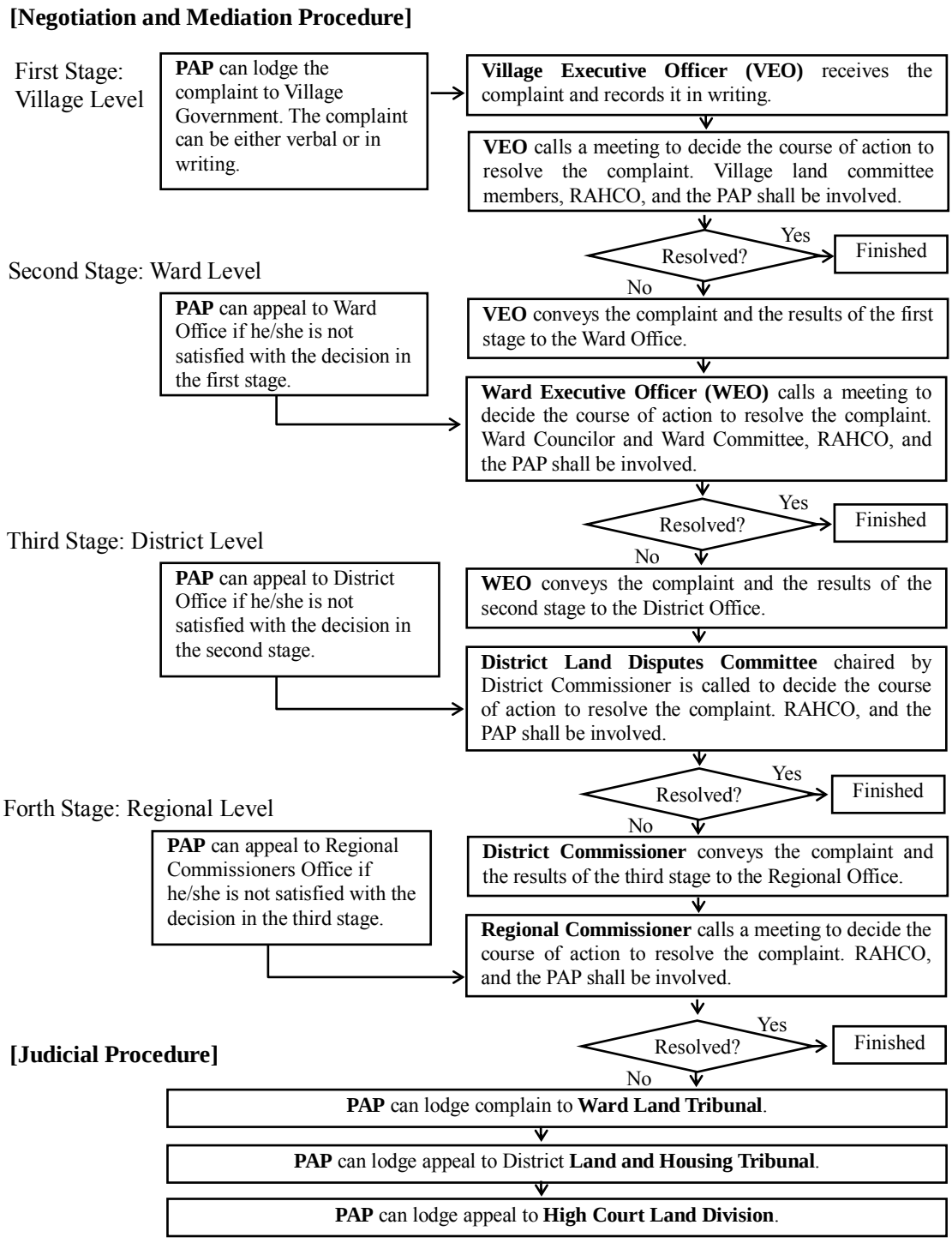
*Qualifications of the Consultant/NGO:
- Experience of implementing CRP which complies with WB OP 4.12 in Tanzania.
- Including the following specialists who have experience in each field: valuer, sociologist, community development expert, and social worker.

Source: JICA Study Team

(8) Grievance Redress Mechanism

In order to redress any grievances during implementation of the CRP, such as regarding compensation amount, entitlement, resettlement places, livelihood restoration and any of the survey results related to the CRP which includes PAP census and socio-economic survey, the following grievance redress mechanism shall be established before implementation. Although Tanzania has judicial procedures for land acquisition and compensation disputes to bring to the Court (Land Act 1999 and Village Land Act 1999), negotiation and mediation procedures before the judicial procedure shall be established to precede this, as the judicial procedure may not be easy to access for most of the affected people.

A flow chart of the grievance redress mechanism is presented in Figure 13.8. At each stage, RAHCO shall be involved as the responsible agency of the CRP implementation.



Source: JICA Study Team

Figure 13.8: Flowchart of Grievance Redress Procedure

13.2.4 Scope of Resettlement Impact

(1) Determination of the Preliminary Cut-off Date

Population census was conducted on 2-9 December, 2015 together with the asset inventory. The date of the completion, 9 December 2015 was identified as the 'preliminary' cut-off date. The

preliminary cut-off date was defined as the date after which an influx of ineligible people and unnecessary development are prevented under the villagers' consensus and observation by the village leaders and the neighbors. After the official project decision, the official cut-off date will be set at the time of the official survey to be conducted based on Tanzanian laws and approved by the Ministry of Lands, Housing and Human Settlements Development (MLHHSD) for determination of the compensation amount to be provided to each PAP. The eligibility will be finalized at the time of the official cut-off date together with the valuation for compensation.

The preliminary cut-off date was agreed in the consultation meetings with PAPs.

(2) Population Census

The results of the population census showed that 201 households with 952 populations would be affected by the project (Table 13.22). As the PAPs are cultivating the land around their houses, most of the PAPs are affected because of their land and less frequently because of the existence of structures (Table 13.23). Eleven illegal land users were identified who cultivated crops or built structures within the existing ROW. In addition to the individual PAPs, village owned public land (village land) is affected at each village.

Table 13.22: Number of Total PAHs and PAPs by Village

Region	Village	Project Affected Households (PAHs)	Project Affected Persons (PAPs)
Morogoro	Munisagara	37	159
	Muzaganza	32	138
	Kikundi	39	199
Dodoma	Kisisi	4	27
	Godegode	28	125
	Gulwe	61	304
Total		201	952

Source: JICA Study Team

Table 13.23: Number of Total PAHs and PAPs by Impact

Type of impact	Project Affected Households (PAHs)			Project Affected Persons (PAPs)		
	Legal	Illegal	Total	Legal	Illegal	Total
Land without structure is affected	87	5	92	505	33	538
Both land and structure are affected	92	6	98	354	28	382
Structure without land is affected	11	0	11	32	0	32
Total	190	11	201	891	61	952

Source: JICA Study Team

(3) Asset Inventory

The measured total affected land area is presented in Table 13.24. Most of the affected land is agricultural land cultivated by individuals (private). The other land type is village land managed by the village government. The village land is basically not used as they are not suitable for either cultivation or housing due to the topographic conditions.

The number of affected structures is presented in Table 13.25. In total, 317 structures are affected. Out of them, 150 were identified as houses. Although the structures need to be relocated, it is difficult to identify whether the PAP needs to move out from their land to another area, because they may be able to stay within their plot just by shifting their house location. The

necessity and the preference of the moving shall be decided in the detailed design stage after the project area is demarcated physically.

Table 13.24: Affected Land Area

Land type	Area (m^2)
Private used land (agricultural land with/without housing)	1,538,508
Village land (bare land/forest)	659,338
Total	2,197,846

Source: JICA Study Team

Table 13.25: Number of Affected Structures

Type of structures		Number
House	Traditional	135
	Modern	10
	Mixed modern & ultra-modern	5
Outer structures	Outer kitchen	53
	Outer toilet	59
	Warehouse/animal shed	48
Public structures	Grain storage	1
	Grave yards	6
Total		317

Traditional: grass/fronds roof, mud/stick walls, mud floor; Modern: corrugated iron sheets, burnt bricks, cement floor; Ultra modern: tiled roof, cement blocks, tiled floor

Source: JICA Study Team

House

House

Community grain storage

Source: JICA Study Team

Figure 13.9: Examples of the Affected Structures

(4) Socio-Economic Conditions of the Affected Households

In the project area, various ethnic groups are living together, especially in Kilosa District, while the Gogo is dominant in Mpwapwa District. The Gogo is predominantly known as Christian. The lifestyles of each tribe are not specified and Kiswahili is commonly spoken between and within the tribes.

From the results of the interview surveys with the affected households, 15% of the affected household heads were found to be illiterate who could neither read nor write Kiswahili. The number of household members was varied, ranging one to twenty per household (Table 13.26). Almost all of the households are small-scale farming households (Table 13.27) and the income of the majority of them is below 5 million TZS/year (equivalent to 2,294 USD/year). Comparing with the national poverty line, USD 1/capita/day, the averaged affected household's condition is close to be the poverty line.

Table 13.26: Number of Affected Households by Number of Household Members

	Number of household members															
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**16**	**20**
Land affected household	19	13	25	30	26	29	10	9	5	7	4	1	1	1	1	1
Structure affected household	10	8	7	21	10	13	2	3	3	4	2	1	0	0	1	0

Source: JICA Study Team

Table 13.27: Number of Affected Households by Occupation

	Occupation					
	Farmer	**Livestock keeper**	**Trading**	**Agricultural officer**	**Fisherman/ woman**	**Artisan**
Land affected household	190	-	2	2	1	2
Structure affected household	107	2	-	-	-	-

Source: JICA Study Team

Table 13.28: Number of Affected Households by Income

	Household Income (TZS/year)				
	100,000- 1,000,000	**1,000,001- 5,000,000**	**5,000,001- 10,000,000**	**10,000,001- 20,000,000**	**20,000,001- 80,000,000.00**
Land affected household	68	85	14	6	1
Structure affected household	23	52	4	16	3

Source: JICA Study Team

(5) Vulnerable Affected Households

Through the interview survey, vulnerable persons listed in Table 13.29 were identified in the affected households.

