CHAPTER 6 SURVEY ON NEW IRRIGATION DEVELOPMENT

6.1 SURVEY POLICY

The survey on New Irrigation Development targets all the planned irrigation projects in Zimbabwe, assuming to be implemented under Japanese Grant Aid Project. Since dams are the main source of irrigation water in Zimbabwe, the projects to be the target of the survey are 1) dam projects as water source and 2) irrigation scheme project (see Figure 6.1.2 for the definition of the term).

The survey procedure is shown in Figure 6.1.1. The first step is to select the target projects from the priority projects list provided by each agency according to the cost scale and investment impact. The results show that the development of irrigation schemes alone is superior (see 6.4 for the detail).

The Regions (see Figure 6.1.2 for the definition of the term) which irrigation scheme is to be developed are selected from the high priority Areas for irrigation projects (see Figure 6.1.2 for the definition of the term). Firstly, three Areas are selected from all over Zimbabwe by prioritizing the Areas from various perspectives. Finally, target Regions for New Irrigation Development (one from each Area) are selected and a New Irrigation Development Plans are prepared through farming condition survey, preliminary design of the facilities, project cost estimation and environmental and social consideration.

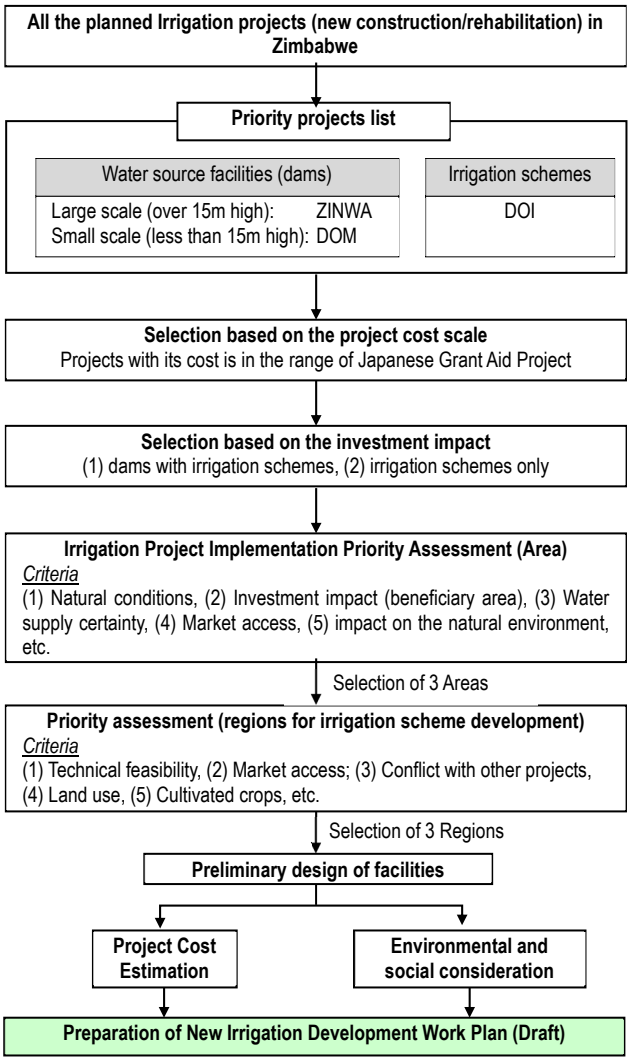
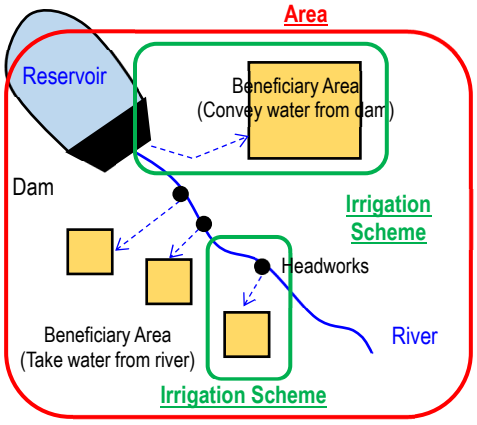


Figure 6.1.1 Procecure of the Survey on New Irrigation Development

6.2 PRIORITY PROJECTS LIST

Generally, a dam and irrigation schemes under that dam are developed at the same time in a project so that irrigation scheme can be functional just after completion of dam construction. However, as already discussed, dam projects and irrigation projects have been conducted as the different projects (see Figure 4.1.1). Therefore, the Survey team requested ZINWA and DOM who is responsible for large and small dam projects respectively, and DOI who is responsible for irrigation schemes, to provide priority projects list.



Area: A dam and all beneficiary areas under the dam
Irrigation Schemes: Individual headworks/water conveyance facility and beneficiary areas under that
Region: Target area for irrigation scheme development

Figure 6.1.2 Definition of the Terms

6.2.1 Large Scale Dam Projects List (ZINWA)

The Ministry of Environment Water and Climate held the "Water Resources Infrastructure Investment Conference" from the 4th -5th of June 2018. The theme of the conference was "Unlocking Water Resources Potential for Economic Growth". The Conference showcased the major water and water related projects in Zimbabwe, highlighting each project's funding requirements and the opportunities that accrue to such investments. The conference presented projects such as 37 dams and 13 mini-hydro-electricity plants, giving investors an opportunity to discuss, evaluate and express interest in the projects.

37 large scale dam projects showcased in the Conference above is provided by ZINWA to the Survey Team as the priority projects. Since some of projects did not have irrigation in its purpose, these projects were excluded from the targets and finally 34 projects shown in Table 6.2.1 were selected as the priority projects of the large dams. The expected project cost in the table includes cost of dam construction only, not including any costs for water supply, irrigation, and power generation facilities. Also, the cost is the amount in case Zimbabwean contractor implements the construction.

Table 6.2.1 Priority Projects List (Large Dams)

	Name of Dam	Location (Province)	Dam Purpose	Expected Project Cost (million USD)
1	Glass Block	Matabeleland South	Water Supply (Bulawayo), Irrigation, Power generation	128.8
2	Nyatana	Mashonaland East	Water Supply, Irrigation, Power generation	733.0
3	Mkwasine	Masvingo	Irrigation	80.8
4	Kudu	Midlands	Irrigation, Power generation	612.8
5	Runde-Tende	Masvingo	Irrigation, Power generation	376.0
6	Gwayi-Umguza	Matabeleland North	Water Supply, Irrigation, Poer generation	181.8
7	Silverstroom	Mashonaland Central	Water Supply, Irrigation, Power generation	171.0
8	Mirror	Manicaland	Water Supply (Chipinge), Irrigation	53.5
9	Dande (and Tunnel)	Mashonaland Central	Water Supply (Chipinge). Irrigation	123.5
10	Eastbourne	Manicaland	Irrigation	41.0
11	Aberfoyle	Manicaland	Irrigation	80.8
12	Amapongokwe (Dam Raising)	Midlands	Water Supply (Gweru), Irrigation	8.0
13	Chitse	Mashonaland Central	Irrigation, Power generation	171.8
14	Mazowe-Nyagui	Mashonaland East	Water Supply (Harare), Irrigation	40.0
15	Swiswamayo	Mashonaland East	Irrigation	350.0
16	Nyakapupu	Mashonaland Central	Irrigation	350.0
17	Chimbadzi	Mashonaland West	Irrigation	150.0
18	Angwa	Mashonaland West	Irrigation	380.0
19	Sisije	Mashonaland West	Irrigation	360.0
20	Sakurgwe	Mashonaland West	Irrigation	450.0
21	Umhlabe	Midlands	Irrigation	360.0
22	Hozori/Silobela	Midlands	Irrigation	180.0
23	Mchingwe	Midlands	Irrigation	150.0
24	Mberengwa	Midlands	Irrigation	360.0
25	Oakley Block	Matabeleland South	Irrigation	100.0
26	Elliot Bridge	Matabeleland South	Irrigation	100.0
27	Mbakwe Mission	Matabeleland South	Irrigation	100.0
28	Chipinda Pools	Masvingo	Irrigation	380.0
29	Marange Dam	Manicaland	Irrigation	180.0
30	Wye Valley	Manicaland	Water supply (Marondera), Irrigation	380.0
31	Chipara	Mashonaland East	Irrigation (Mutoko)	20.0
32	Mavhuradonha	Mashonaland Central	Irrigation (Mzarabani)	40.0
33	Ziminya	Matabeleland North	Irrigation	51.0
34	Nyanyadzi	Manicaland	Irrigation	28.0

Source: The Survey team based on documents of "Water Resources Infrastructure Investment Conference"]

6.2.2 Small Scale Dam Projects List (DOM)

15 small scale dam projects shown in Table 6.2.2 were provided by DOM to the Survey team as the priority projects. All the projects were still in the concept stage and its cost was not available.

Table 6.2.2 Priority Projects List (Small Dams)

	Name of Dam	Location		New Construction/ Rehabilitation	Irrigated Area (ha)	Benefitted Households (HH)	Expected Project Cost (million USD)
		Province	District				
1	Chatendei	Manicaland	Buhera, Ward 6	Rehabilitation	50	60	N/A
2	Shagari	Midlands	Gweru	Rehabilitation	174	N/A	N/A
3	Korora	Mashonaland Central	Muzarabani	Rehabilitation	100	10	N/A
4	Wajetsi	Mashonaland West	Hurungwe	Rehabilitation	150	200	N/A
5	smiling vale	Masvingo	Masvingo	N/A	N/A	N/A	N/A
6	Sachipiri	Mashonaland East	Chikomba	Rehabilitation	215	42	N/A
7	somakandana	Matabeleland North	Nkayi	New Construction	N/A	N/A	N/A
8	Mutsindikwa	Manicaland	Buhera, ward 5	Rehabilitation	N/A	N/A	N/A
9	Chomukute	Mashonaland Central	Bindura	Rehabilitation	20	10	N/A
10	Vhuti	Mashonaland West	Hurungwe	New Construction	70	100	N/A
11	Kildonani	Mashonaland East	Seke	Rehabilitation	210	41	N/A
12	Shagari	Midlands	Gweru	Rehabilitation	174	N/A	N/A
13	Gambiza	Mashonaland West	Kadoma	New Construction	200	300	N/A
14	kachecheti	Matabeleland North	Hwange	Rehabilitation	5	N/A	N/A
15	Chinyika	Mashonaland West	Goromonzi	Rehabilitation	18	37	N/A

Source: The Survey team based on documents provided by DOM

6.2.3 Irrigation Scheme Projects List (DOI)

Irrigation schemes are implemented under three programmes in Zimbabwe. DOI provided priority projects list by programmes. The expected project cost in the tables hereinafter includes the cost of irrigation scheme only, not includes any costs for dam even if its water source is dams. Also, the cost is the amount in case Zimbabwean contractor implements the construction.

(1) Public Sector Investment Programme (PSIP)

This programme is the public works by Zimbabwean own budget. The priority projects list under this programme is shown in Table 6.2.3. Since all the projects target to develop all the beneficiary area in the target Area, the name of irrigation scheme can be read as name of Area.

Table 6.2.3 Priority Projects List under PSIP (Irrigation Scheme)

	Name of Irrigation Scheme (Name of Area)	Location		Water Source	Irrigated Area (ha)	Expected Project Cost (million USD)
		Province	District			
1	Manyuchi	Masvingo	Mwenezi	Dam	900	7.7
2	Dande	Mashonaland Central	Guruve	Dam	5,000	42.5
3	Mola	Mashonaland East	Kariba	Dam	10,000	85.0
4	Ruenya (Rwuenya)	Mashonaland East, Manicaland	N/A	Dam	4,000	34.0
5	Oric	Manicaland	Mutasa	River	4,000	34.0
6	Osborne	Manicaland	Mutare	Dam	5,000	42.5
7	Muzhwi Mushandike	Masvingo	Masvingo	Dam	2,000	17.0
8	Kanyemba	Mashonaland Central	Mbire	River	10,000	85.0
9	Mabwematema	Midlands	Zvishavane	Dam	600	5.1
10	Vungu	Midlands	Kwekwe	Dam	4,000	34.0
11	Mundi Matonga	Midlands	Mberengwa	Dam	1,000	8.5
12	Semwa	Midlands	Rushinga	Dam	5,000	42.5
13	Tuli Manyange	Matabeleland South	Gwanda	Dam	1,000	8.5
14	Kudu Munyati	Mashonaland East	Sanyati	Dam	5,000	42.5

Source: The Survey team based on documents provided by DOI

(2) Smallholder Irrigation Revitalization Programme (SIRP)

This is a programme to rehabilitate the existing irrigation schemes supported by IFAD (see Table 2.3.2 for programme contents). In this programme, 125 irrigation schemes are selected as the target for the rehabilitation, and feasibility study for all the 125 schemes have been conducted. Although some of rehabilitation works are completed, but some have not due to budget shortage of IFAD. DOI proposes this kind of irrigation schemes, which feasibility study is completed but have no plan to be rehabilitated under this programme, as the priority projects (see Table 6.2.4).

Table 6.2.4 Priority Projects under SIRP (Irrigation Scheme)

	Name of Irrigation Scheme	Location		Irrigated Area (ha)	Expected Project Cost (million USD)
		Province	District		
1	Sikhunyana	Midlands	KWEKWE	200	0.7
2	Mbembeswana	Midlands	GWERU	201	3.1
3	Machena	Masvingo	ZAKA	22	N/A
4	Valley	Matabeleland South	MATOBO	N/A	2.3

Source: The Survey team based on documents provided by DOI

(3) Building Climate Resilience of Vulnerable Agriculture Livelihood in Southern Zimbabwe

This is a programme funded by GCF of UNDP (GCF Programme) (see Table 2.3.3 for programme contents). Under this programme, 21 irrigation schemes (rehabilitation:15 and new construction:6) are to be developed and 17 target schemes have selected.

According to the budget demarcation document of the GCF Programme, GoZ is responsible for the construction cost for all the 21 irrigation schemes. DOI proposes all the 17 out of 21 schemes, which are already selected as the target, as the priority projects (see Table 6.2.5).