Table 13.29: Number of Vulnerable Affected Persons

Vulnerability	**Frequency**
Disease /Sick	4
Elderly	39
Orphan	2
Widow	5
Women household heads	47
Total	**97**

Source: JICA Study Team

(6) Tenants

Five affected tenants of land are identified through this survey. Information of those tenants are summarized in Table 13.30.

Table 13.30: Information of Affected Land Tenants

Tenant	Village	Description
1.	Gulwe	Small scale peasant, a tenant on the father's land; has another small farm away.
2.	Godegode	Rents a land on which he grows seasonal crops (maize, sunflower). Has another plot in the nearby village
3.	Kikundi	A rich peasant living in Dar es Salaam; rents land at Kikundi for irrigation farming for commercial reasons. Has other source of income.
4.	Mzaganza	Rents on land of his father in law on which he grows maize. Does not have another plot.
5.		Rents a plot on which he grows seasonal crops. Has other source of income.

Source: JICA Study Team

13.2.5 Compensation Plan

(1) Compensation for the Loss

The affected people are small scale farmers who are based on their farm land. Although the percentages of the affected area of each owner's land were not quantified through this survey, 136 landowners out of 172 respondents answered that they did not have alternative plots other than the land in the project area. In such cases, JICA's compensation policy generally leads to land-for-land compensation by providing alternative land instead of cash compensation. However, a problem in this area is the difficulty to find alternative spare land due to the mountainous topographic conditions. As many people were aware of this situation, the majority of the affected landowners replied that they prefer cash compensation rather than in-kind compensation because the area is precarious; namely, hilly, periodically affected by floods, dry and inaccessible (Table 13.31).

Considering this situation, cash compensation is deemed to be suitable for those who prefer cash compensation in this project, given that they will receive livelihood support from the Livelihood Restoration Program (LRP).

Table 13.31: The PAP's Preference on Compensation Form

Compensation form	Number of respondents
Cash	108 (61%)
In-kind (land)	27 (15%)
Both cash and in-kind	42 (24%)
Total respondents	177

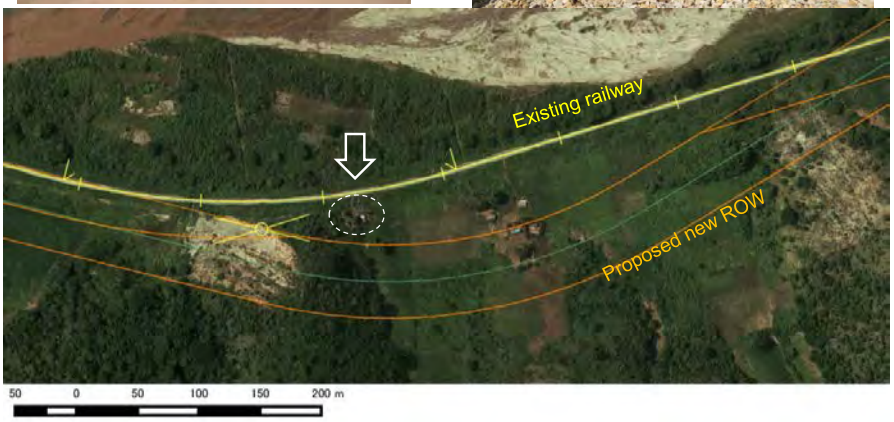
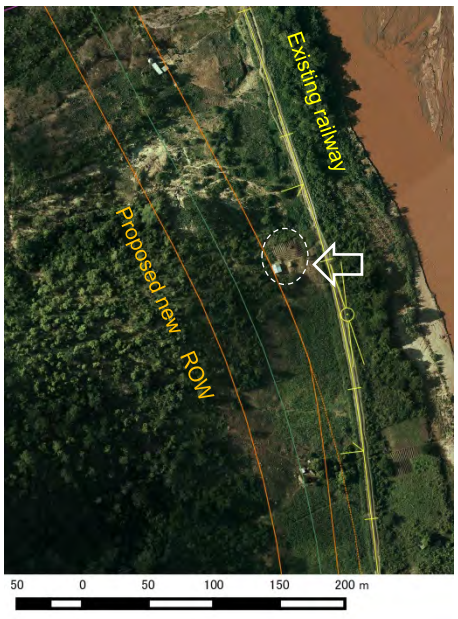
Source: JICA Study Team

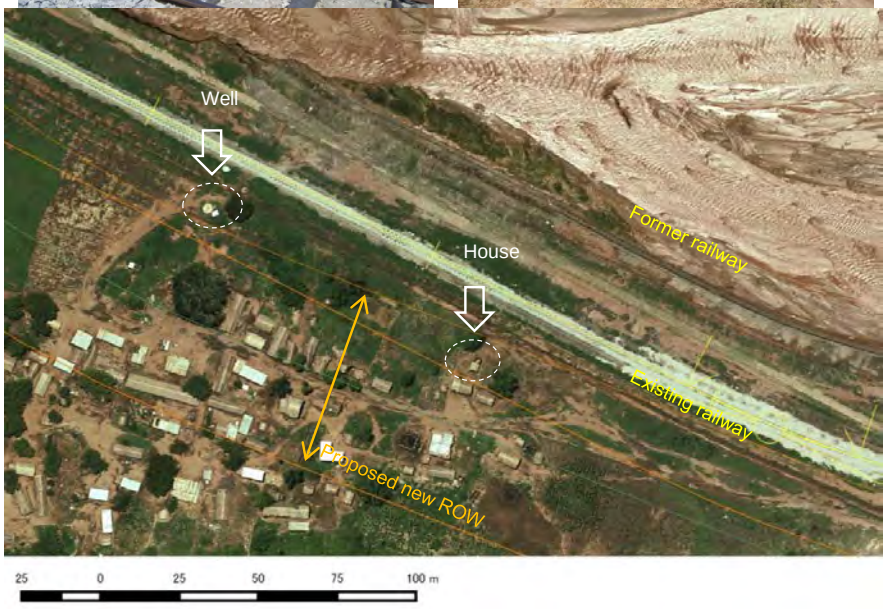
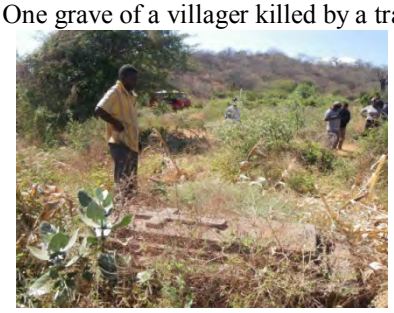
(2) Compensation for Assets in the Existing Right of Way (ROW)

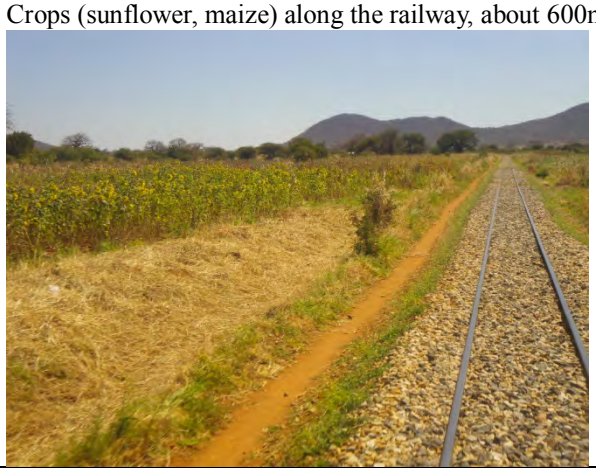
The area within the existing ROW, thirty meters width from the center line of the railway track, is owned by RAHCO and any erection of structures and execution of works are forbidden without permission. Considering that WB OP4.12 recognizes those persons who encroaches the ROW as eligible for the compensation while Tanzanian law does not, the status of each affected asset in the existing ROW are investigated. The results and the resettlement policy for each case are presented in Table 13.32 and Table 13.33.

Table 13.32: Affected Assets in the Existing ROW

Survey date: 14-16 June, 2016

No.	Location	Type of Asset and the Condition
1	Km 302 Munisagara Rerouting section (2)-600m	Three structures. Not in the new ROW.   
2	Km 305 Munisagara Rerouting section (2)-3800m	Two structures. Not in the new ROW.  

No.	Location	Type of Asset and the Condition
3,4	Km 315 Kikundi Rerouting section (3) - 2500m	One house and one well. The well is not in the new ROW, while the house is.   
5	Km 371 Gulwe Rerouting section (9)-8800m	【Just outside of the existing ROW】 One grave of a villager killed by a train accident in 2004.  

No.	Location	Type of Asset and the Condition
6	Km 305 Munisagara Rerouting section (2)-3600m	Crops (sunflower, maize) along the railway, about 200m. 
7	Km 371 Gulwe Rerouting section (9)-8200-8800m	Crops (sunflower, maize) along the railway, about 600m. 

Source: JICA Study Team

Table 13.33: Resettlement Policy on Assets without Land in the Existing ROW

No.[*1]		Type of Asset	Condition			Resettlement Policy
			Within the Existing ROW? (30m from the existing rail)	**Recognized as Encroacher?**	**Within the New ROW?**	
1		Three structures	**Yes**	**Yes**	No	No resettlement
2[*2]	2-1	Two structures	**Yes**	**Yes**	No	No resettlement
	2-2	One structure	No	No	No (To be scrutinized in the detailed design stage.)	No resettlement (same policy in case the structure will be within the new ROW)
3		One structure	**Yes**	No	**Yes**	It will be compensated by the Tanzanian Government because the structure is in the existing ROW due to the relocation of the existing railway.
4		Well	**Yes**	No	No	It needs to be relocated because it will be separated from the community. Development of a new well at the resettlement site has already been planned.
5		Grave	No	No	**Yes**	It will be compensated by the Tanzanian Government
6		Crop	**Yes**	**Yes**	**Yes**	The PAP is allowed harvesting crops that are within the affected area. The deadline for the harvest shall be discussed and determined with the PAP during the Detailed Design stage.
7		Crop	**Yes**	**Yes**	**Yes**	The PAP is allowed harvesting crops that are within the affected area. The deadline for the harvest shall be discussed and determined with the PAP during the Detailed Design stage.

*1 The number is consistent with Table 13.32.
*2 The three structures are owned by one household and the structure 2-2 is their residence. In case the structure 2-2 would be resettled, JICA thinks that the other two structures 2-1 should be resettled together. However, the other two structures cannot be compensated under the Tanzanian laws and regulations because they are in the existing ROW. Therefore, RAHCO and JICA came to an understanding that it might be better to have an option for the PAPs that the three structures can be left there even though the residence might cross the new ROW because the construction activities can be implemented not affecting the structures. RAHCO pointed out that in case the structures would be left there, the PAPs shall not make any new development with the proposed ROW. The decision on this matter would be made in close consultation with the PAPs during the Detailed Design.
Source: JICA Study Team

(3) Livelihood Restoration Program

During the socio-economic interview survey, it was asked to the PAPs what kind of assistance they prefer for compensating their affected livelihood. As summarized in Table 13.34, 67 out of 171 respondents answered they preferred agricultural land-based assistance, such as training on modern farming, while the other 104 preferred non-land-based assistance, such as trading and enterprising. The latter preference is basically from the younger generations who seem to be unsatisfied by the livelihood conditions in the project area.

According to the Kilosa District Office, the District government has experiences of providing training on agriculture, beekeeping, poultry, entrepreneurship, and savings/loans in other areas in the District. That training and implementation are deemed to be applicable to the affected area for this project with the cooperation of the Districts. The details shall be discussed in the detailed design stage.

Table 13.34: Summary of the PAP's Livelihood Restoration Preference

Livelihood Restoration Preference	Number of respondents	Description of the respondents
(1) Agricultural production based assistance (land based): training on modern/scientific farming, access to credits and lucrative markets.	67	Mainly aged PAPs (50 years and above), PAPs who have extra land either within the same village or in another village PAPs who preferred land for land compensation, Vulnerable households headed by the older persons.
(2) Non-farm based assistance (non-land based): training on small enterprising especially in agricultural products; access to credits, practical skills training, e.g., carpentry, masonry, tailoring, etc.	104	Mainly persons of young age, in their 20s to early 40s.

Source: JICA Study Team

(4) Resettlement Site

The railway rerouting was planned to avoid residential area as much as possible; however, it is not avoidable that the section at Km315-316 affects a community in Kikundi Village. As there is not enough spare land for relocating the affected residents, it was requested by the villagers to develop a resettlement site at the mountain slope within the village (Figure 13.10).

The resettlement site is planned to be about one hectare, which is equivalent to the area of the affected community. The land belongs to the village and currently not used for any purpose, and is covered by vegetation (Figure 13.11). Environmental and social impacts are hardly expected for the development as it is not a primary forest and it is easily accessible from the existing residential area. As shown in Table 13.35, available infrastructure in the new resettlement site will be the same with the current settlement.

The construction outline and the settlement procedure are planned as follows:

(Construction)

- After clearing the vegetation, the slope is leveled by excavating and spreading the excavated soil.

- The leveled land is compacted and rainwater drainages are installed.
- One well with hand pump is installed.
- The construction cost is shown in Table 13.36.

(Settlement)
- After identification of the households to be relocated to the site, the procedure for selecting plots are discussed and confirmed among the PAPs; for example, selection by lottery.
- The PAPs build their structure at the allocated plots by themselves and move to.
- The District Officers or assigned NGO staff assists the procedure coordinating with the village government if necessary.

Expected schedule of the resettlement is presented in Table 13.37.

Table 13.35: Comparison of the Infrastructure in the Current Settlement and the New Resettlement Site

Infrastructure	Current Affected Settlement	Plan of the New Resettlement Site
Area	About one hectare	Planned to be one hectare.
Water source	A communal well with hand pump	A new communal well with hand pump is installed.
Rainwater drainage	(none)	Rainwater drainages are installed.
Road	A communal road	A communal road is planned in the area to connect with the existing .residential area adjacent to the site.

Source: JICA Study Team

Table 13.36: Construction Cost of the Resettlement Site Development

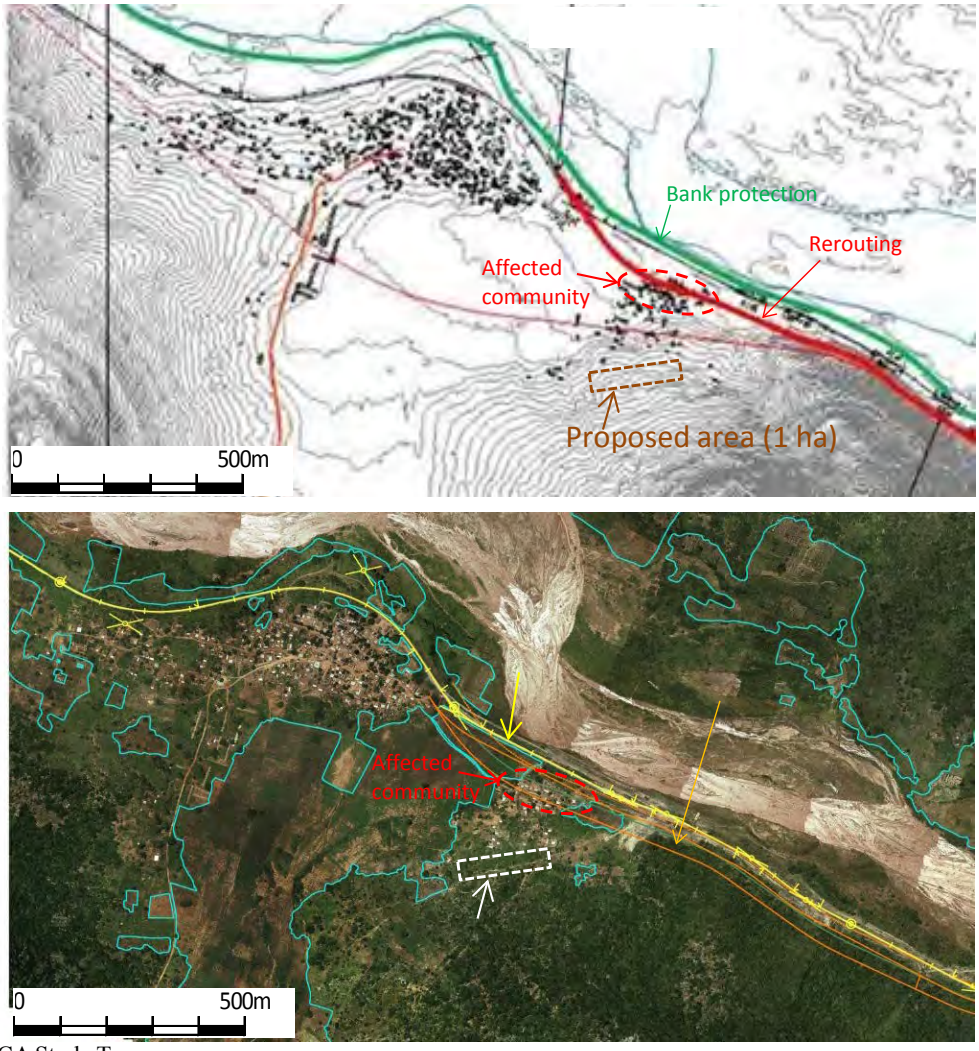
Items	TZS
Land development (including drainages)	309,705,732
Development of a well	30,508,317
Total	340,214,049

Source: JICA Study Team

Table 13.37: Expected Schedule of the Site Preparation and Resettlement

Year	2017				2018									
Month	9	10	11	12	1	2	3	4	5	6	7	8	9	10
Detailed Design of the Site and Cordination with the Village Government														
Selecting Construction Contractor														
Leveling the resettlement site														
Installing a well with hand pump														
Construction of houses and relocation														

Source: JICA Study Team



Source: JICA Study Team

Figure 13.10: Location of the Affected Community and the Proposed Resettlement Site

Source: JICA Study Team

Figure 13.11: Condition of the Proposed Resettlement Site

13.2.6 Implementation Schedule

Expected implementation schedule of the CRP is presented in Table 13.38. As the CRP prepared in this Study is recognized as the Preliminary CRP with a preliminary valuation, it needs to be updated together with the implementation of official asset valuation. The survey will be commenced after the project area is demarcated on the ground based on the detailed design.

Table 13.38: Implementation Schedule of the CRP

	Year	2017				2018									
	Month	9	10	11	12	1	2	3	4	5	6	7	8	9	10
1. Demarcation of the project area															
2. Compensation Process															
2.1 Consultation with PAPs/Establishment of Committee															
2.2 Census and Socio-Economic Survey					official cut-off-date										
2.3 Valuation (field survey and filling valuation form)															
2.4 Preparing the Report (CRP/Valuation Report)															
2.5 Approval of the CRP/Valuation Report by the Ministry of Land including coordination with local government															
2.6 Compensation Payment															
2.7 Handling Greivances															
3. Preparing Resettlement Site and LRP															
3.1 Detailed Design of the Resettlement Site and Cordination with the Village Government															
3.2 Selecting Construction Contractor for the Resettlement Site															
3.3 Construction of the Resettlement Site															
3.4 Preparing Implementation Plan of the LRP															
4. Relocation/LRP/Monitoring															

Source: JICA Study Team

13.2.7 Cost and Budget

The estimated cost for implementing the CRP is presented in Table 13.39. The budgetary responsibility is under the project proponent, RAHCO.