Table 6.2.5 Priority Projects under GCF Programme (Irrigation Scheme)

	Name of irrigation Scheme	Location (Province)	Beneficiaries	Irrigated Area (ha)	Expected Project Cost (Million USD)
1	Bwanya	Masvingo	300	150	1.68
2	Pikinini Jawanda	Masvingo	300	30	0.43
3	Nyahombe	Masvingo	300	30	0.43
4	Chizumba	Masvingo	250	65	0.81
5	Matezva	Masvingo	100	20	0.26
6	Bindamombe	Masvingo	300	30	0.43
7	Muzhwi	Masvingo	300	N/A	N/A
8	Farai - Veneka	Manicaland	135	60	0.86
9	Vimbanai/Mutandahwe	Manicaland	68	27	0.32
10	Musirizwi	Manicaland	200	60	0.77
11	Mudzimwa	Manicaland	60	20	0.26
12	Mhakwe	Manicaland	50	20	0.26
13	Mwerihari	Manicaland	210	21	0.27
14	Masholomoshe	Matabeleland South	131	39	0.53
15	Mankonkoni	Matabeleland South	100	40	0.54
16	Zamangoni / Masiyapambili	Matabeleland South	40	20	0.26
17	Gwalabana Dam (Mihlo)	Matabeleland South	600	22	0.28

Source: The Survey team based on documents provided by DOI

6.3 SELECTION BASED ON THE PROJECT COST SCALE

Japanese Grant Aid Project (implemented by Japanese contractor under supervision by Japanese consultant) is the expected funding source of the New Irrigation Development. One of the criteria to be selected as the Grant Aid Project is project cost scale. If project cost is small, any Japanese contractor would not apply, whilst if cost is huge, the project shall be the subject for Japanese Yen Loan project. Therefore, projects which cost is in the range of the Grand Aid Project are selected as preliminarily.

Figure 6.3.1 shows the number of priority projects of each program by cost scale. It is clear that ZINWA prioritizes on the huge projects which cost is over 100 million USD. On the other hand, cost of priority projects under PSIP is well distributed from 5 to 90 million USD, whilst SIRP and GCF Programme target small projects, cost of many projects under these two programmes are under 10 million USD.

*Cost of small-scale dam projects proposed by DOM are not available since those are still under concept stage.

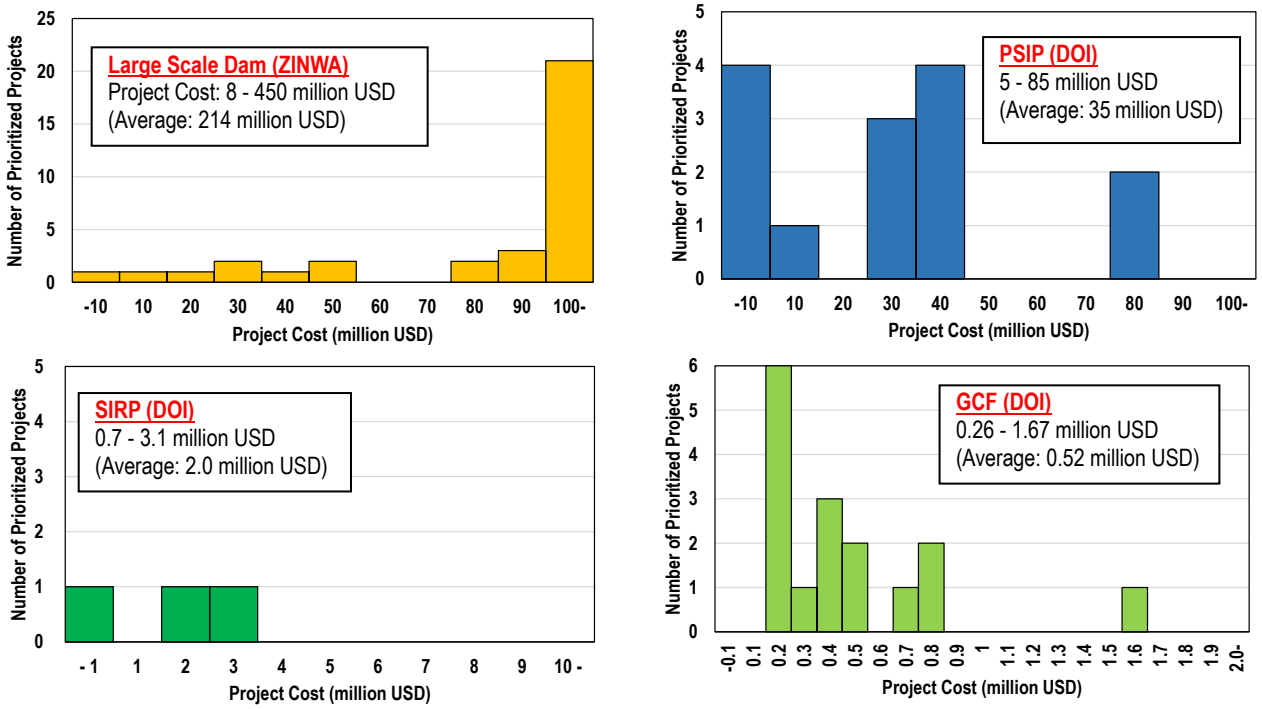


Figure 6.3.1 Priority Projects by Cost Scale

Taking into account the cost scale of recent Grant Aid Projects, from 9 to 23 million USD (= from 1.0 to 2.5 billion JPY) is set as expected range of project cost for Japanese Grant Aid Project. Additionally, the cost of the Grand Aid Project might be from 1.5 to 2.0 times bigger than the cost in case Zimbabwean contractor implements. Based on these conditions, projects having cost (in case Zimbabwean contractor implements) about from 4.5 to 15 million USD (= from 0.5 to 1.7 billion JPY) can be the target for Japanese Grand Aid Project.

Figure 6.3.2 is a figure compiling four figures in Figure 6.3.1. Taking into account the project cost range already discussed, six projects (Large scale dam: 1 and PSIP: 5) can be selected as the targets for the Japanese Grant Aid Project.

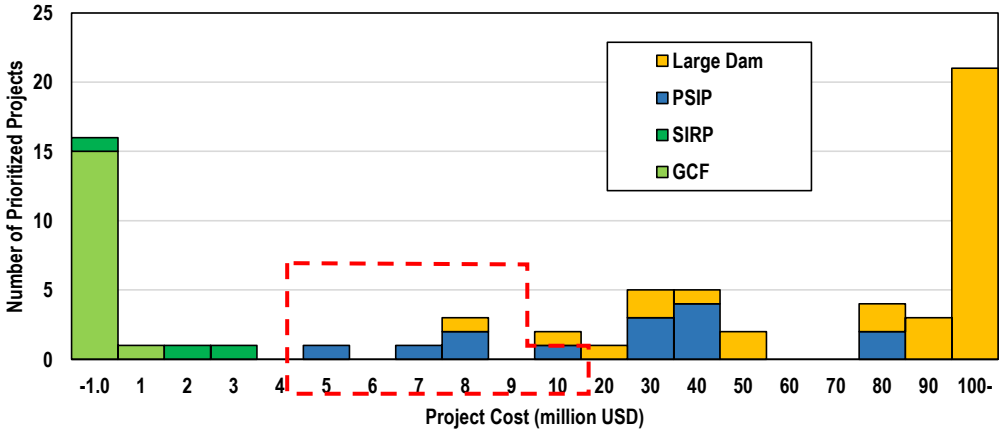


Figure 6.3.2 Priority Projects by the Project Cost Scale (All the Projects)

6.4 SELECTION OF TARGET PROJECTS BASED ON THE INVESTMENT IMPACT

6.4.1 Utilization Status of Dams in Zimbabwe

As already discussed in 4.1, dams and irrigation facilities have been developed separately, and this causes a construction order, dam is constructed fist and construction of irrigation schemes follow. It is hard to find any projects which dam and irrigation schemes were developed at the same time.

Due to this situation, there are many dams which construction was already completed and full of water is stored, but stored water has not been utilised for any purpose, since no irrigation, water supply and power generation facilities are yet to be developed (see Figure 6.4.1 and Figure 6.4.2 as samples).

* Stored water has not been utilized since there are no irrigation facilities after a discharge valve.

Figure 6.4.1 A Samplle of Dams which Stored Water has not been Utilized-1 (Chiwake Dam)

- The biggest inland dam (whole the catchment area is in the Zimbabwean national land) in Zimbabwe.
- Height is 89.2m and capacity is 1.826 billion m^3.
- Dam has supplied irrigation water only for the existing farmland after completion of construction, and therefore no irrigable area has been expanded
- No power has been generated since hydro power plants are yet to be constructed.

Figure 6.4.2 A Samplle of Dams which Stored Water has not been Utilized-2 (Tokwe Mukoshi Dam)

6.4.2 Evaluation of Investment Impact by Development Scenarios

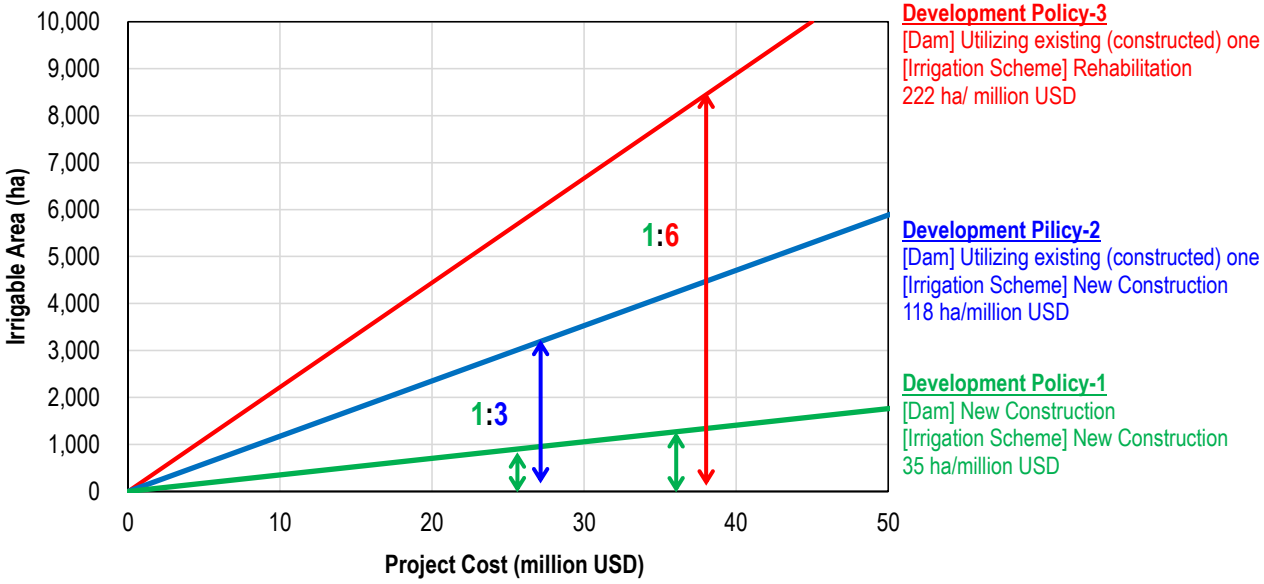
Taking into account the situation discussed in 6.4.1, three scenarios below can be considered as development policies of the New Irrigation Development.

Table 6.4.1 Development Policies of New Irrigation Development

	Dam	Irrigation Scheme	Irrigable Area/ million USD
Development Policy-1	New Construction	New Construction	35 ha
Development Policy-2	Utilizing existing (constructed) one	New Construction	118 ha
Development Policy-3	Utilizing existing (constructed) one	Rehabilitation	222 ha

*Irrigable area is in case of gravity. If pump(s) and/or sprinkler(s) are included in the target, value would be about 1/4 times.
*The cost is in case Zimbabwean contractor implements.

Figure 6.4.3 illustrates the irrigable area / million USD shown in Table 6.4.1. Irrigable area under Development Policy-1 (including dam construction) is 1/3 of Development Policy-2 and 1/6 of the Development Policy-3 only.



*Project cost is for gravity irrigation and in case local contractor in Zimbabwe implements the construction
*The irrigable area under a project including equipment such as pumps and sprinklers may be as small as 1/4 of the area for gravity irrigation.

Figure 6.4.3 Irrigable Area per Millon USD by Development Policies

6.4.3 Selection of the Components based on the Investment Impact

As already discussed, Zimbabwe has many dams which construction is completed but has never been utilized its stored water for irrigation, since irrigation schemes under the dam have not been developed. Also, according to the interview with Zimbabwean side, they desire the effective use of this kind of dams.

Whilst, if dam is newly constructed with the new irrigation scheme, it can irrigate only 1/3 in case of new construction of irrigation schemes only (not including dam), and only 1/6 in case of rehabilitation of irrigation schemes only (not including dam).

Taking into account above investment impact, only irrigation schemes development projects (both new construction and rehabilitation) without any dam development is selected as the targets for New Irrigation Development.

6.4.4 Selection of the Target Projects

Five irrigation scheme development projects out of six projects selected according to the project cost scale in 6.3, are selected as the targets (see Figure 6.4.4).

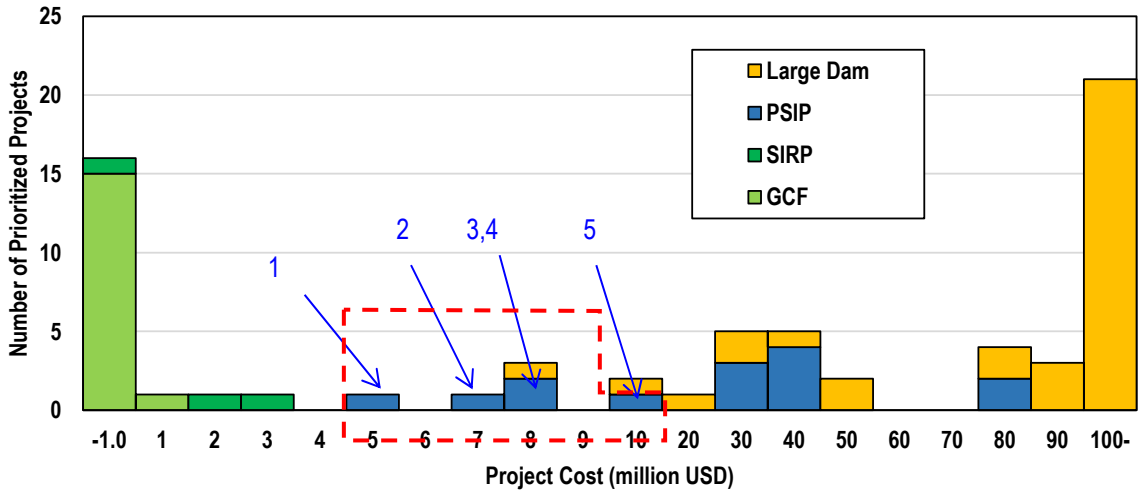


Figure 6.4.4 Target for the New Irrigation Development

Outline of the selected five irrigation schemes development projects is show in Table 6.4.2. As already discussed, since all the projects are under PSIP and target to develop all the beneficiary area under the target Area, the name of irrigation scheme can be read as the name of the Area.