Table 13.39: Cost for Implementing the CRP

	Resettlement Activity	Cost (TZS)	Contingency (TZS)	Total (TZS)
1	Compensation costs for Crops and Trees	14,415,000	1,441,500	15,856,500
2	Compensation costs for Land	439,569,200	43,956,920	483,526,120
3	Compensation costs for Housing Structures	484,098,731	48,409,873	532,508,604
4	Transport allowance	3,300,000	330,000	3,630,000
5.	Disturbance allowance	46,904,147	4,690,415	51,594,562
6.	Accommodation allowance	76,946,000	7,694,600	84,640,600
7.	Resettlement Assistance	100,000,000	10,000,000	110,000,000
8.	Community support	217,844,429	21,784,443	239,628,872
9.	Livelihood Restoration Program	1,200,000,000	120,000,000	1,320,000,000
10.	Grievance handling	12,000,000	1,200,000	13,200,000
11.	Management & administration	80,000,000	8,000,000	88,000,000
12	Monitoring & evaluation	200,000,000	20,000,000	220,000,000
	Total			3,162,585,258

Note: contingency is estimated as 10% of the cost.
Source: JICA Study Team

13.2.8 Monitoring Plan

RAHCO shall take full responsibility for conducting regular monitoring of the CRP implementation. Indicators of the monitoring are listed in Table 13.40. The monitoring shall be continued until the project activities are completed.

In addition to the internal monitoring, RAHCO shall engage an independent agency to undertake the external monitoring. TOR for the external monitoring is presented in Table 13.41.

Table 13.40: Monitoring Indicators

Items	Indicators
Progress of compensation and relocation	− Number of compensation payments − Number of prepared relocation plots − Number of structures constructed − Number of PAPs relocated − Number of vulnerable people assisted
Procedure	− Institutional establishment (internal unit in RAHCO and CRP Committee) − Grievance mechanism − Consultation meetings with PAPs
Grievance	− Logged grievance and the solutions
Livelihood Restoration Program	− Number of participants/beneficiaries − Implementation of the activates
Socio-economic conditions	− Income change between before and after the relocation − Accessibility to public infrastructure/services

Source: JICA Study Team

Table 13.41: TOR for External Monitoring

A. Project Background
Reli Assets Holding Company (RAHCO) has intended to improve the section between Kilosa and Gulwe of the Central Railway Line which is suffering from the frequent damages caused by the floods. To implement the improvemet, the Project will require land acquisition and involuntary resettlement for rerouting the existing railway with the length of 25km which will affect households according to the land acquisition and resettlement action plan. RAHCO will implement land acquisition and resettlement activities following the updated RAP to meet the requirements of lenders. RAHCO seeks to engage an independent External Monitoring Agency (EMA) to undertake monitoring and evaluation of the RAP implementation process.

B. Key Objective of External Monitoring
Monitoring is an integral part of the resettlement process. The External Monitoring Agency (EMA) will review implementation process as per set policies and criteria in the RAPs report, assess the achievement of resettlement objectives, the changes in living standards and livelihoods, restoration of the economic and social base of the project affected people, the effectiveness, impact and sustainability of entitlements, the need for further mitigation measures if any, and to learn strategic lessons for future policy formulation and planning.

C. Scope of Work
The scope of work of the External Monitoring Agency (EMA) will include the following activities:-

1. To develop specific monitoring indicators for undertaking monitoring of the Resettlement Action Plans (RAPs).
2. To review and verify the progress in land acquisition/resettlement implementation of the Project.
3. Identify the strengths and weaknesses of the land acquisition/resettlement objectives and

approaches as well as implementation strategies.

4. Evaluate and assess the adequacy of compensation given to the APs and the livelihood opportunities and incomes as well as the quality of life of APs of project-induced changes.
5. Identification of the categories of impacts and evaluation of the quality and timeliness of delivering entitlements (compensation and rehabilitation measures) for each category and how the entitlements were used and their impacts and adequacy to meet the specified objectives of the Plans. The quality and timeliness of delivering entitlements, and the sufficiency of entitlements as per approved entitlement matrix.
6. Provide a summary of whether involuntary resettlement was implemented (a) in accordance with the RAPs, and (b) in accordance with the stated policy.
7. To review the quality and suitability of the relocation sites from the perspective of the both affected and host communities.
8. Verify expenditure & adequacy of budget for resettlement activities.
9. To analyze the pre-and post-project socio-economic conditions of the affected people. The methodology for assessment should be very explicit, noting any qualifications.
10. Review results of internal monitoring and verify claims through sampling check at the field level to assess whether land acquisition/resettlement objectives have been generally met. Involve the affected people and community groups in assessing the impacts of land acquisition for monitoring and evaluation purposes.
11. To monitor and assess the adequacy and effectiveness of the consultative process with affected people, particularly those vulnerable, including the adequacy and effectiveness of grievance procedures and legal redress available to the affected parties, and dissemination of information about these.
12. Identify, quantify, and qualify the types of conflicts and grievances reported and resolved and the consultation and participation procedures.
13. Describe any outstanding actions that are required to bring the resettlement activities in line with the policy. Describe further mitigation measures needed to meet the needs of any affected person or families judged and/or perceiving themselves to be worse off as a result of the Project. Provide a timetable and define budget requirements for these supplementary mitigation measures.
14. Describe any lessons learned that might be useful in developing the new national resettlement policy and legal/institutional framework for involuntary resettlement.
15. Verifying internal reports by field-checking delivery of compensation to PAPs, including the levels and timing of the compensation; readjustment of land; preparation and adequacy of resettlement sites; construction of houses; provision of employment, the adequacy of the employment, and income levels; training; special assistance for vulnerable groups; repair, relocation, or replacement of infrastructure; relocation of enterprises, compensation, and adequacy of the compensation; and transition allowances;
16. Interviewing a random sample of PAPs in open-ended discussions, to assess their knowledge and concerns about the resettlement process, their entitlements, and the rehabilitation measures;
17. Observing the functioning of the resettlement operation at all levels, to assess its effectiveness and compliance with the RAP;
18. Checking the type of grievance issues and the functioning of grievance redress mechanisms by reviewing the processing of appeals at all levels and interviewing aggrieved PAPs:
19. Advising RAHCO regarding possible improvements in the implementation of the RAP.

D. Methodology and Approach

The general approach to be used is to monitor activities and evaluate impacts ensuring participation of all stakeholders especially women and vulnerable groups. Monitoring tools should include both quantitative and qualitative methods. The external monitor should reach out to cover:

- PAPs who had property, assets, incomes and activities severely affected by Project works and had to relocate either to resettlement sites or who chose to self-relocate, or whosesource of income was severely affected.
- PAPs who had property, assets, incomes and activities marginally affected by Project works and did not have to relocate;

- PAPs by off-site project activities by contractors and sub-contractors, including employment, use of land for contractor's camps, pollution, public health etc.;

Supplemented by Focused Group Discussions (FGD) which would allow the monitors to consult arrangement of stakeholders (local government, resettlement field staff, NGOs, community leaders, and most importantly, APs), community public meetings: Open public meetings at resettlement sites to elicit information about performance of various resettlement activities.

E. Other Stakeholders and their Responsibility

1. Responsibility of the executing Agencies (EAs)

The EAs through their Project Implementation Unit (PIU) will ensure timely supply of background references, data and other necessary information to the EMA and provide access to project sites and relevant places to let the EMA implement external monitoring activity.

2. Responsibility of the Implementing organization(s)

Organizations that will assist EAs in implementing land acquisition and resettlement activities will provide information required by the EMA at site and at their Project Offices. It will on behalf of EAs ensure free access to project sites and related areas and the database on land acquisition and resettlement activities.

F. Team Composition of the External Monitoring Agency

The EMA should focus on Data collection, processing and analysis to pin point problem areas and weaknesses, and to light on deserving measures to achieve the objectives on schedule are the special interest of the subject. Thus, there is a need for a dedicated monitoring team with adequate gender representation. Further, it is essential that the central team or field level coordinators responsible for monitoring, are skilled and trained in data base management, interview technique, and social and economic/finance. Keeping in mind these criteria, the team should ideally include:

Position/expertise	Qualification and experience
1. Team Leader/ Implementation Specialist	Master in social science with 10-year working experience in social impact assessment including census and socioeconomic surveys, stakeholders' consultation, and analyzing social impacts to identify mitigation measures in compliance with social safeguard policies of the international development financing institutions and national legislations. Experience of preparing resettlement framework and action plans and implementation of plans for externally financed projects is essential.
2. Social Impact Specialist	Master in social science with 5-year working experience in social impact assessment including census and socioeconomic surveys, stakeholders' consultation, and analyzing social impacts to identify mitigation measures in compliance with social safeguard policies of the international development financing institutions and national legislations. Experience of preparing resettlement framework and action plans and implementation of plans for externally financed projects is essential.
3. Data Analyst	Graduate with working experience and knowledge of software such as SPSS (Statistical Package for the Social Sciences)

G.Time Frame and Reporting

The EMA will be employed over a period of 3 years with intermittent inputs from the professional team to continue 2 years after completion of the RAP implementation.

Quarterly and annual monitoring reports should be submitted to RAHCO with copies to JICA. An evaluation report at the end of the project should be submitted to RAHCO and concerned parties with critical analysis of the achievement of the program and performance of EAs and implementing organizations.

The external monitors will provide monitoring and evaluation report covering the following aspects:

- Whether the resettlement activities have been completed as planned and budgeted;
- The extent to which the specific objectives and the expected outcomes/results havebeen achieved and the factors affecting their achievement or non-achievement;

- The extent to which the overall objective of the Resettlement Plan, pre project orimproved social and economic status, livelihood status, have been achieved and thereasons for achievement / non achievement;
- Major areas of improvement and key risk factors;
- Major lessons learnt; and
- Recommendations.

Formats for collection and presentation of monitoring data will be designed in consultation with EAs.

H. Qualification of the External Monitoring Agency
The EMA will have at least 10 years of experience in resettlement policy analysis and implementation of resettlement plans. Further, work experience and familiarity with all aspects of resettlement operations would be desirable. NGOs, Consulting Firms or University Departments (consultant organization) having requisite capacity and experience on the same can qualify for services

Interested agencies should submit a proposal to RAHCO with a brief statement of the approach, methodology, and relevant information concerning previous experience on monitoring of resettlement implementation and preparation of reports.