Table 6.4.2 Selected Irrigation Schemes (Areas) Target for New Irrigation Development

Name of Irrigation Scheme (Name of Area)	Location		Name of water source (dam) (Progress of implementation)	Planned Irrigable Area	Expected Project Cost (million USD)	
	Province	District			By Zimbabwean Contractor*	By Japanese Grant Aid Project**
Manyuchi	Masvingo	Mwezeni	Manyuchi (Already Constructed)	900 ha	7.7	11.6
Muzhwi-Mushandike	Masvingo	Masvingo	Muzhwi (Already Constructed)	2,000ha	17.0	25.5
Mabwematema	Midlands	Zvishavane	Palawan (Design Stage)	600ha	5.1	7.7
Mundi Mataga	Midlands	Mberengwa	Mundi Mataga (Already Constructed)	1,000ha	8.5	12.8
Tuli Manyange	Matabeleland South	Gwanda	Tuli Manyange (Under Construction)	1,000ha	8.5	12.8

*Irrigable Area x 8,500 USD/ha
In Zimbabwe, 7,000 – 10,000USD is required to develop 1 ha of the farmland. 8,500 USD is the median of this range
** Project cost by Zimbabwean contractor × 1.5

6.5 EVALUATION OF THE IRRIGATION PROJECT IMPLEMENTATION PRIORITY (AREA)

For the selected five projects (= five Areas), the priority of irrigation project implementation is evaluated based on multiple criteria such as natural conditions, investment impact, market access, and environmental and social impacts, and the three Areas are selected finally.

6.5.1 Evaluation Procedure

Evaluation criteria are set and the situation of each criterion is divided into five stages. Also score (1 - 5 points) is assigned to each stage. Each Area is assigned a score for each criterion, and the three Areas with the highest total score are selected.

6.5.2 Evaluation Criteria

Five evaluation criteria are set from viewpoints from natural conditions, social conditions and environmental and social conditions (see Table 6.5.1).

Table 6.5.1 Criteria for Prioritization of Irrigation Project Implementation

	Item	Evaluation criteria	Reasons for selecting criteria
1	Natural conditions (rainfall) and irrigation needs	Agro-ecological zone classification of the beneficiary area	Agro-ecological zones are classified according to rainfall and agricultural type, as this corresponds to the classification of irrigation needs.
2	Investment impact	Scale of the target beneficiary area	The larger the beneficiary land, the more efficient agricultural development can be (lower project costs per ha).
3	Certainty of water supply	Construction status of the dam	Because irrigation agriculture cannot be implemented if the irrigation scheme is in place but the dam construction is not completed.
4	Market access	Travel time to the nearest major market (provincial capital)	This is because the shorter the journey, the easier it is for beneficiary farmers to access the market and the higher the beneficiary farmers' income.
5	Impact on the natural environment	Existence of Protected Areas (Pas) and IBAs in the beneficiary area	Development activities are restricted in PA and IBA, which in some cases makes it difficult to implement the project.

As the following criteria have a significant impact on the effectiveness of the project and the decision to implement the project, the score will be doubled.

- Investment impact (Scale of the target beneficiary area)
  A significant impact on agricultural production
- Certainty of water supply (construction status of the dam)
  A significant impact on the realization of the project effectiveness
- Impact on the natural environment (Existence of PAs and IBAs in the beneficiary area)
  A significant impact on the project feasibility

6.5.3 Evaluation Results

(1) Natural Conditions (Rainfall) and Irrigation Needs: Agro-Ecological Zone Classification of the Beneficiary Area

As indicated in 2.1.3, Zimbabwe is divided into five agro-ecological zones and the characteristics of each zone can be summarised as Table 6.5.2.

Table 6.5.2 Characteristics of each Agro-Ecological Zone

Agro-Ecological Zone	Annual Precipitation	Type of Farming	The Need for Irrigation
Zone I	>1,000mm	Specialized & Diversified	Low necessity of irrigation
Zone II	750 - 1,000mm	Intensive	Need of supplementary irrigation
Zone III	650 - 800mm	Semi-Intensive	Need of irrigation
Zone IV	450 - 650mm	Semi-Extensive	The most need of irrigation
Zone V	< 450mm	Extensive	High necessity due to impossible of planting without irrigation

The distribution of scores for each agro-ecological zone of the beneficiary area based on the above characteristics is shown in Table 6.5.3.

Table 6.5.3 Allocated Scores (Natural Conditions (Rainfall) and Irrigation Needs)

Scores	5	4	3	2	1
Agro-ecological zone	Zone IV	Zone III	Zone V	Zone II	Zone I
The need for irrigation	Highest	Necessary	High need but may not be able to secure the amount of source water	Need for supplementary irrigation	Less necessary

The agro-ecological zones of the representative point in each beneficiary area are shown in Figure 6.5.1. Also, the results of the scoring of each Area based on Table 6.5.3 is shown in Table 6.5.4.

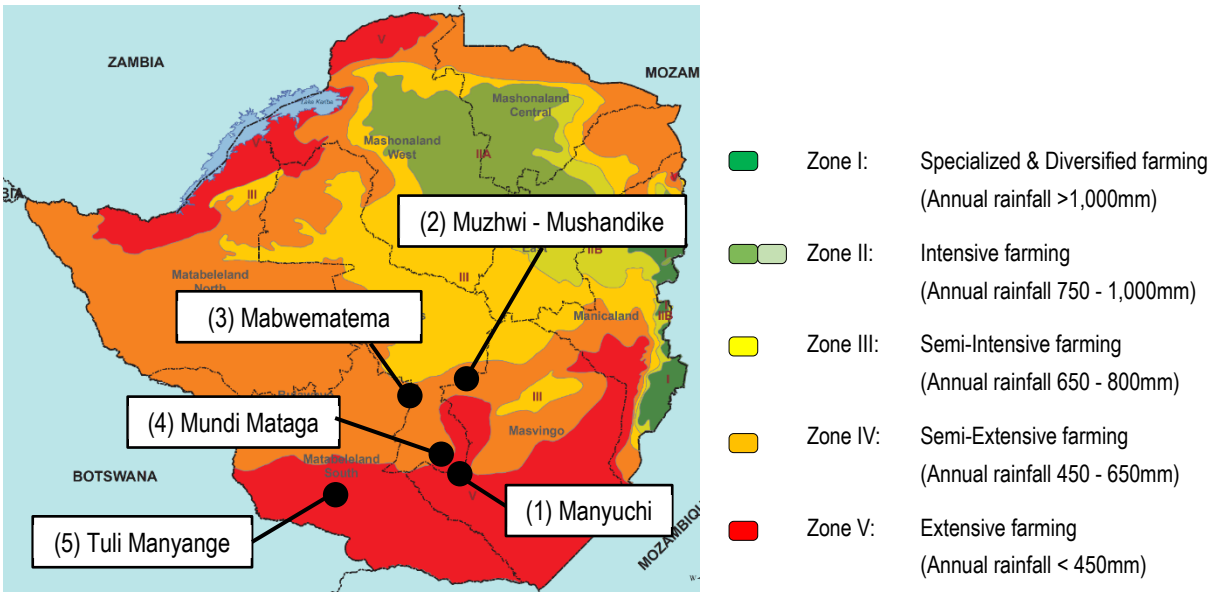


Figure 6.5.1 Agro-Ecological Zones of each Area

Table 6.5.4 Scores of each Area (Natural Conditions (Rainfall) and Irrigation Needs)

Areas	(1) Manyuchi	(2) Muzhwi-Mushandike	(3) Mabwematema	(4) Mundi Mataga	(5) Tuli Manyange
Agro-ecological zone	Zone V	Zone IV	Zone IV	Zone IV	Zone V
Scores	**3**	**5**	**5**	**5**	**3**

(2) Investment Impact: Scale of the Target Beneficiary Area

In general, the larger the beneficiary land, the more efficient the agricultural development (the lower the project cost per ha), so the scores are allocated according to the order of the beneficiary area scale as shown in Table 6.5.5. As this criterion has a significant impact on agricultural production, doubled scores are allocated.

Table 6.5.5 Allocated Scores (Investment Impact)

Scores	10	8	6	4	2
Scale of the target beneficiary area	Largest	Second largest	Third largest	Fourth largest	Smallest

The results of the scoring according to the scale of beneficiary area in each Area are shown in 表 6.5.6

Table 6.5.6 Scores of each Area (Investment Impact)

Areas	(1) Manyuchi	(2) Muzhwi-Mushandike	(3) Mabwematema	(4) Mundi Mataga	(5) Tuli Manyange
Scale of the target beneficiary area (ha)	900	2,000	600	1,000	1,000
Rank of the scale	Fourth largest	Largest	Smallest	Second largest	Second largest
Scores	**4**	**10**	**2**	**8**	**8**

(3) Certainty of Water Supply: Construction Status of the Dam

If the irrigation scheme is in place but the construction of the water boy structure, dam, is not completed, irrigated agriculture cannot be practiced. Therefore, scores are allocated according to the construction status of the dam as shown in Table 6.5.7. Since this criterion has a significant impact on the realization of project effectiveness, doubled scores are allocated.

Table 6.5.7 Allocated Scores (Certainty of Water Supply)

Scores	10	8	6	4	2
Construction status of the dam	Constructed and water is stored	-	Constructed but water is not stored	-	Under construction or in planning

The results of the scoring according to the construction status of each Area's dam are shown in Table 6.5.8.

Table 6.5.8 Scores of each Area (Certainty of Water Supply)

Areas	(1) Manyuchi	(2) Muzhwi-Mushandike	(3) Mabwematema	(4) Mundi Mataga	(5) Tuli Manyange
Construction status of the dam	Constructed and water is stored	Constructed and water is stored	Constructed and water is stored	Constructed and water is stored	Under construction
Scores	**10**	**10**	**10**	**10**	**2**

(4) Market Access: Travel Time to the Nearest Major Market (Provincial Capital)

As the lower the travel time, the easier it is for beneficiary farmers to access the market and the higher the beneficiary farmer' income, the scores are allocated according to the travel time from the beneficiary area to the nearest provincial capital as shown in Table 6.5.9.

Table 6.5.9 Allocated Scores (Market access)

Scores	5	4	3	2	1
Travel time to the nearest provincial capital	Shortest	Second shortest	Third shortest	Fourth shortest	Longest

The route from the representative point of each Area's beneficiary area to the nearest provincial capital, and the paved/unpaved road sections along the route are shown in Figure 6.5.2. The time required to reach the nearest provincial capital is calculated on the assumption that the transportation is by vehicle and 100 km/hr on paved roads and 30 km/hr on unpaved roads.

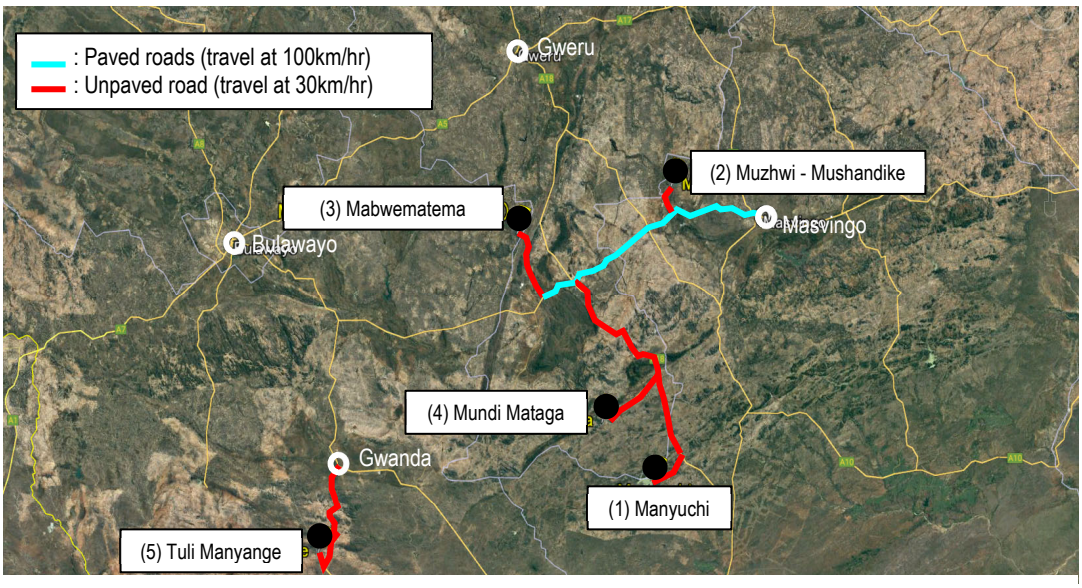


Figure 6.5.2 Route from the Representative Point of each Area's Beneficiary Area to the Nearest Provincial Capital

The results of the scoring according to the travel time required from the representative point of each Area's beneficiary area to the nearest provincial capital are shown in Table 6.5.10.

Table 6.5.10 Scores of each Area (Market Access)

Areas		(1) Manyuchi	(2) Muzhwi-Mushandike	(3) Mabwematema	(4) Mundi Mataga	(5) Tuli Manyange
Nearest provincial capital		Masvingo	Masvingo	Masvingo	Masvingo	Gwanda
Road distance to the nearest provincial capital	Paved road	101 km	44 km	101 km	101 km	0 km
	Unpaved road	126 km	13 km	50 km	104 km	48 km
Travel time to the nearest provincial capital		5.2 hr	0.9 hr	2.7 hr	4.5 hr	1.6 hr
Rank off the time		Longest	Shortest	Third shortest	Fourth shortest	Second shortest
Scores		**1**	**5**	**3**	**2**	**4**

(5) Impact on the Natural Environment: Existence of PAs and IBAs in the Beneficiary Area

Since development activities are restricted in PAs and IBAs, and in some cases it is difficult to implement the project, the scores are allocated according to the existence of PAs and IBAs in the beneficiary area as shown in Table 6.5.11. As this criterion has a significant impact on the feasibility of the project, doubled scores are allocated.

Table 6.5.11 Allocated Scores (Impact on the Natural Environment)

Scores	10	8	6	4	2
Existence of PAs or IBAs in the beneficiary area	Not exist	-	-	-	Exist

Location of representative point of each Area's beneficiary area, PAs and IBAs are shown in Figure 6.5.3. Also, the results of the scoring according to the existence of PAs and IBAs are shown in Table 6.5.12.

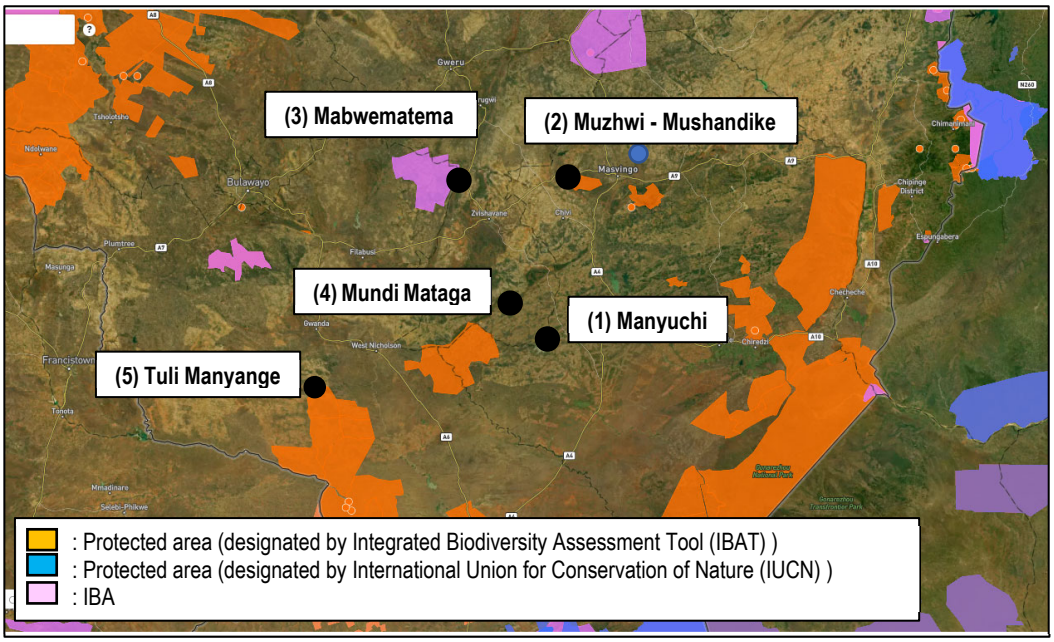


Figure 6.5.3 Location of Representative Point of each Area's Beneficiary Area, PAs and IBAs

Table 6.5.12 Scores of each Area (Impact on the Natural Environment)

Areas	(1) Manyuchi	(2) Muzhwi-Mushandike	(3) Mabwematema	(4) Mundi Mataga	(5) Tuli Manyange
Existence of PAs and IBAs in the beneficiary area	Not exist	Exist (PA)	Exist (IBA)	Not exist	Exist (PA)
Scores	**10**	**2**	**2**	**10**	**2**

6.5.4 Selection Results

The results of the scores for each evaluation criterion are shown in Table 6.5.13. The top three Areas with the highest total scores, (1) Manyuchi, (2) Muzhwi - Mushandike and (4) Mundi Mataga Areas are selected.

Table 6.5.13 Summary of Scores for each Evaluation Criterion

Criteria \ Areas		(1) Manyuchi	(2) Muzhwi-Mushandike	(3) Mabwematema	(4) Mundi Mataga	(5) Tuli Manyange
1	Natural conditions (rainfall) and irrigation needs	3	5	5	5	3
2	Investment Impact	4	10	2	8	8
3	Certainty of water supply	10	10	10	10	2
4	Market access	1	5	3	2	4
5	Impact on the natural environment	10	2	2	10	2
Total		**28**	**32**	**22**	**35**	**19**
Rank		**3**	**2**	**4**	**1**	**5**

6.6 NEW IRRIGATION DEVELOPMENT PLAN (MUZHWI - MUSHANDIKE AREA)

6.6.1 Outline of the Water Resources Development Plan

The Muzhwi Dam, the water source for the Area, was originally constructed on the Tokwe River to irrigate sugar cane plantations in the Triangle area. Later on, Tokwe Mukoshi Dam was constructed in 2017 between Muzhwi Dam and Triangle area, and water source to Triangle area was shifted from Muzhwi Dam to Tokwe Mukoshi Dam. Thus, the stored water of the Muzhwi Dam is now available to irrigate region between Muzhwi Dam and Tokwe Mukoshi Dam.

Based on the available water for irrigation at the Muzhwi Dam, it is estimated that 3,000 ha can be irrigated by surface irrigation, of which 1,000 ha will be used by the DOI to divert water to the Mushandike area. Therefore, remaining 2,000 ha is the potential for new irrigation development.

6.6.2 Selection of a Region for Irrigation Scheme Development

(1) Verification of DOI Recommended Region

The following two types of water diversion methods from Muzhwi Dam to Mushandike Area are proposed (see left figure in Figure 6.6.2). At the time of the Survey, F/S for these diversion methods was being carried out by a Zimbabwean consultant.

[Water Diversion Method-1]

Water is pumped from Muzhwi Dam into the Mushandike Dam influent river and once stored in the Mushandike Dam. After that, irrigation water is supplied to Mushandike Area from Mushandike Dam.

[Water Diversion Method-2]

Water is once discharged from Muzhwi Dam into the Tokwe River and delivered from the downstream headworks to Mushandike Area by a pipeline (without storage at Mushandike Dam).

Since the use of these existing plans, especially the Water Diversion Method-2, may lead to efficient and effective irrigation development, a plan based on the Water Supply Method-2 is examined.

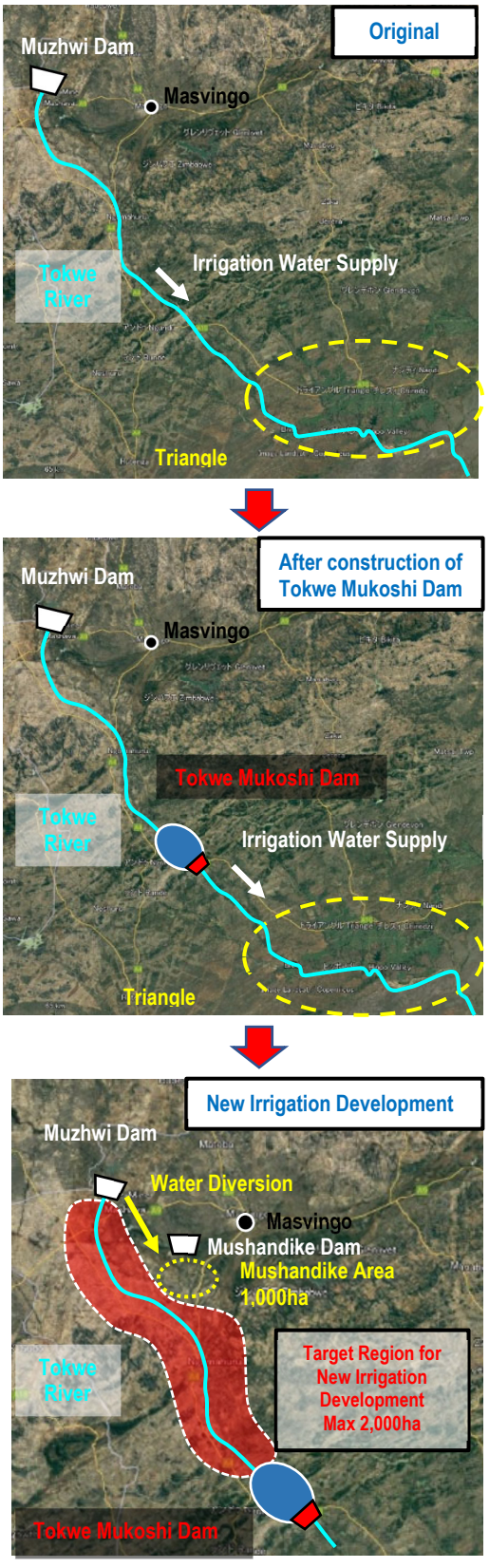


Figure 6.6.1 History of the Muzhwi Dam Water Resources Development Plan

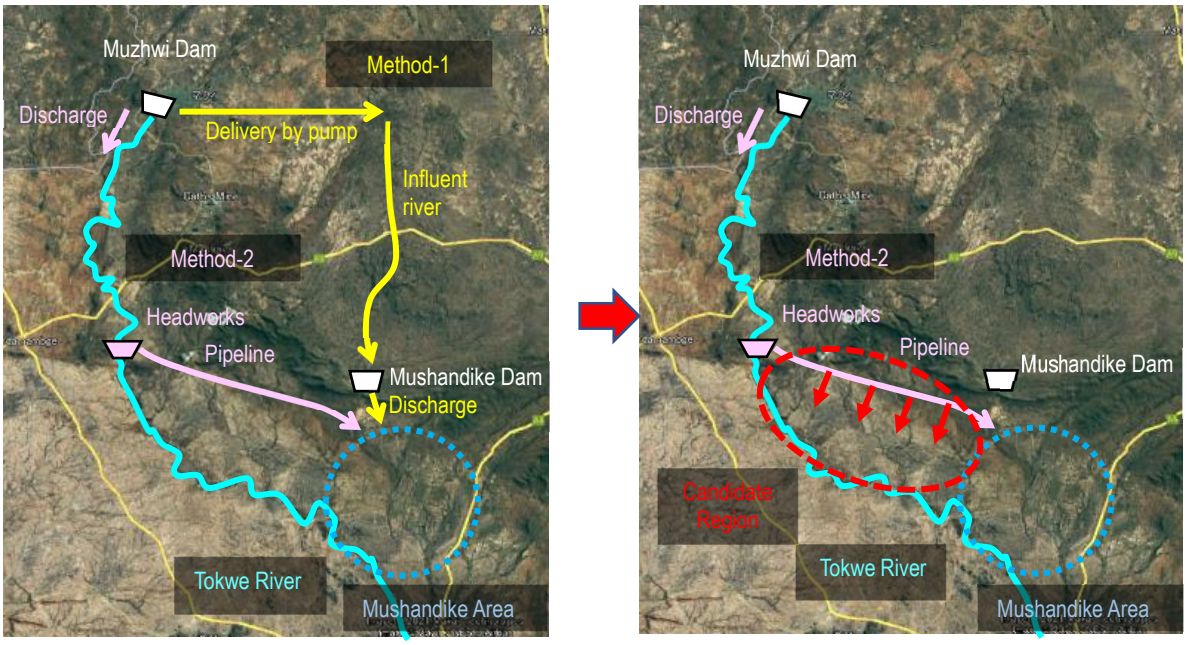


Figure 6.6.2 Water Diversoin Method from Muzhwi Dam to Mushandike Area

Since the function of pipeline planned in Method-2 is only water delivering, it was thought that the farmland along the pipeline could be irrigated by adding a branch pipeline to the planned pipeline (see right figure in Figure 6.6.2). However, Method-2 would require over 30 km of pipeline and the cost of construction would be enormous, being difficult to be implemented by the Grant Aid Project. Therefore, the use of the existing plan was abandoned and a new selection of a region for irrigation scheme development was made.

(2) Selection of the Target Region

The Regions where gravity irrigation could be applied in the section from Muzhwi Dam to Tokwe Mukoshi Dam were studied but no suitable regions were found. Therefore, it was decided to select the beneficiary areas based on the assumption of pump irrigation. The selection criteria are shown in Table 6.6.1.

Table 6.6.1 Criteria for Selecting Region for Irrigation Scheme Development

Item	Selection Criteria	Remarks
Project cost scale	The sale of beneficiary area is about 200 ha - 300 ha.	Based on the case of Nyakomba Irrigation Scheme (Pump Irrigation)
Economic facility size	Pump output = Elevation between the intake point and the night storage is relatively small difference.	
	Pipeline extension = Extension between intake point and night storage is relatively short.	
Market access	The distance from the beneficiary area to highway or main road is short.	
Conflict with other projects	A region has no irrigation projects implemented/planned by GoZ and/or other development partners.	The implementation of multiple projects under the same IMC can lead to disparities between beneficiary farmers and disputes between beneficiaries (for example, disputes over water use costs).

Four number of potential Regions are considered for the section from Muzhwi Dam to Tokwe Mukoshi Dam (see Figure 6.6.3). As candidate Regions 1-3 do not meet the criteria as below, the candidate Region-4 comprising Villages 17C, 18A and 19B of the Mushandike Old Resettlement Area is selected as the target Region for the irrigation scheme development.

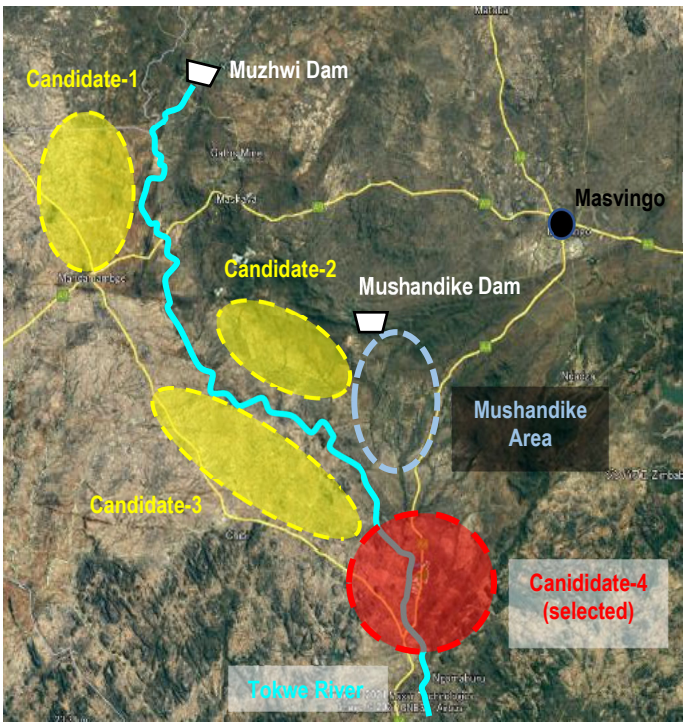


Figure 6.6.3 Location of the Potential Regions

[Candidate Region-1: Upper right bank of Tokwe River]

A part of this region is the target site of the GCF programme (see Table 2.3.3)

[Candidate site 2: Left bank side of Tokwe River]

The point of intake would be at the same point as the water supply facility to the Mushandike Area, and it may be difficult to deploy the intake facility economically. Also, the distance from the beneficiary area to the main road is long.