The profile of its agency, along with full signed CVs of the team to be engaged, must be submitted along with the technical proposal.

I. Budget and Logistics
The budget should include all expenses such as staff salary, office accommodation, training, computer/software, transport, field expenses and other logistics necessary for field activities, data collection, processing and analysis for monitoring and evaluation work. Additional expense claims whatsoever outside the proposed and negotiated budget will not be entertained. VAT, Income Tax and other charges admissible will be deducted at source as per Government laws.

Source: JICA Study Team

13.2.9 Consultation Meetings

(1) Meetings in December 2015

A series of consultation meetings with the PAPs were held at six villages to be directly affected by the land acquisition for the railway rerouting and the river-training works (Table 13.42). The purpose of the meeting was to disclose the proposed project location, identify the affected individuals, and obtain their opinion/consensus on the compensation policies. The meeting was called by the village leaders thorough the network among the villagers.

Agenda and the points of explanation in the meetings are listed below:

1. Opening remarks/self-introduction of the survey team
2. Purpose and meeting objective
   - ✓ It was explained that the survey is preliminary survey as a part of the feasibility study and the official valuation for compensation will be conducted after the official decision of the project.
3. Project information
   - ✓ The place which needs land acquisition was explained using project maps and clarification with attendees.
   - ✓ Draft plan of the temporary construction access road was also explained.
4. Ordinal compensation process based on the Tanzanian laws
   - ✓ District valuers explained the process of asset valuation and compensation as well as allowances in accordance with the Tanzanian laws.
5. Compensation policies considering JICA's policies

- ✓ It was explained that the JICA's compensation policies would also be applied, combining with the Tanzanian laws, to minimize the social impacts.
- ✓ Entitlement Matrix (in Swahili) which shows compensation policies for this project was explained and provided to the village leaders.
- ✓ It was explained that Livelihood Restoration Program (LRP) is provided to the affected people and the contents would be decided based on the people's requirements.
- ✓ Although it cannot be the official cut-off-date to restrict the land use and the transaction, it was explained that unnecessary development for being compensated should be prevented under observation by the village leaders and the villagers after the completion of the survey.

6. Identification of the affected people
   - ✓ At the end of the meeting, affected people claimed to be identified under the witness of the other villagers.

The participants raised questions on the compensation policies and the details of the procedures, which were answered by the consultants and RAHCO (Table 13.43). No dissenting voice or objection against the project or the compensation policies was identified through the meetings.

Table 13.42: Consultation Meetings with the PAPs (1–7 December 2015)

Date	Village name (Ward and District name)	Number of participants	
		Total	(Women)
1Dec.	Munisagara (Msanze, Kilosa)	130	(32)
	Mzaganza (Kidete, Kilosa)	30	(7)
2 Dec.	Kikundi (Kidete, Kilosa)	173	(74)
6 Dec.	Kisisi (Godegode, Mpwapwa)	116	(74)
	Godegode (Godegode, Mpwapwa)	181	(54)
7 Dec.	Gulwe (Gulwe, Mpwapwa)	138	(23)

Source: JICA Study Team

Table 13.43: Major Comments and Response in the Meetings (1–7 December 2015)

Subjects	Raised Issues		Response
Project implementation /general frameworks	1)	When will the construction activities be commenced? (Munisagara)	After completion of the feasibility study and the compensation.
	2)	PAPs to be informed early in advance before project implementation to avoid further use of the project area.(Mzaganza)	PAPs will be informed when the official valuation is carried out.
	3)	Who is going to compensate? The government of Tanzania or Japan? (Munisagara)	The government of Japan funds for the project. Compensation will be paid by the government of Tanzania.
	4)	Progress of each step of the project should be informed from time to time after the meeting. (Mzaganza)	Noted.
Compensation / valuation	5)	Does RAHCO commit compensating for encroachers? (Munisagara)	RAHCO is requested to comply with JICA's policy to compensate for encroachers.
	6)	Will it be compensated if only half of the structure is affected? (Munisagara)	Yes. All affected asset will be compensated.
	7)	Is it possible to continue construction of the house if it is already under construction? (Kikundi, Godegode)	Yes, because it is still preliminary valuation stage.

Subjects	Raised Issues	Response
	8) Many people are lack of legal documents of land ownership. Is it possible to be compensated? (Kisisi)	Land ownership is recognized by inheritance, traditional and legal ownership.
	9) What about if graves are affected? (Kikundi, Godegode, Gulwe)	There is a law for compensating graves.
	10) What about if watering place is affected? (Kikundi)	If the land belongs to the village, the village will be compensated.
	11) Will natural tree be compensated? (Kisisi)	If it has value, it will be compensated.
	12) Compensation should be paid fairly, promptly and timely. (Munisagara) 13) The government should fairly compensate to all affected persons in order to maintain their living standard together with their families (Mzaganza)	It will be made in accordance with law.
	14) Assure of the compensation because the Tanzanian system is so prolonged. (Kisisi)	RAP committee team will be established for assurance.
	15) Construction should be started after compensation and resettlement (Mzaganza)	It will in accordance with both Tanzanian law and JICA's policy.
	16) What can we do if we don't satisfy the compensation payment? (Mzaganza, Kikundi, Gulwe)	You can appeal through the grievance mechanism.
	17) Valuation schedule should be informed in advance to the PAPs. (Munisagara)	Noted.

Source: JICA Study Team

(2) Meetings in June 2016

In order to provide a feedback of the results of the CRP, another series of consultation meetings with the PAPs were held at six affected villages (Table 13.44). The main purpose of the meetings was to confirm the compensation policy and finalize their consensus. The participants were the PAPs called by the village leaders, and the word officers.

Agenda and the points of explanation in the meetings are listed below:

1. Introduction
   - ✓ It was announced that the preliminary CRP has been completed in this study.
   - ✓ It was informed that the final CRP would be taken place, expected to be in 2017.
2. Compensation policy of affected structure
   - ✓ It was explained that the Tanzanian law would be the base of the valuation for compensation. The PAPs consent on this policy was confirmed.
   - ✓ In addition, it was explained that a community support would be provided by JICA through RAHCO in accordance with JICA's policy.
   - ✓ Although the details of the community support would be decided in the next study stage, the PAPs were inquired about their requests on the community support for information for the next stage.
3. Compensation policy of affected land
   - ✓ Considering that the alternative spare land is limited in the project area, it was explained that land-for-land compensation would not be feasible although it was recommended by JICA's policy. The PAPs opinion on this issue was collected.

- ✓ It was confirmed that a Livelihood Restoration Program (LRP) would be provided based on the JICA's policy for the PAPs who lose farmland. PAPs were inquired about their requests on the contents of the LRP.

4. Cut-off-date
   - ✓ It was confirmed that unnecessary development should be prevented until the final CRP survey stage.
   - ✓ It was explained that a legal cut-off-date would be established in the final CRP which was expected to be taken place in 2017.
5. Grievance redress mechanism
   - ✓ Grievance redress mechanism proposed in the CRP was introduced to the PAPs.
6. Provision of the reports
   - ✓ Following documents were introduced and provided to the village leaders.
     - − Summary of the preliminary RAP (CRP)
     - − Entitlement matrix
     - − Summary of ESIA report

The major results of the meetings are listed below:

- All participants at each village agreed that the compensation of structure would be based on Tanzanian law. They also appreciated the community support. They understood that the details of the support would be decided in the next stage together with the budget scale.
- All participants at each village agreed with cash compensation for the affected land considering limitation of spare land with exception of residential land in Kikundi. (In Kikundi, it was already agreed that residential land to be resettled would be developed for the PAPs.)
- Requests on the community support and the LRP are listed in Table 13.45 and Table 13.46.

The other major questions/comments from the participants and the responses by the consultant, RAHCO and the JICA Study Team are listed in Table 13.47.

Table 13.44: Consultation Meetings with the PAPs (14–16 June 2016)

Date	Village name (Ward and District name)	Number of participants*	
		Total	(Women)
Tuesday 14 June.	Munisagara (Msanze, Kilosa)	26	(5)
Wednesday 15 June	Mzaganza (Kidete, Kilosa)	60	(17)
	Kikundi (Kidete, Kilosa)	38	(10)
	Kisisi (Godegode, Mpwapwa)	9	(0)
Thursday 16 June	Godegode (Godegode, Mpwapwa)	27	(6)
	Gulwe (Gulwe, Mpwapwa)	66	(12)

'* including village leaders and word officers
Source: JICA Study Team

Table 13.45: Request of the Community Support

Village name	Requests
Munisagara	− School infrastructure - especially class rooms and teachers' houses are inadequate; − Road to the village - the community faces difficulty and risk by utilising the railway as access to the village; − Dispensary – needs to be repaired
Mzaganza	− Dispensary since there is none; − Access road to the village since there is no road; − Safe and clean water supply - the villagers currently fetch water for domestic use from the river which is always turbid and not safe; − Completion of Kidete dam embankment - so that flooding to the downstream can be controlled; − Rehabilitation of church (Roman Catholic) buildings; − Rehabilitation of class rooms and teachers' house - since the school has 6 class rooms which are dilapidated and pause a safety risk to pupils; − Construction of village office
Kikundi	− Dispensary since there is none in the village; − Class rooms for their primary school since there are only 2 rooms; − Teachers' house - the school has no teacher's house which makes it difficult for teachers to stay far from school premises; − Water supply - requesting an additional water well; − Rehabilitation of the existing road to Mpwapwa
Kisisi	− Water supply for the village - water is a problem since they depend on Chinyasungwe river and others where they have to walk 7km to reach; − Dispensary - since they have to travel 9km to Godegode in search for health services; − Class rooms - Kisisi Primary School has 4 rooms where only 2 rooms are in use. The other 2 are out of order and pose safety risks to pupils. Other pupils take their classes outside, sitting under tree shades
Godegode	− Health centre - the existing dispensary is overloaded − Water supply - the village is experiencing water scarcity − Police station - to boost security
Gulwe	− Water supply - since the currently used sources are not reliable and unsafe; − Secondary school - since the village has no secondary school. Students travel a distance of between 15 to 20km daily for studies; − Health centre - since the existing serves 3 villages of Chiseyu, Uyuma and Gulwe, all found in Gulwe Ward.