[Candidate Site - 3: Lower right bank of Tokwe River]

From the point of view of economic facilities layout, the beneficiary areas are limited to the riverside, but in this case, the distance from the beneficiary areas to the main road becomes longer. On the other hand, if the area near the main road is selected, there is far from the river and the scale of the facilities becomes larger.

6.6.3 Current Status of the Irrigation Scheme Development Target Region

(1) Water Body Structure (Dam and Related Facilities)

Two intake valve units are set at the bottom of the Muzhwi Dam intake tower, which function is to discharge water into the downstream river.

Both of these two valve units have failed in the past, after then one unit is blocked and dysfunctional, another is in operation with a replaced valve. The replaced valve has smaller scale than the original one as it stated as a temporary measure. However, this valve has been in operation since then without being replaced by valve of the appropriate size (see Figure 6.6.4)

Therefore, these valves need to be replaced with the appropriate size to supply irrigation water to all the 3,000 ha of beneficiary area to be developed, including the target Region in this Survey.

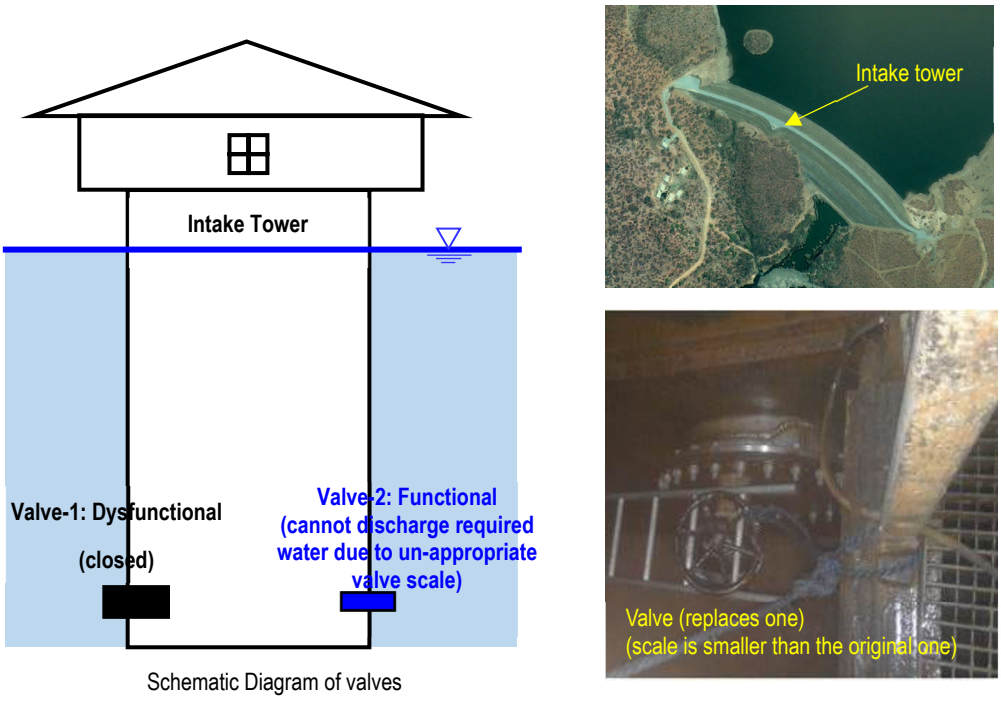


Figure 6.6.4 Status of Valves

(2) Farming Activities

1) Non-irrigated area

Main cultivated crops in the non-irrigated area in the Muzhwi-Mushandike Area are maize, sorghum ground nuts and cotton, but no-cultivation in the dry season due to almost no rainfall. The typical crop planting period of these typical crops is as shown in Figure 6.6.5.

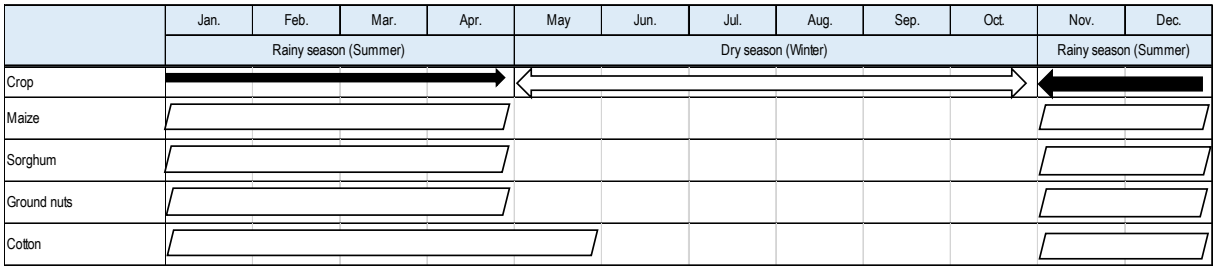


Figure 6.6.5 Crop Planting Period of the Typical Crops (Non-Irrigated Area)

The average of cropping area is 1 ha by each beneficiary farmer in this non-irrigated area and major cultivated crops and area are 0.5 ha of maize for staple food, 0.2 ha of sorghum, 0.2 ha of cotton and 0.1 ha of ground nuts. The annual consumption of maize is about 0.15 ton/person, so the average of household (5 people / household) will consume 0.75 ton/year. The estimated farmer's gross income is about 208.4 USD/year excluding the self-consumption of maize (see Table 6.6.2).

Table 6.6.2 The Estimated Farmer's Gross Income（Non-irrigated area）

Crop	Cultivated Area (ha)	Yield / Area (ton/ha)	Yield (ton)	Self-Consumption (ton/household)	Yield – Self-Consumption (ton)	Sales Price (USD/ton)	Gross income (USD)
Maize	0.5	1.5	0.75	0.75	0	-	0.0
Sorghum	0.2	0.5	0.10	-	-	344.0	34.4
Ground nuts	0.1	2.0	0.20	-	-	360.0	72.0
Cotton	0.2	0.6	0.12	-	-	850.0	102.0
Total	1.0	-	-	-	-	-	208.4

2) Irrigated area

The survey for existing irrigated area was conducted to examine the assumed situation after irrigation scheme is developed. The typical crop planting period is as shown in Figure 6.6.6.

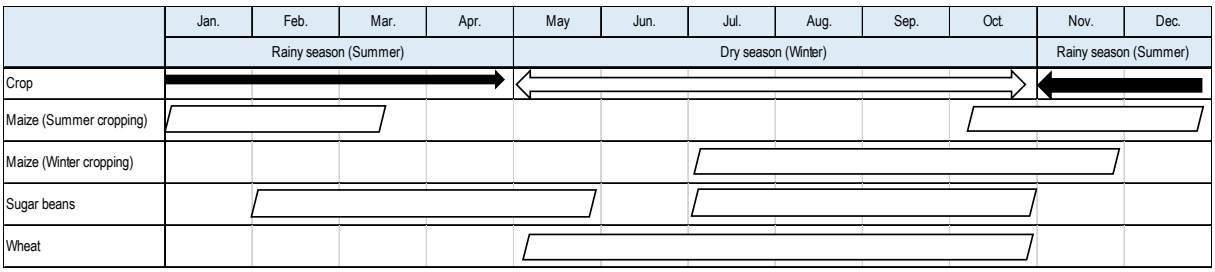


Figure 6.6.6 Crop Planting Period of the Typical Crops (Irrigated Area)

The average of farmland is 1.5 ha by each beneficiary farmer, but the total annual planted area is 3.0 ha. The maize is main cultivated crop and area are 1.5 ha (Summer cropping: 1.0 ha, Winter cropping: 0.5 ha), 1.0 ha of sugar beans (Summer cropping: 0.5ha, Winter cropping: 0.5ha) and 0.5ha of wheat. The beneficiary farmers in the irrigated area can plant wheat and sugar beans, which have high sales prices, even in the dry season by irrigation (winter cropping), and maize in winter cropping is also cultivated.

The estimates of changes in farmland use ratio before and after irrigation are shown in Table 6.6.3

Table 6.6.3 The Estimating Changes in Farmland Use Ratio before and after Irrigation

Crop	Cultivated Area before Irrigation (ha)	Cultivated Area after Irrigation (ha)	Increased Farmland Use Ratio (%)
Maize (Summer cropping)	0.5	1.0	-
Maize (Winter cropping)	0.0	0.5	
Sorghum	0.2	0.0	-
Ground nuts	0.1	0.0	-
Cotton	0.2	0.0	-
Wheat		0.5	
Sugar beans (Summer cropping)	0	0.5	-
Sugar beans (Winter cropping)	0	0.5	-
Total	1.0	3.0	300

The average of cultivated area is 1.0 ha in the non-irrigated area and 3.0 ha in the irrigated area, and it is expected that the land use ratio in the non-irrigated area will be third times after the development of the irrigation scheme.

The same as non-irrigated area, the estimation of beneficiary farmer's gross income per year in irrigated area excluding the self-consumption of maize are shown in Table 6.6.4.

Table 6.6.4 The Estimated Farmer's Gross Income（Irrigated area）

Crop	Cultivated Area (ha)	Yield / Area (ton/ha)	Yield (ton)	Self-Consumption (ton/household)	Yield – Self-Consumption (ton)	Sales Price (USD/ton)	Gross Income (USD)
Maize (Summer cropping)	1.0	4.0	4.0	0.75	3.25	344.0	1,118.0
Maize (Winter cropping)	0.5	3.0	1.5	-	-	344.0	516.0
Wheat	0.5	5.0	2.5	-	-	799.0	1,997.5
Sugar beans （Summer cropping）	0.5	1.2	0.6	-	-	1,000.0	600.0
Sugar beans (Winter cropping)	0.5	1.2	0.6	-	-	1,000.0	600.0
Total	3.0	-	-	-	-	-	4,831.5

In the irrigated area, the farmers can introduce the high-priced crops (wheat, sugar beans), and the land use ratio has improved because of the planting during dry season (winter cropping), resulting increase the gross income of beneficiary farmers. As a result, it is 4,831.5 USD / year / household, which is about twenty-third (23) times of that in the non-irrigated area at 208.4 USD / year / household. Therefore, it is estimated that if new irrigation scheme is developed in the Muzhwi-Mushandike Area and the conversion from non-irrigated area to irrigated area is carried out, the gross income of farmers will increase significantly.

6.6.4 Facility Layout Plan

(1) Basic Policy

- The maximum pump head shall be 80 m. If it exceeds this value, the pumps shall be arranged in a multi-stage system.
- The pumps are operated in alternating two systems. A pump system is operated for a period of 24 hours (nighttime: 16 hours + daytime: 8 hours) and then 24 hours deactivated (see 6.9.1 for details).

1) Nighttime (16:00 – 8:00: 16 hours) **2) Daytime (8:00 – 16:00: 8 hours)**

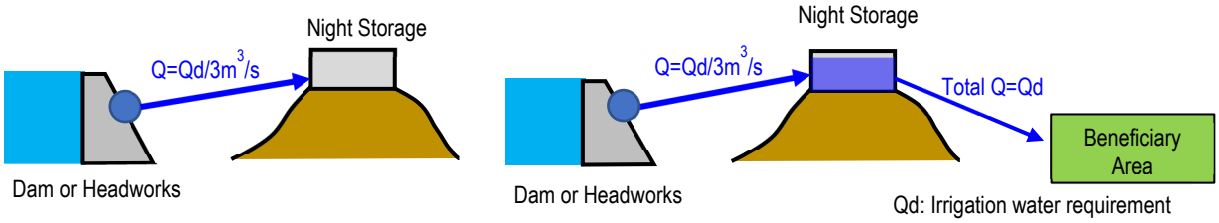


Figure 6.6.7 Pump Operetaion Plan

- The expected crop planting plan after commencement of irrigation is examined in 6.6.3, however its feasibility is not sure and secured. Therefore, based on the actual irrigation situation in Mushandike Area, the water requirement is calculated on the assumption that the same area is planted with maize and wheat.
- Water-saving irrigation (hose irrigation) is the basis for the following reasons.
  - ✓ To create more beneficiary area and beneficiary farmers
  - ✓ To reduce the scale (cost) of main facilities per unit beneficiary area
  - ✓ To be in line with national development policy (Water-saving irrigation is recommended in the national development policies, such as NDS-1)

- The application efficiency of water-saving irrigation is 1.5 time smaller than that of under surface irrigation (water-saving irrigation can irrigate 1.5 times as much area as surface irrigation with the same amount of water).

(2) Facility Layout

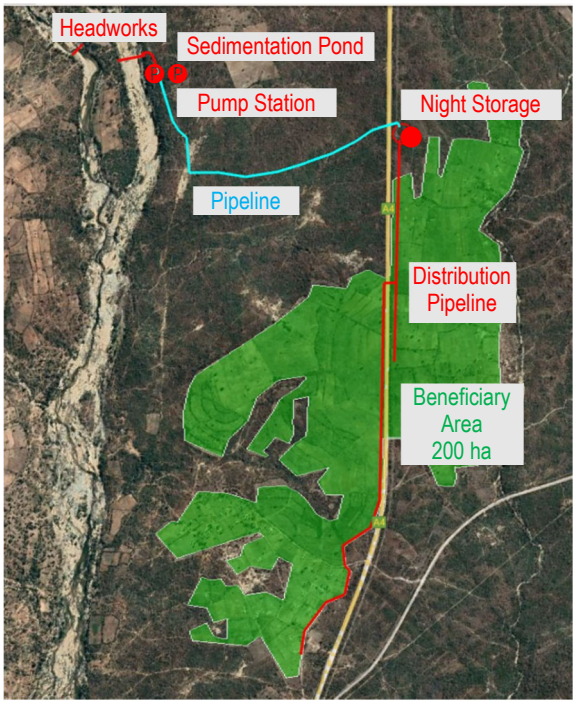


Figure 6.6.8 Facility Layout Plan

Table 6.6.5 Specification of the Facilities

Facilities	Specification
Headworks	H =4m B =225m
Sedimentation Pond	1 unit
Pumps	110 kW x 2 units
Pipeline	Φ=400 mm、L=1.7 km
Night Storage	V=9,100 m^3
Distribution Pipeline	Φ=400~500 mm L=4.1 km
Beneficiary Area	Under Surface Irrigation: 200 ha Under Water-saving irrigation: 200 ha * The 200 ha is the maximum area defined by topographical conditions and cannot be increased by introducing water-saving irrigation.

The noted points to plan the facility layout is shown in Table 6.6.6.

Table 6.6.6 Points to be Noted for Facility Layout

Target Facilities	The Direction of Facility Layout Plan
Headworks: 2 places (The Tokwe River)	Since there is farmland in the sandbank of the Tokwe River, the headworks are layouted at the upstream of the sandbank so as not to affect the farmland. In addition, the location of the headworks is the point where the rock foundation of the headworks is exposed, and river width is narrow enabling the crest length short.
  Farmland in the sandbank	
Sedimentation Pond: 1 unit	Due to the riverbed condition of the Tokwe River, sediment control measures are necessary, thus a sedimentation pond is arranged at the pump station.
Pump Station: 1 unit (2 pump systems)	A pump station is arranged next to the sedimentation pond.
Pipeline: L=1.70 km	The existing pathway, which makes construction of the pipeline and land acquisition for the construction easy, is used as the route.

Target Facilities	The Direction of Facilities Layout Plan
  Existing pathway	
Night Storage: 1 unit	The night storage is arranged near the beneficiary area with higher elevation.
  Proposed construction site of Night storage	
Distribution Pipeline: L=4.10 km	The distribution pipeline is arranged along the route with highest elevation that can distribute water to all the beneficiary area.

(3) Related Facilities

In addition to the main facilities mentioned above, the following related facilities are planned to be installed.

1) Standby generator

The results of the interviews with the IMC of the existing irrigation scheme (Biri Extension irrigation scheme in Mundi Mataga Area, irrigated area 145 ha) revealed the followings.

- The electricity supply in Zimbabwe is erratic, and irrigation pumps are deactivated during the daytime, resulting in occasional interruptions of the irrigation water supply.
- On the other hand, sometimes power is restored during the night time, and when this happens, beneficiary farmers have to work in the dark. In addition to the physical dangers of working in the dark, there is a high proportion of women and elderly people working on farms, and a high risk of crime.

Taking into account these situations, a standby generator is planned to be installed to cope with the unstable power supply and to avoid night work.

2) Storage house

In the past till 2002, GMB has come to the field to buy crops even if the volume of sales was small. Now, however, the GMB only picks up the crop if the volume of sales exceeds 10 ton, and if the volume

is less than 10 ton, the beneficiary farmers have to transport the crop to the GMB by themselves.

Taking into account the situation above, a storage house is planned to be installed in order to 1) ensure the volume of agriculture production exceeds 10 tons by gathering from each beneficiary farmers under the IMC, 2) create a situation where GMB comes to the farmland from their side, 3) improve access to markets through 1) and 2), and 4) increase beneficiary farmers' income.

6.6.5 Environmental and Social Consideration

(1) Natural Environment Aspects

The source of water for the new irrigation scheme will be Tokwe River which is the downstream of Muzhwi Dam. The water flow of the Tokwe River is low at present because of the low water discharge from the Muzhwi Dam. In case of the development of irrigation scheme, water volume of Tokwe River will be increased with securing the continuous flow from Muzhwi Dam and positive impacts are expected on aquatic biodiversity in the river

Figure 6.6.9 Condition of Tokwe River at Planned Intake Point

It was confirmed that there are some farmers who use the land of sandbank of river as farmlands near the intake point. Although it is possible to avoid the impacts of water level raising at these farmlands by locating the intake point (headworks) at upstream of those lands, such farmland use should be restricted in the river considering the risk of sudden flooding. Further survey is necessary to confirm if any other similar farmers exist or not in the upstream side of the planned intake point of river. Also, awareness should be given among local people for the safety of the river.

The area around Mushandike Dam reservoir is designated as a protected area of Mushandike Sanctuary. Mushandike Dam is located at around 20 km north of the planned irrigation scheme. Mushandike Dam is not the source of planned irrigation scheme and location of Sanctuary is 20 km far from the scheme. Therefore, the project activities will not affect to the Mushandike Sanctuary. Any other protected areas or important biodiversity areas (Ramsar wetlands, IBAs) are not located in and around the project area.

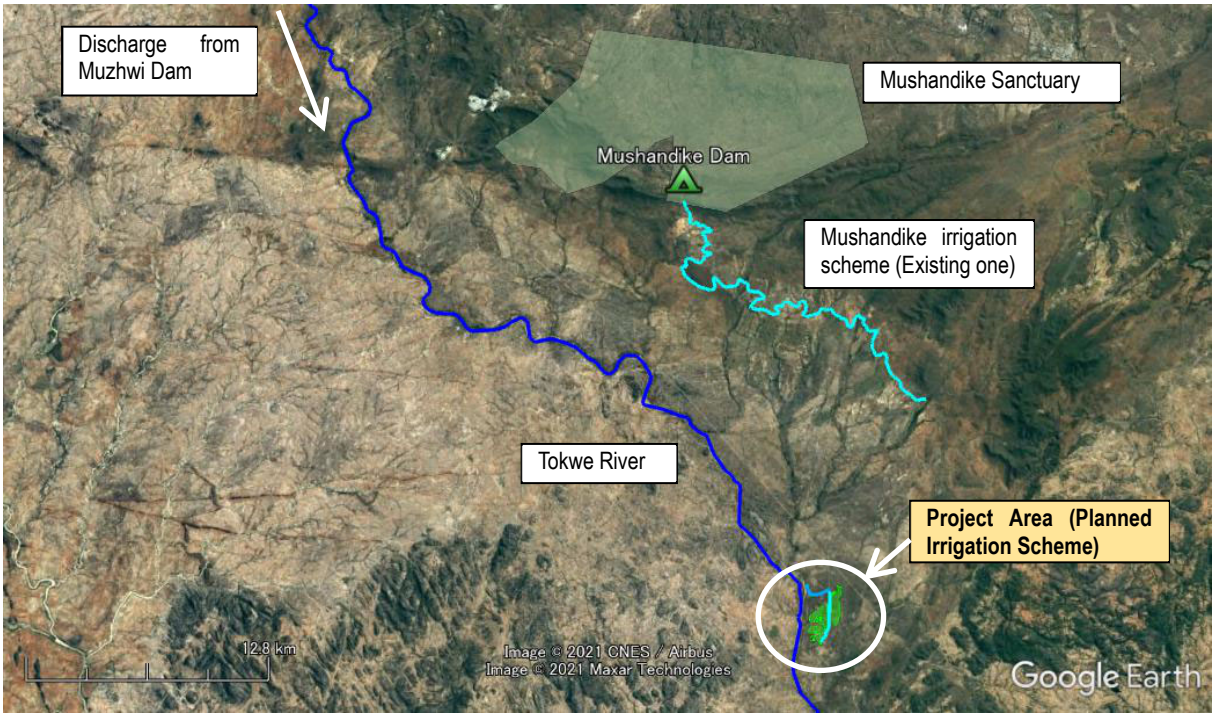


Figure 6.6.10 Location of the Mushandike Sanctuary (Protected Area) and Planned Irrigation Schem

(2) Social Environment Aspects

The beneficiary areas of the proposed irrigation scheme are composed of Villages No. 17-C, 18-A and 19-B belonging to the Mushandike Old Resettlement Area. The Old Resettlement Area is the areas that were settled under the Old Resettlement Programme of GoZ (1980-1998).

The whole of the Mushandike Old Resettlement Area comprises villages No.1 to No. 37, which were settled by the people from the neighbouring Communal Lands. Villages are called by only village No. and have no specific name. As the result of the expansion of the villages by the descendants of settlers, the original villages are called A and the enlarged villages are called B or C. The number of farmers in each village ranges from 30 to 100.

Villages No. 10 to 16, 21, 22 and 23 of the Mushandike Old Resettlement Area are irrigated by the existing irrigation scheme named as Mushandike Irrigation Scheme. Other villages are non-irrigated and depend on rain-fed agriculture (See Figure 6.6.11).

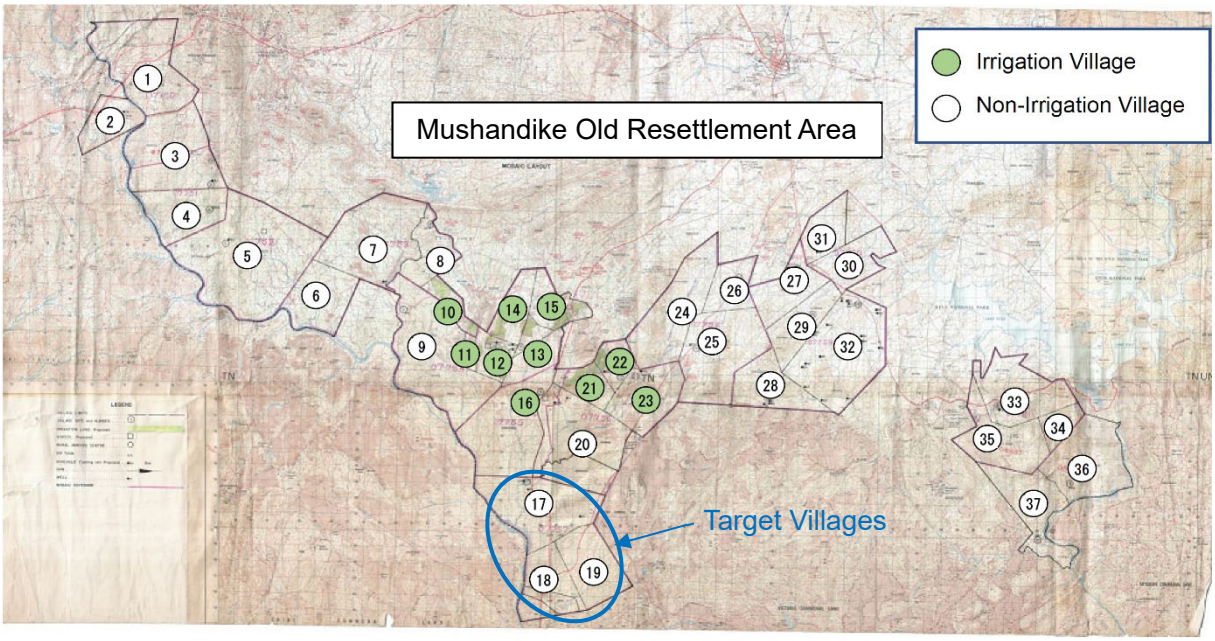


Figure 6.6.11 General Layout of Mushandike Old Resettlement Area

Source: Edited by the Survey team based on the map of department of land in Masvingo province

In case of the development of new irrigation scheme, the plots of the beneficiary area will be allocated equally to the beneficiary farmers of the area, including the current land users. The allocation of plots will be carried out under the management of Traditional Leaders and District Councils (see 3.6.1 for the detail).

The acquisition of lands for the proposed construction sites will be taken from the state lands since land ownership of the Old Resettlement Area belongs to the state and land use is managed by Traditional Leaders and District Council. In case of the land acquisition, coordination with those traditional decision-making organizations will be necessary.

(3) Scoping

Preliminary evaluation (scoping) of the environmental and social impacts on the planned new irrigation scheme development project is examined with reference to the general features of the irrigation project in Zimbabwe and the site conditions. The scoping result is shown in Table 6.6.7.

Table 6.6.7 Scoping Result for the Irrigation Scheme Development Plan in Muzhwi-Mushandike Area

Category	No.	Environmental Item	Scoping Result		Reason
			Construction Stage	Operation Stage	
Pollution	1	Air Quality	B-	D	**Construction stage:** Exhausts from the construction machineries and vehicles can be the causes of air pollution in the neighboring area of construction work, temporarily. Mitigation measures such as proper maintenance of heavy machineries and so on are required. **Operation stage:** Although the pump equipment will be operated, but the electrical driven pump will be selected. Therefore, air pollution in the operation stage is not anticipated.
	2	Water Quality	B-	B+	**Construction stage:** It is anticipated the adverse impact on water quality of the river during headworks construction work. Proper countermeasures such as installing silt fence are necessary in order to minimize water pollution in the river. **Operation stage:** Positive impacts are expected for water quality of Tokwe River since the water volume of river will be increased with constant discharge from Muzhwi Dam.
	3	Waste/ Garbage	B-	D	**Construction stage:** Generation of the construction wastes by the removal work of existing structures, removal sand by the excavation work, and garbage from workers camp and so on., are anticipated. Proper treatment of such wastes is required. **Operation stage:** Impacts are not anticipated.
	4	Soil Contamination	B-	D	**Construction stage:** Leakage of the oils from construction machinery can be the cause of soil contamination. Mitigation measures such as proper maintenance of heavy machineries are required. **Operation stage:** Impacts are not anticipated.
	5	Noise and Vibration	B-	B-	**Construction stage:** Impacts of noise and vibration around construction sites are anticipated. Considerations for the neighboring area of construction sites are necessary such as avoiding nighttime construction works, and so on. **Operation stage:** Impacts are not anticipated.
	6	Subsidence	D	D	The works affecting to land subsidence are not anticipated.
	7	Odor	D	D	The works generating odor are not anticipated.
	8	Sediment	B-	B-	**Construction stage:** During the construction work of the headworks, proper coffering work should be selected to secure the flow of sands from upstream to downstream. **Operation stage:** Installment of scour gate, sedimentation pond at the headworks is necessary as the countermeasures of sedimentation of rivers.
Natural environment	9	Protected Areas	D	D	There are no protected areas for habitats such as national protection areas, Ramsar convention wetlands, Important Bird Areas (IBAs) in the project area.
	10	Ecosystem	C	B+	**Construction stage:** Minor impacts on river works are expected, but large scale impacts on ecosystems are unlikely. **Operation stage:** Positive impacts are expected on the aquatic biodiversity of the river since water volume of the river will be increased with constant discharge from Muzhwi dam.
	11	Hydrology	B-	C	**Construction stage:** During the construction work of the intake weir, proper coffering work should be selected to secure the water flow from upstream to downstream. **Operation stage:** The water level of Tokwe River will be increased due to the discharge from Muzhwi Dam. The situation around the river due to rising water level should be considered, especially during commissioning.