Source: JICA Study Team

Table 13.46: Request of Livelihood Restoration Program (LRP)

Village name	Requests
Munisagara	− Assistance for agriculture − Poultry
Mzaganza	− Irrigation infrastructure − Bee-keeping − Entrepreneurship training e.g. soap making, raising of livestock (cows, poultry)
Kikundi	− Farming implements and inputs i.e. seeds, insecticides, machinery etc.
Kisisi	− Equipment for increasing agricultural production - tractors, ox, fertiliser, etc. − Capacity building on how to increase land productivity − Fish farming − Modern livestock keeping

Village name	Requests
Godegode	− Water pumps to enable water for irrigation reach their farms − Agricultural implements, e.g. tractors, power tillers etc. − Skills development through trainings on entrepreneurship
Gulwe	− Poultry − Open up vegetable gardens and give training on how to grow healthy vegetables − Piggery and milk cows raring − Training on carpentry − Provision of agricultural implements − Beekeeping − Fish farming

Source: JICA Study Team

Table 13.47: Questions/Comments and Response in the Meeting (14–16 June 2016)

Subjects	Raised Issues	Response
RAP survey	1) How will I be compensated since I was not considered in the previous survey? (Godegode)	The survey exercise will be repeated. The previous survey was to get the overview of the situation. In the second survey, PAPs will be photographed while standing in their piece of land to be taken by the project and requested to sign valuation report. Therefore, there is still a chance to come for updating the PAPs database.
	2) A tenant was recorded on my land and not me, how will I be considered? (Godegode)	There will be another survey which gathers PAPs details.
Compensation of structure	3) What Tanzania laws state for valuation and compensation of assets? (Mzaganza)	Tanzania laws take into consideration type of house, type of construction materials, age and current condition at the time of valuation (depreciation).
	4) If PAPs want to rebuild the affected house, how will it be considered during valuation? (Gulwe)	The laws in Tanzania do not consider replacement; only gives cash compensation.
	5) There was a plan that the project would re-build the affected houses at the resettlement site in Kikundi. Is the plan still valid? (Kikundi)	If the PAPs chose in-kind compensation, namely compensation by re-built houses, community support program will not be provided. ->The PAPs agreed with cash compensation so that they could build the houses at the resettlement site by themselves.
Compensation of land	6) Shall land be sold or taken by the project? (Mzaganza)	No land shall be taken without compensation.
	7) If I sell a piece of land to someone and that person constructs a house, how will that be handles? (Kikundi)	Compensation will be on owner of that land. However, that will be confirmed at the final survey to be undertaken in 2017.
	8) I have a piece of land on which a tenant has constructed a residential house. What will I get? (Kikundi)	Owner of the house will be compensated for a house and land owner shall be compensated for land.
	9) What guide is used to determine value of PAPs' land? (Godegode)	Value of land depends on size, location and current local price. The district has guidelines in determining the value of land for the entire district council jurisdiction.

Subjects	Raised Issues	Response
	10) I used to cultivate food crops on my land. How will I continue my livelihood? (Godegode)	Land in Tanzania is vested in the custody of the President of the United Republic. If the government has national interest in your piece of land, then there are procedures laid down by law on how to acquire that land.
	11) Why is allowance not given on disturbance due to loss of land since it might take longer for PAPs to get a new piece of land considering the fact that land is limited in the village? (Godegode)	Bare land does not be considered for disturbance allowance. Moreover, land grown with crops is considered i.e. land is compensated and crops compensated as well
Community support	12) Who specifically are the beneficiaries of the community support program? (Munisagara)	Community support program intends to benefit the entire community.
	13) How do PAPs benefit if their assets are affected but community support program is extended to the entire community and not the PAPs? (Kisisi)	Apart from the compensation to each PAP, JICA wishes to contribute to the community of which structures are affected.
	14) Why is the entire community benefiting from JICA through community support program while the PAPs are compensated by Tanzania only? (Godegode)	Compensation for structures shall be governed by Tanzania laws, which take into consideration value of structures and some additional allowances but no more support. JICA proposes to assist the entire community/village from which built structures are lost to the proposed project.
Livelihood Restoration Program	15) How long will the Livelihood Restoration Program last?	The program can be operated by JICA for 2- 3 years after which PAPs should be able to continue by themselves.
	16) Will the money for livelihood restoration be given directly to PAPs or shall be channeled through the district office?	Livelihood Restoration Program does not involve provision of cash to PAPs. The program shall sponsor what is required or requested by PAPs.
Cut-off-date	17) Since the valuation exercise is planned in 2017, can we continue crop cultivation until that time? (Munisagara, Gulwe)	Cultivation can be continued until the cut-off date is announced in the final RAP expected to be in 2017.
	18) If not compensated within 6 months of the cut-off date, where should we report? (Mzaganza)	Grievance handling procedure shall be established.
	19) What about those PAPs who had plans to construct extra rooms to their houses and now are not supposed to do any developments to the existing situation, how should they live? (Mzaganza)	Developments can be undertaken on emergency cases. If the PAP had plans to add rooms to the house before the preliminary survey was undertaken, it means there was need to do so in order to shelter the family.
	20) I was told to stop construction of my house. (Godegode)	If you already began constructing and you have a great need for that house for habitat and that there no other alternatives then should continue with construction. However,

Subjects	Raised Issues	Response
		PAPs were cautioned not to construct houses beyond their requirements.
	21) What if land owners decide to build houses on the land earmarked for the project provided they are in need of that house? (Godegode)	Buildings to be compensated should be on felt and genuine requirements only and not targeting compensations. If extra houses are found and the assessment identifies possibilities of conflict raptures, it might be required to liaise with neighbors to the newly built houses on the reasons for building that house or otherwise the design might be forced to change.
Others	22) How will PAPs be sure that their money posted in the bank account is what was agreed upon? (Kikundi)	PAPs will be informed of the total amount of their compensation. If the amount posted is not what the PAP signed, then there will be a desk to handle such grievances.
	23) How will compensation be handled if the previously identified owner of land passed away? (Godegode)	In case the departed person did not prepare a will, then it is the family to resolve the ownership so that there wouldn't be setbacks during valuation exercise.
	24) What is the plan to deal with special groups of PAPs (disabled, elderly, and children) who are not able or capable to make use of compensation to rebuild their lives? (Gulwe)	Vulnerable groups will be assisted.
	25) Where will mobilization vehicles pass during re-routing of the railway? (Gulwe)	The temporary road to be used for mobilization shall be opened within 30m buffer zone and other public roads that exist in the area. But if it is necessary to open up a route across the community areas, there will be memorandum of understanding signed between the Contractor and the particular person.
	26) A PAP has a conflict of land ownership with the village government of an area preliminary identified as affected by the re-routing. How will that be handled during valuation? (Gulwe)	The compensation team will not work on areas with conflicts. The village government was advised to resolve the misunderstandings so that during the valuation exercise, all conflicts should have been solved.

Source: JICA Study Team

13.3 Checklist and Monitoring Form under JICA's Guidelines

The environmental checklist for the railway project was filled, as per Table 13.48.

Table 13.48: Environmental Checklist

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a)Y (b)N (c)N/A (d)N	(a) The report was prepared in January 2016. (b) The report was submitted to NEMC in March 2016. (c) N/A (d) The other permits will be obtained/renewed in a timely manner; those are a permission for transportation of heavy cargo for construction, environmental certificate to open a new quarry, works permit for construction workers, a permit for transportation of chemicals, and a permit for transportation of waste.
	(2) Explanation to the Local stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a)Y (b)Y	(a) A series of local stakeholder meetings were held at the scoping stage and the final stage of the EIA Study. The project outlines, potential impacts and the mitigation measures were explained and accepted. (b) Comments from the stakeholders at the scoping stage were incorporated in the EMP.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a)Y	(a) The rerouting sections were selected from six alternatives based on the results of comparison in terms of the economic and physical feasibility and minimization of resettlement and land acquisition.
2 Pollution Control	(1) Water Quality	(a) Is there a possibility that soil runoff from the bare lands resulting from earthmoving activities, such as cutting and filling will cause water quality degradation in downstream water areas? (b) Do effluents from the project facilities, such as stations, comply with the country's effluent standards and ambient water quality standards? Is there a possibility that the effluents will cause areas not to comply with the country's ambient water quality standards?	(a)N (b)Y	(a) As the turbidity is already high in the rivers, soil runoff will not affect the water quality. However, the condition will be monitored. (b) The station facilities newly planned for this project will be designed to be equipped with enough capacity for the domestic wastewater treatment. As the discharge volume will be limited, it will not cause significant water pollution.
	(2) Wastes	(a) Are wastes generated from the project facilities, such as stations and depot, properly treated and disposed of in accordance with the country's regulations?	(a)Y	(a) Waste disposal by the passengers at the stations is limited. The collected waste is disposed in accordance with the village rules.
	(3) Noise and Vibration	(a) Do noise and vibrations from the vehicle and train traffic comply with the country's standards?	(a)N/A	(a) Tanzania does not have ambient noise and vibration standards. Impacts of noise and vibration by trains will be the same as with the present condition.
	(4) Subsidence	(a) In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence (especially in case of Undergrounds/Subways)?	(a)N/A	(a) Extraction of a large volume of groundwater is not planned.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
3 Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a)N	(a) The project area is not located in protected areas.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Are adequate protection measures taken to prevent impacts, such as disruption of migration routes, habitat fragmentation, and traffic accident of wildlife and livestock? (e) Is there a possibility that installation of rail roads will have impacts, such as destruction of forest, poaching, desertification, reduction in wetland areas, and disturbance of ecosystems due to introduction of exotic (non-native invasive) species and pests? Are adequate measures for preventing such impacts considered? (f) In cases the project site is located at undeveloped areas, is there a possibility that the new development will result in extensive loss of natural environments?	(a)N (b)N (c)Y (d)Y (e)N (f)N/A	(a) The project site does not encompass ecologically-valuable habitats such as primeval forests. (b) Although some species to be protected according to the IUCN list were reported, the project site does not encompass the protected habitats of those species. (c) Although significant ecological impacts are not anticipated, flora and vegetation conservation plans will be developed before the construction commences to secure bio-diversity. (d) Terrestrial migratory species were not found in the project area. Habitat fragmentation is not anticipated as the railway already exists. For livestock, culverts will be installed at the rerouting sections to secure pathways to cross the rail. (e) As the project is not to install a new railway, those impacts are not anticipated. (f) The project site is not an undeveloped area with the existing railway.
	(3) Hydrology	(a) Is there a possibility that alteration of topographic features and installation of structures, such as tunnels will adversely affect surface water and groundwater flows?	(a)N	(a) River-training works will change the river course; however, it will not cause adverse impacts because it is within the flood plain.
	(4) Topography and Geology	(a) Is there a soft ground on the route that may cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides, where needed? (b) Is there a possibility that civil works, such as cutting and filling will cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides? (c) Is there a possibility that soil runoff will result from cut and fill areas, waste soil disposal sites, and borrow sites? Are adequate measures taken to prevent soil runoff?	(a)N (b)N (c)Y	(a) Mountain slopes to be cut for rerouting consist of hard rocks. (b) Slope failures or landslides are not anticipated. (c) Measures for managing soil erosion and the runoff will be applied; for example, controlling work areas of equipment/vehicles, preparing sedimentation ponds, and compacting disturbed areas.
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement	(a)Y (b)Y (c)Y (d)Y	(a) A Livelihood Restoration Program will be provided for minimizing the impacts caused by the agricultural land acquisition. (b) During this Study, compensation and assistance policy