Category	No.	Environmental Item	Scoping Result		Reason
			Construction Stage	Operation Stage	
	12	Topography and Geology	D	D	The works affecting to the existing topography and geology in the area are not anticipated since large scale earth filling and cutting works is not planned.
Social environment	13	Resettlement	C	C	**Construction and Operation stage**: Land acquisitions are expected at the locations of planned construction sites such as pipelines, night storage. Lands will be acquired from state lands and coordination with the local traditional decision-making organizations is necessary during acquisition process. It is necessary to avoid or minimize the impact of house relocation with considering the facility layouts to avoid the existing settlements.
	14	The poor	B^+	A^+	**Construction stage:** Positive impacts are expected since the project may create job opportunities for construction works. **Operation stage:** Positive impacts are expected since the project contributes to the beneficiary farmers' livelihood including poor people through the conversion from rainfed agriculture to irrigated agriculture.
	15	Ethnic Minorities and Indigenous Peoples	D	D	There are no ethnic minorities and indigenous people in the project area.
	16	Livelihood/ local economy	B^+	A^+	**Construction stage:** Positive impacts are expected since the project may create job opportunities for construction works. **Operation stage:** Positive impacts are expected since the project contributes to the beneficiary farmers' livelihood including poor people through the conversion from rainfed agriculture to irrigated agriculture.
	17	Land use and local resource utilization	B^-	D	**Construction stage:** In case the land development is included in the project component, construction works affect to the existing land use of farmlands. Mitigation measures are necessary such as implementing construction work during agricultural off-season. **Operation stage:** Impacts are not anticipated.
	18	Water Usage or Water Rights and Rights of Common	B^-	A^+	**Construction stage:** River work may impact on the existing water use of neighboring people such as for livestock drinking. Mitigation measures are necessary such as the provision of livestock watering space and so on. **Operation stage:** Positive impacts are expected among the beneficiary farmers for stable water use for irrigational agriculture.
	19	Existing social infrastructures and services	B^-	D	**Construction stage:** Due to the increasing of construction vehicles, local transportation around construction area may be affected. Mitigation measures are necessary such as proper allocation of traffic guards, and so on. **Operation stage:** Impacts are not anticipated.
	20	Social institutions	C	C	**Construction stage:** Land acquisitions are expected at the locations of planned construction sites such as pipelines, night storage. Coordination with the local traditional decision-making organizations is necessary during acquisition process. **Operation stage:** In case the land development is included in the project component, allocation of farmland plots will be managed by the traditional decision-making organizations. It will be necessary to coordinate with theses traditional organizations in the process of support to beneficiary farmers including the establishment of Irrigation Management Committees (IMCs).
	21	Misdistribution of benefit and damage	C	C	**Construction stage:** In case the land development is included in the project

Category	No.	Environmental Item	Scoping Result		Reason
			Construction Stage	Operation Stage	
	22	Conflict			component, it is expected the construction works will affect to the existing agricultural activities during construction period. Consideration should be given to the allocation of farmland plots after land development such as prioritization to the existing farmers. **Operation stage:** In case the land development is included in the project component, allocation of farmland plots will be managed by the traditional decision-making organizations. In the case of similar projects in Zimbabwe, farmland plots are allocated equally to the beneficial farmers. Same consideration should be given in the project.
	23	Cultural heritage	D	D	There are no cultural heritages around project area.
	24	Land scape	D	D	There are no project components affecting land scape.
	25	Gender	D	D	No impacts are expected during both construction and operation stages.
	26	Rights of the Child	D	D	No impacts are expected during both construction and operation stages.
	27	Hazards (Risk), Infectious diseases such as HIV/AIDS	B-	D	**Construction stage:** There are risks of spreading infection diseases such as HIV due to the entering of construction workers into the area. **Operation stage:** Impacts are not anticipated.
	28	Work environment (including safety)	B-	D	**Construction stage:** Safety and health of construction workers shall be considered during construction work. **Operation stage:** Impacts are not anticipated.
Others	29	Accident	B-	D	**Construction stage:** There are risks of accidents by operating construction machineries, vehicles and so on, during construction work. **Operation stage:** Impacts are not anticipated.
	30	Transboundary impact, climate change	D	A+	**Construction stage:** Impacts are not anticipated. **Operation stage:** Positive impacts are significantly expected. The development of irrigation scheme will lead to the shift from rainfed agriculture to stable irrigated agriculture. This will have a significant positive impact on the livelihoods of the beneficiary farmers, who have been vulnerable to climate change.

A+/-: Significant positive/negative impact is expected. B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. D: No impact is expected.

(4) Evaluation of the Environmental Category (Proposed)

Detail examinations for environmental and social impact assessments, mitigation measures and monitoring plan formulations for new irrigation project need to be carried out by further surveys in the later stage.

As the result of preliminary evaluation at screening stage, it is assumed the project will fall under Category B in the category classification of JICA environmental and social consideration guideline with the reasons of 1) the project area is not located in sensitive area such as national protected areas and other important biodiversity areas, 2) large scale involuntary resettlement and/or land acquisition are not expected and the 3) project scale and components of new project are similar to past JICA irrigation project (Nyakomba Irrigation Scheme Development Project) with Category B.

6.6.6 Project Cost

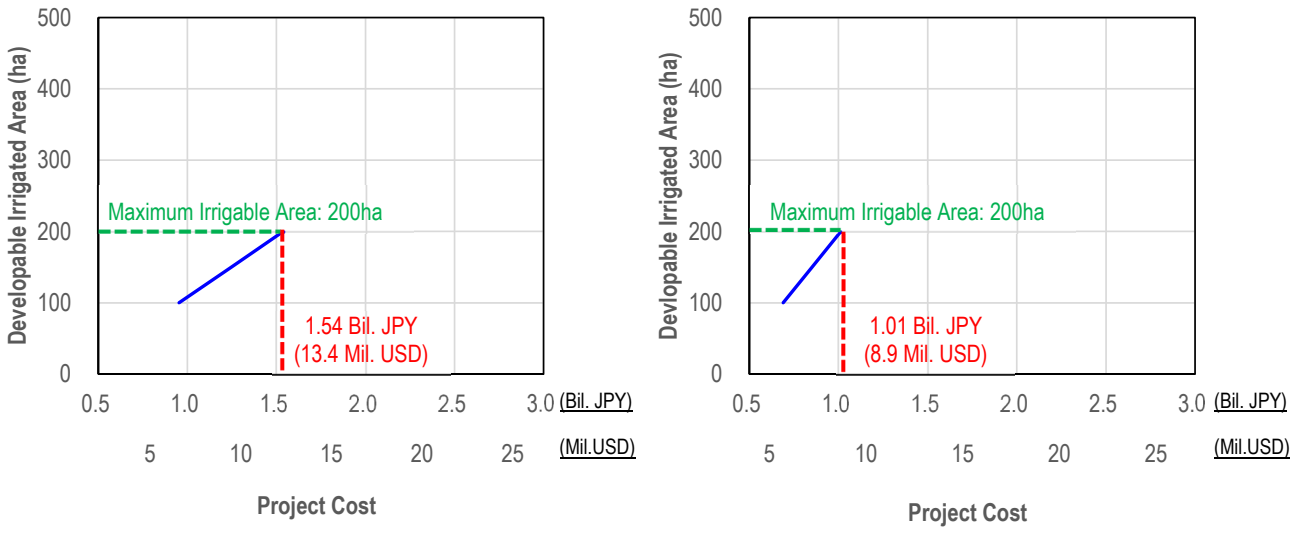
The project cost for several cases with different target beneficiary area scale with conditions below is calculated to understand the relationship between the project cost and the developable irrigated area.

(1) Exchange Rate:1 USD=114.674 JPY (JICA Settlement Rate: 2022 January)
(2) Unit Price: Estimate by quotation from Zimbabwean companies
(3) Indirect Cost: 58% of direct cost (calculated from quotations from Zimbabwean companies)
(4) Construction Cost under the Grant Aid Project: 150% of the construction cost in case Zimbabwean contractor implements
(5) Design and Supervision Fee: 8% of the construction cost under the Grant Aid Project
(6) Soft Components: 2% of the construction cost under the Grant Aid Project
(7) Preliminary Costs: 5% of total of construction cost under the Grant Aid Project, design and supervision fee, and soft components

The relationship between the project cost and the developable irrigated area is calculated for two cases, development of on-farm facilities and land development are implemented under the Grant Aid Project or by Zimbabwean side.

The results of the calculations are shown in Figure 6.6.12. The project cost includes the cost of replacing the valve of the dam intake tower. Also, cost for on-farm facilities is in case of water-saving irrigation.

The total area of 200 ha can be irrigated for approximately 1.54 billion JPY (=13.4 million USD) in case the on-farm facilities and land development are implemented under the Grant Aid Project, and for approximately 1.01 billion JPY (= 8.9 million USD) in case they are implemented by Zimbabwean side. However, due to topographical conditions, the irrigated area cannot be increased beyond 200 ha.



1) In case on-farm facilities and land development are implemented under Grant Aid Project.

2) In case on-farm facilities and land development are implemented by Zimbabwean Side

Figure 6.6.12 Relation between Project Costs and Developable Irrigated Area

6.7 NEW IRRIGATION DEVELOPMENT PLAN (MANYUCHI AREA)

6.7.1 Outline of the Water Resources Development Plan

The Manyuchi dam, the water source for the Area, was constructed by a private company to supply irrigation water to the sugar cane plantations near Mwenezi.

Some time after the construction of the dam, the operation of the dam was transferred from the private company to the State of Zimbabwe, and the private company which paid the initial cost of construction has the right to use 80% of the available capacity and the State of Zimbabwe has the right to use 20%. The private company have not contributed to the O&M of the dam as they have paid the initial cost of construction, but an agreement has been concluded between the State of Zimbabwe and the private company under which the private company will also contribute to the cost of O&M from 2029.

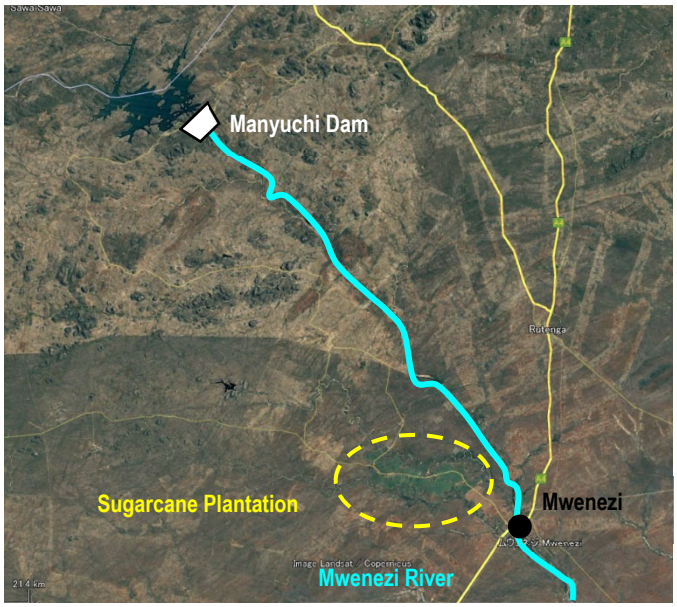


Figure 6.7.1 Manyuchi Dam Water Resources Development Plan

At the time of the Survey, 16,415 ha were already irrigated, additionally water was supplied to 500 ha of orange plantations, urban water supplies and national parks. Based on the available water for irrigation at Manyuchi Dam, it is estimated that 1,000 ha could be irrigated by surface irrigation.

6.7.2 Selection of a Region for Irrigation Scheme Development

DOI has selected the Regions in Manyuchi Area shown in Table 6.7.1 as high priority regions for the development of irrigation schemes, and the target Region is selected from these regions. It should be noted that the figures in the table are planned values and it has been confirmed that there is no problem to increase or decrease them. Pump irrigation is required in all the regions. In particular, in Mhoromokwa, Pakini Jawanda and Magomana regions, which are located upstream from the dam, direct intake of water from the reservoir, for example by setting pumps on floating piers, is required.