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Are the compensations going to be paid prior to the resettlement? (e) Are the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(e)Y (f)Y (g)Y (h)Y (i)Y (j)Y	based on both Tanzanian law and JICA's policies were explained to the affected people. (c) The preliminary resettlement plan was developed during the Study including compensation policies and the socioeconomic Study results. It will be updated and detailed after the project implementation is officially decided. (d) Both Tanzanian law and JICA's policies regulate the payment to be prior to the resettlement. (e) The compensation policies are presented in the report of this Study. (f) The policy includes the assistance for old people, women heads of households, widows, single mothers, orphans, physically and mentally challenged and the infirmed people. (g) So far, there have been no objections from the affected people. (h) RAHCO will establish an internal unit and the CRP Committee with local governments. RAHCO takes full responsibility for budgetary preparation. (i) Internal and external monitoring will be conducted by RAHCO. (j) It will be established under cooperation of the local governments.
	(2) Living and Livelihood	(a) Where railways are newly installed, is there a possibility that the project will affect the existing means of transportation and the associated workers? Is there a possibility that the project will cause significant impacts, such as extensive alteration of existing land uses, changes in sources of livelihood, or unemployment? Are adequate measures considered for preventing these impacts? (b) Is there any possibility that the project will adversely affect the living conditions of inhabitants other than the affected inhabitants? Are adequate measures considered to reduce the impacts, if necessary? (c) Is there any possibility that diseases, including infectious diseases, such as HIV will be brought due to immigration of workers associated with the project? Are adequate considerations given to public health, if necessary? (d) Is there any possibility that the project will adversely affect road traffic in the surrounding areas (e.g., by causing increases in traffic congestion and traffic accidents)?	(a)N/A (b)N (c)Y (d)N (e)N (f)N	(a) The railway is not newly-installed, but already exists. (b) The project will not cause impacts widely spread out of the affected communities. (c) The inflow of construction workers may bring infectious diseases. Prevention programs will be established with the cooperation with local government officers. (d) Traffic congestion is not anticipated as the existing traffic is limited. (e) Culverts will be installed at the rerouting sections to secure pathways to cross the rail. (f) Structures with high altitudes which will cause sun-shading and radio interference are not planned.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		(e) Is there any possibility that railways will impede the movement of inhabitants? (f) Is there any possibility that structures associated with railways (such as bridges) will cause a sun shading and radio interference?		
4 Social Environment	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a)Y	(a) Although the archaeological and cultural heritage of the project area remains unknown, some archaeological sites were found around the project site. In accordance with the EMP, the contractor has to observe and record the resources discovery during the earthworks and inform to the Ministry of Natural Resources and Tourism if something is discovered.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a)N/A	(a) There is no specific landscape to be protected.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(a)N/A (b)N/A	(a)(b) There are no ethnic minorities nor indigenous people to be considered.
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(a)Y (b)Y (c)Y (d)N/A	(a) RAHCO and TRL comply with the Occupational Health and Safety Act No. 5 (2003), Employment and Labor Relations Act No.6 (2004), Workers' Compensation Act Cap 263 (2008) and other relevant regulations. (b) Protective masks will be provided to the construction workers who are involved in the dust generation works. Fire extinguisher and fire alarms are equipped in the TRL offices. Gumboots, groves, overcoats, and helmets are provided to staffs working at workshops. For gang men, gumboots and groves are provided. (c) For the construction workers, a "public health and safety and construction health and safety plan" and "construction site management plan" will be established and implemented. For operation, TRL will prepare/update the safety program including safety training. (d) It is hardly expected that the project security guard violate the other individual's safety.
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts?	(a)Y (b)Y (c)Y (d)N/A	(a) Management of the construction noise, water pollution, air pollution and waste are included in the EMP. (b) In accordance with the EMP, investigation of flora and fauna has to be conducted before commencement of the construction works. If protected species are found, measures

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		(c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts? (d) If the construction activities might cause traffic congestion, are adequate measures considered to reduce such impacts?		such as re-planting needs to be considered. (c) Temporary disturbance of socioeconomic activities and public health and safety hazards are managed in accordance with the EMP. (d) Traffic congestion is not anticipated.
	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a)Y (b)Y (c)Y (d)Y	(a) The monitoring plan was developed as a part of the EIA. (b) The items, parameters, frequency, and areas are described in the monitoring plan in the EIA. (c) The Environmental Control Officer (ECO) of RAHCO will take responsibility on the monitoring. The budget is under the responsible of RAHCO. (d) NEMC can request proponents to submit the monitoring results.

Source: Input by the JICA Study Team, using JICA template.

Table 13.49: Environmental Monitoring Form for Construction Stage

Potential Impact	Item	Monitoring area	Parameter to be monitored	Baseline (Average/Max/Total, etc.)	Result (Average/ Max/ Total, etc.)	Measurement unit	Target level or standard	Monitoring frequency
Mobilization								
Impact # 1: Land disturbances / soil erosion at onsite and offsite location	Land surface condition	Project site	Rills and gullies Sediments in receiving water bodies			None mg/l	No erosion None	Once every six months
Impact # 2: Loss / damage / disturbance of indigenous vegetation and contained biodiversity species	Vegetation and wild animals	Entire project site	Types of vegetation being cleared, Existence of endemic /protected species, Area being cleared			Numbers	No endemic/ protected species cleared Clearance should be restricted to project corridor	Continuously during mobilization and construction phase
Impact # 3: Depletion at point source	Material procurement	Point of sourcing and Project site	Procurement records			all procurements from licensed operator	No material from unlicensed supplier, No new borrow pit	Monthly during construction
Impact # 4: Impaired air quality & contribution to climate change due to release of dust, greenhouse gases and other noxious air pollutants	Air quality	Construction site	CO2, NOx, dust			mg/l, ppm	NOx = 150 µg/ Nm3 for 24-hours average value [1] CO = Daily average of hourly values shall not exceed 10mg/kg and average of hourly values in eight consecutive hours shall not exceed 20 mg/kg. Dust (measured as PM10) = 150µg/m3 measured over 24hour average [2]	Once every six month
Impact # 5: Release of oils and fuels in the aquatic environment	Water quality (oil)	Surface water bodies	Oil contents			mg/l	10 [3]	Once every six month

Potential Impact	Item	Monitoring area	Parameter to be monitored	Baseline (Average/Max/Total, etc.)	Result (Average/ Max/ Total, etc.)	Measurement unit	Target level or standard	Monitoring frequency
Impact # 6: Contamination of surface waters with demolition debris and soils	Water quality (turbidity etc.)	Project site	All types of waste including § Heaps of soils § Plastics wastes § Glass wastes § Turbidity § Suspended solids in receiving water bodies § BOD			None NTU mg/l mg/l	No haphazard disposal of waste 300 [3] 100 [3] 30 [3]	Continuous throughout the project cycle
Construction								
Impact # 7: Land disturbances / soil erosion	Land surface condition	Construction site	Rills and gulliesSediments in receiving water bodies			Nonemg/l	No erosionNone	Once every six months
Impact # 8: Impaired air quality & contribution to climate change due to release of dust (including fugitive (unavoidable, residual), greenhouse gases and other noxious air pollutants	Air quality	Construction site	CO2, NOx, dust			mg/l, ppm	NOx = 150 µg/ Nm3 for 24-hours average value [1] CO = Daily average of hourly values shall not exceed 10mg/kg and average of hourly values in eight consecutive hours shall not exceed 20 mg/kg. Dust (measured as PM10) = 150µg/m3 measured over 24hour average [2]	Once every year
Impact # 9: Impaired land and water qualities and contained resources from discharge of pollutants (wastes, oily substances etc.)	Water quality	Surface water bodies	Oil contents All types of waste including § Heaps of soils § Plastics wastes § Glass wastes § Turbidity § Suspended solids in receiving water bodies § BOD			mg/l None NTU mg/l mg/l	10 [3] No haphazard disposal of waste 300 [3] 100 [3] 30 [3]	Once every year

Potential Impact	Item	Monitoring area	Parameter to be monitored	Baseline (Average/Max/Total, etc.)	Result (Average/ Max/ Total, etc.)	Measurement unit	Target level or standard	Monitoring frequency
Impact # 10: Temporary disturbances / flight of aquatic fauna from noise emission	Noise	Project site	Noise levels			dB	<85 dB [4]	Once month after commencement of construction
Impact # 11: Destruction of archeological and Cultural heritage resources	Archeological and cultural heritage	Project site	No. of discoveries			Number	All discoveries should be reported	Continuously
Impact # 12: Change or modification of population and its quality of life due to land take	Affected people	All villages along the project corridor	Existing of land related conflicts, Types of land use			Number of conflicts	Zero	Continuously
Impact # 13: Construction health and safety hazards	Health and safety	Construction site	・ Personnel health records ・ Noise levels ・ Concentration of pollutants such as dust in the working environment ・ Number injuries			None dB ppm numbers	 Noise = <85dB Dust = Not to exceed 250 mg/Nm3(24h mean value) [1] Zero injuries	Once every year
Impact # 14: Temporary disruption of socioeconomic activities	Socioeconomic activities	Entire project site	Existence of complaints			Number of complaints	As minimum as possible	Continuously during construction
Impact # 15: Loss of aesthetics due to haphazard disposal of demolition waste	Waste	Project site	All types of waste including § Heaps of soils § Plastics wastes § Glass wastes § Turbidity § Suspended solids in receiving water bodies § BOD			None NTU mg/l mg/l	No haphazard disposal of waste 300 [3] 100 [3] 30 [3]	Continuous throughout the project cycle

Potential Impact	Item	Monitoring area	Parameter to be monitored	Baseline (Average/Max/Total, etc.)	Result (Average/ Max/ Total, etc.)	Measurement unit	Target level or standard	Monitoring frequency
Impact # 16: Nuisance and disturbances from noise / vibrations (exceeding allowable level for people comfort) due to construction activities	Noise	Project site	Noise levels			dB	<85 dB [4]	Once month after commencement of construction
Impact # 17: Occupational Health and Security and Safety (HSS) risks	Health and safety	Project area	Incidences of breach of health and safety			Number of incidents	Zero	Continuously
Impact # 18: Public HSS risks: traffic accidents, Risks of human-human transmission of diseases (STD, HIV, etc.) Infections from putrescible wastes with disease pathogens	Infectious disease	hospital / dispensary	STDsHIV/AIDS infectionsCholera			Number of people infected	No or as minimum infectious cases	At the beginning of the project and once every year
Impact # 19: Vandalism of structures / equipment, theft of materials and portable items during construction	Vandalism	Construction site and stores	Destroyed infrastructure and loss of equipment			Number of theft incidences	No or minimum destruction, theft incidences	Continuously during construction

[1] Environmental Management (air Quality Standard)Regulation of 2007
[2] USA National Air Quality Standard
[3] Environmental Management (Water Quality Standards) Regulations 2007
[4] Environmental Management (Noise and Vibration Management and Control) Regulations of 2007
Source: JICA Study Team

Table 13.50: Environmental Monitoring Form for Operation Stage

Potential Impact	Item	Monitoring area	Parameter to be monitored	Baseline (Average/Max/ Total, etc.)	Result (Average/Max/ Total, etc.)	Measurement unit	Target level or standard	Monitoring frequency
Impact # 20: Release of oils and fuels in the environment	Water quality	Surface water bodies	Oil contents			mg/L	10 [1]	Once every six month
Impact # 21: Impairment of local air quality	Air quality	Along railway	CO2, NOx, dust			mg/L, ppm	NOx = 150 µg/ Nm3 for 24-hours average value [2] CO = Daily average of hourly values shall not exceed 10mg/kg and average of hourly values in eight consecutive hours shall not exceed 20 mg/kg. Dust (measured as PM10) = 150µg/m3 measured over 24hour average [3]	Once every six month
Impact # 22: Occupational and Public health and safety	Health and safety	Project site	・ Personnel health records ・ Noise levels ・ Concentration of pollutants such as dust in the working environment ・ Number injuries			None dB ppm numbers	Noise = <85dB Dust = Not to exceed 250 mg/Nm3(24h mean value) [2] Zero injuries	Once every year
Impact # 23: Potential loss of lives and property as a result of falling off from moving train, collision with train at road crossing as a result of increased train frequencies	Accidents	Railway stations	Reported cases of such injuries			Number	Zero	Once every month

Potential Impact	Item	Monitoring area	Parameter to be monitored	Baseline (Average/Max/ Total, etc.)	Result (Average/Max/ Total, etc.)	Measurement unit	Target level or standard	Monitoring frequency
Impact # 24: Additional pressure and demands on local social services and resources (increase water users, toilet users)	Social services	Railway stations	Number of toilets at each station Incidences of open defecations			Number of functioning toilets, Clean water Signs of open defecation	As many as possible No open defecation	Once at the beginning of operation and then one year and availability of clean water Continuously
Impact # 25: Vandalism of structures / equipment, theft of materials and portable items	Vandalism	Entire project	Reported cases of vandals			Reported cases	No or minimum vandalism cases	Continuously
Impact # 26: Physical damage of project structures and disruption of railway operations and schedules due to natural causes	Project structure	Project site	Physical strength of impacted structure			None	No structure weakness	Once every year
Impact # 27: Impairment of environmental quality due to accidental event	Accidents	Site of accident	Vegetation, Oil contamination			Decontaminated soils and plants mg/L	10 [1]	Immediately after accident and once every six months
Impact #28 Impairment of railway operations as a result of flooding of Gombe Dam	Flood at dam	Gombe Dam Area	Flooding tendencies			Visual	Flood should not extent beyond the dam boundaries	Continuously during rainy season
Impact # 29: Increased train frequencies and therefore smoothen passenger and cargo movement	Number of passenger	TRL Head Quarters	Train frequencies			Number	At least one passenger train per day	Once every year
Impact # 30: Protection of roads from heavy cargo as is the current practice	Number of cargo	TRL Head Quarters	Cargo tonnage transported by train			Tonnage	At least 80% of cargo is reported by train by 2019	Once every year

Potential Impact	Item	Monitoring area	Parameter to be monitored	Baseline (Average/Max/ Total, etc.)	Result (Average/Max/ Total, etc.)	Measurement unit	Target level or standard	Monitoring frequency
Impact # 31: Increased income to local suppliers	Local economy	Procurement supply list	Supplies and services received from the residents			Number of supplies and services from the residents	As many supplies and services from the residents	Monthly
Impact # 32: Employment opportunities	Employment	Employed employees	Number of residents employed			Number of employees	As many tenant employees as possible	Every year
Impact # 33: Increased income and improved or livelihoods as result of increased agricultural production, trading activities, and movement of people within the region and bordering countries	Local economy	Affected villages	Incomes of local people in the project area			Per capita income	National per capita income average	Once every year
Impact # 34: Improved comfort of passengers as a result of increased train frequencies	Comfor of passengers	Affected villages	Passenger perception			Perception	Positive perception	Once (six months after commissioning of the project sections)
Impact # 35: Improved quality of the landscape features and appearance of the river embankments	Landscape	The project area	Landscape			Visual appearance	Attractive visual appearance	Once after completing the construction work
Impact # 36: Improved flood management emanating from proper operation of the Gombe Dam	Flood at dam	Dam area	Flooding tendencies			Over flooding	No flooding beyond the border of the dam	Continuously during rainy season

[1] Environmental Management (Water Quality Standards) Regulations 2007
[2] Environmental Management (air Quality Standard)Regulation of 2007
[3] USA National Air Quality Standard
Source: JICA Study Team

Table 13.51: Monitoring Form for Land Acquisition

Progress of Land Acquisition

	Kilosa	Mpwapwa	(Expected) Date of Completion
Vacation of Land(% of progress)			YYYY/MM
Number of Affected Households			

Procedures

Procedure	Date		Submission of Monitoring Report	
			Internal Monitoring	External Monitoring
Institutional Arrangement		2017 (1st qtr)	YYYY/MM/DD	YYYY/MM/DD
Establishment of Project Management Unit	YYYY/MM/DD	2018 (1st qtr)	YYYY/MM/DD	YYYY/MM/DD
Establishment of Grievance Redress Committee	YYYY/MM/DD	2018 (2nd qtr)	YYYY/MM/DD	YYYY/MM/DD
Detailed Measurement Survey (DMS) and Replacement Cost Survey (RCS)		2018 (3rd qtr)	YYYY/MM/DD	YYYY/MM/DD
Bidding and Contract Process to hire independent agency	YYYY/MM/DD	2018 (4th qtr)	YYYY/MM/DD	YYYY/MM/DD
Start of DMS & RCS	YYYY/MM/DD	2019 (1st qtr)	YYYY/MM/DD	YYYY/MM/DD

Grievance Redress

	Grievance received	Grievance resolved		Note (if any)
1	YYYY/MM/DD	YYYY/MM/DD		
2	YYYY/MM/DD	YYYY/MM/DD		
3	YYYY/MM/DD	YYYY/MM/DD		
	YYYY/MM/DD	YYYY/MM/DD		
	YYYY/MM/DD	YYYY/MM/DD		

Public Information Meeting

	Agenda	Date	Place	Number of Participants
1		YYYY/MM/DD		
2		YYYY/MM/DD		
3		YYYY/MM/DD		
		YYYY/MM/DD		
		YYYY/MM/DD		

Income
Restoration
Program

	Content of Activity	Date	Place	Number of Participants
1		YYYY/MM/DD		
2		YYYY/MM/DD		
3		YYYY/MM/DD		
		YYYY/MM/DD		
		YYYY/MM/DD		

Source: JICA Study Team

14. Project Evaluation and Estimation of Project Effects

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15. Conclusions and Recommendations

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