Table 6.7.1 Priority Regions for Irrigation Scheme Development

Regions	District	Planned Beneficiary Area
Mhoromokwa	Mwenezi	200 ha
Pikini Jawanda	Mwenezi	400 ha
Magomana	Mwenezi	200 ha
Murove	Mwenezi	200 ha
Chizumba	Mwenezi	120 ha
Dinhe	Mwenezi	70 ha
Lapache	Mwenezi	600 ha
Malikango	Chiredzi	200 ha

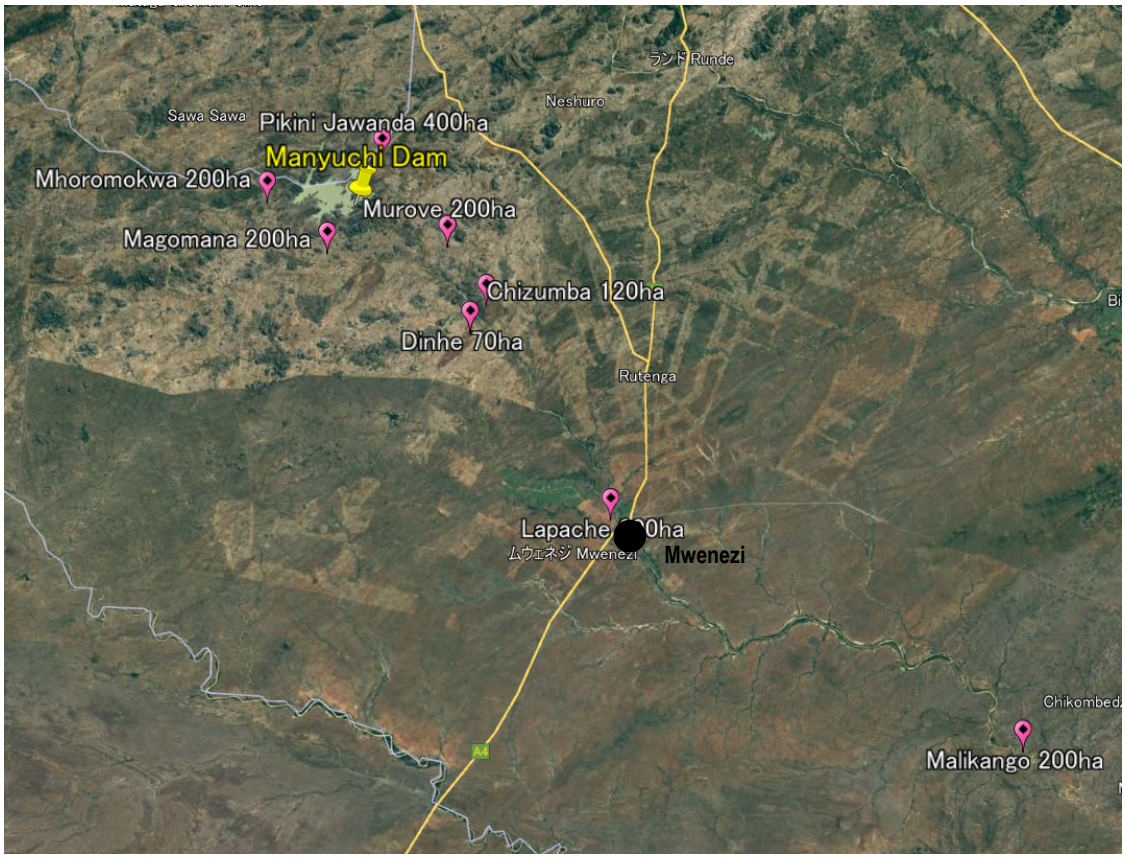


Figure 6.7.2 Location of the Priority Regions

The selection criteria are shown in Table 6.7.2

Table 6.7.2 Criteria for Selecting Region for Irrigation Scheme Development

Item	Selection criteria	Remarks
Technical Feasibility	It does not require direct water take from the reservoir.	It is technically difficult to take water from the reservoir directly.
Market access	The distance from the beneficiary area to the main road is not too far.	
Conflict with other projects	A region has no irrigation projects implemented/planned by GoZ and/or other development partners.	The implementation of multiple projects under the same IMC can lead to disparities between beneficiary farmers and disputes between beneficiaries (for example, disputes over water use costs).
Land use	Many of the beneficiary areas are Communal Land or Old Resettlement Area.	The beneficiaries of the New Irrigation Development are small-scale farmers.
Main crops	The main crop is an agricultural product other than fodder crops.	An objective of New Irrigation Development is to increase food self-sufficiency.

The results of comparing the status of each candidate region with the above criteria are shown in Table 6.7.3. The Dinhe Region is selected as the target Region for the irrigation scheme development as it satisfies all the criteria. In the Dinhe Region, irrigation facilities were already provided by CESVI, but the pumps are out of order and irrigation is not being implemented. The beneficiary farmers have been interviewed and they are of the opinion that the beneficiary areas where the CESVI facilities have been deployed can be included in the target beneficiary area of this Survey, but subject to consultation between the concerned parties.

Table 6.7.3 Selection of the Target Region

Item	Selection Criteria				
	Technical Feasibility (water take directly from the reservoir)	Market Access (Distance to main road)	Other Irrigation Projects	Land use	Main crops
Mhoromokwa	Required	Not too far	None	Communal Land	Other than feed crops
Pikini Jawanda	Required	Far away	GCF	Communal Land	Other than feed crops
Magomana	Required	Not too far	None	Communal Land	Other than feed crops
Murove	Unnecessary	Far away	CESVI	Communal Land	Other than feed crops
Chizumba	Unnecessary	Far away	CESVI, GCF	Communal Land	Other than feed crops
Dinhe	**Unnecessary**	**Far away**	**CESVI (no longer functional)**	**Communal Land**	**Other than feed crops**
Lapache	Unnecessary	Close	None	A1 and A2 Farm	Fodder crops
Malikango	Unnecessary	Too far	None	Communal Land	Other than feed crops

: Match with the criterion

6.7.3 Current Status of the Irrigation Scheme Development Target Region

(1) Water Body Structures (Dam and related Facilities)

Manyuchi Dam has three units of discharge facilities, and two out of three are equipped with a valve for each. The purpose of the valves is to discharge water into the downstream river, and the remaining unit is for a future power generation facility.

The valves on these two units are in good working order and it has been determined that there are no items that need to be addressed by the Grand Aid Project.

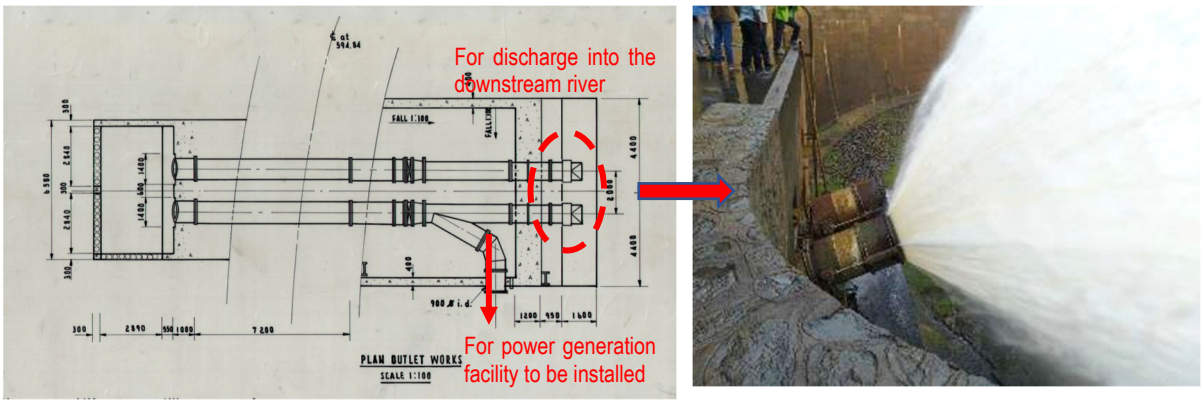


Figure 6.7.3 Status of the Discharge Facilities

(2) Farming Activities

1) Non-irrigated area

In the non-irrigated area in Manyuchi Area, the farmers practice rainfed cultivation. The main cultivated crops are maize, sorghum, ground nuts, bambara beans, millet and cotton, which are with strong drought resistance. The typical crop planting period is as shown in Figure 6.7.4. The farmers cannot plant any crops during dry season since there is no rainfall.

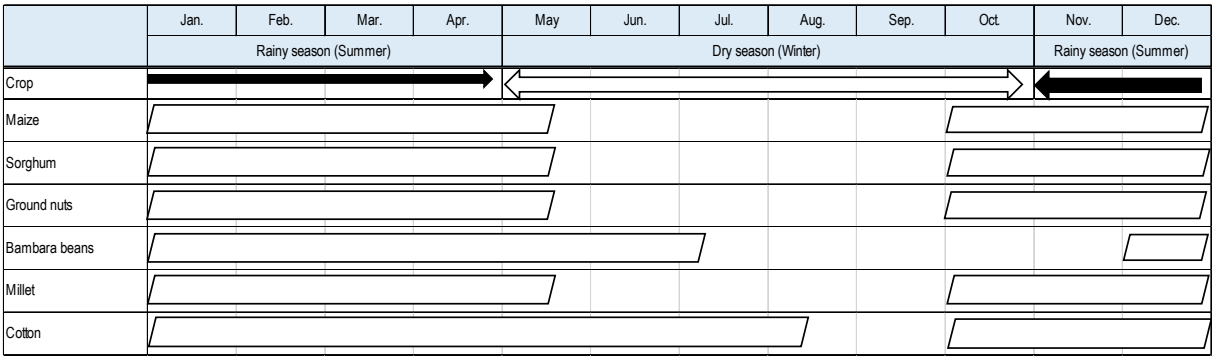


Figure 6.7.4 Crop Planting Period of the Typical Crops (Non-Irrigated Area)

The average of cropping area is 2 ha by each beneficiary farmer in this non-irrigated area. Major cultivated crops and area are 0.5 ha of maize, 0.25 ha of sorghum, 0.25 ha of millet, 0.2 ha of ground nuts, 0.2 ha of bambara beans and 0.6 ha of cotton.

The farmer's gross income is calculated based on this ha, yield of each crop and the selling price. However, since the yield of maize does not reach the amount of self-consumption, the shortfall is assumed to have been purchased and is reduced from the gross income. The estimated farmer's gross income in non-irrigated area is about 99.45 USD per year as shown in Table 6.7.4

Table 6.7.4 The Estimated Farmer's Gross Income（Non-irrigated area）

Crop	Cultivated Area (ha)	Yield / Area (ton/ha)	Yield (ton)	Self-Consumption (ton/household)	Yield – Self-Consumption (ton)	Sales Price (USD/ton)	Gross Income (USD)
Maize	0.50	0.20	0.100	0.75	▲ 0.65	333.0	▲ 216.45
Sorghum	0.25	0.25	0.625	-	-	150.0	93.75
Ground nuts	0.20	0.30	0.060	-	-	330.0	19.80
Bambara beans	0.20	0.10	0.020	-	-	330.0	6.60
Millet	0.25	0.25	0.625	-	-	150.0	93.75
Cotton	0.60	0.20	0.120	-	-	850.0	102.00
Total	2.00	-	-	-	-	-	99.45

2) Irrigated area

The survey for the Murove irrigation scheme (existing irrigation scheme) in the Manyuchi Area was conducted to examine the assumed situation after irrigation scheme is developed. The Murove irrigation scheme has been being developed with the support from CESVI, an international NGO in Italy, and 110 beneficiary farmers collective their farmland and carry out a farming business in which a total of 30 ha of farmland. The centre pivot irrigation system has been introduced under the initiative of CESVI. All the beneficiary farmers cultivate jointly paprika 10 ha and sugar beans 20 ha. The beneficiary farmers started to cultivate the green maize 20 ha from this year. There is no self-consumption since all the crops under contracted cultivation, and all the agricultural products are sold to contracted company. The typical crop planting period is as shown in Figure 6.7.5.

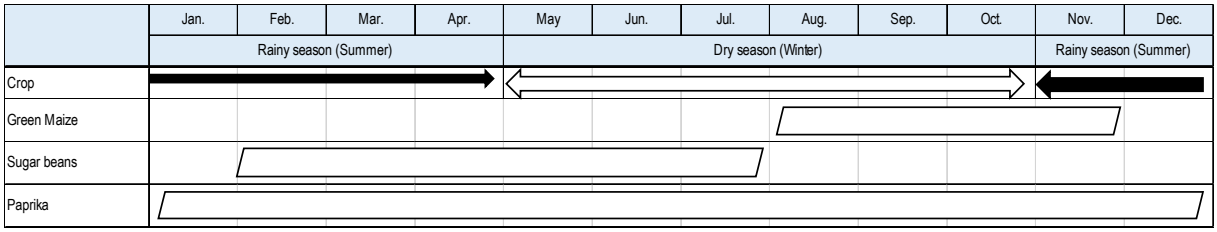


Figure 6.7.5 Crop Planting Period of the Typical Crops (Irrigated Area)

Although 30 ha of farmland is shared, the average of farmland per one beneficiary farmer is 0.27 ha only. Based on this ha per one beneficiary farmer, the estimates of changes in farmland use ratio before and after irrigation are as shown in Table 6.7.5.

Table 6.7.5 The Estimating Changes in Farmland Use Ratio before and after Irrigation

Crop	Cultivated Area before Irrigation (ha)	Cultivated Area after Irrigation (ha)	Increased Farmland Use Ratio (%)
Maize	0.50	0.0	-
Sorghum	0.25	0.0	
Ground nuts	0.20	0.0	-
Bambara beans	0.20	0.0	-
Millet	0.25	0.0	-
Cotton	0.60	0.0	
Green maize	0.0	0.18	-
Sugar beans	0.0	0.18	-
Paprika	0.0	0.09	
Total	2.0	0.45	22.5

The cultivated area after irrigation is smaller than the before one. The farmland use ratio after irrigation is 22.5 % compared to before irrigation. However, the beneficiary farmers integrate their farmland to be 30 ha, the centre pivot irrigation system was introduced, and it leads to increase in their work efficiency. Also, as the beneficiary farmers can plant the same crops at large scale farmland, it is that they get advantage in high volume of selling agricultural products, and possible to profitable marketing. For this reason, the beneficiary farmers in the Murove irrigation scheme have the contract with agricultural company and the selling price is also high. The estimation of beneficiary farmer's gross income per year in this area are shown in Table 6.7.6.

Table 6.7.6 The Estimated Farmer's Gross Income（Irrigated area）

Crop	Cultivated area (ha)	Yield / area (ton/ha)	Yield (ton)	Self-consumption (ton/household)	Yield – Self-consumption (ton)	Sales price (USD/ton)	Gross income (USD)
Maize	0	0	0	0.75	▲ 0.75	333.0	▲ 249.75
Green Maize	0.18	9.0	1.620	-	-	1,250.0	2,025.00
Sugar beans	0.18	2.5	0.450	-	-	1,860.0	837.00
Paprika	0.09	2.3	0.207	-	-	1,500.0	310.50
Total	0.45	-	-	-	-	-	2,922.75

The sales prices of the crops are high due to contract farming, and the unit yield (ton/ha) is also high. As a result of this high sales price and high unit yield, even after deducting the purchase cost of maize for self-consumption, the gross income is 2,922.75 USD, which is about 29 times that of 99.45 USD in the non-irrigated area. Although the sugar beans and paprika have been the main products until now, the green maize will be cultivated after harvesting sugar beans with the purpose of income increasing. In particular, the optimum seeding time for green maize is after the end of July or after August, which is the dry season avoiding the frost timing. The green maize can be cultivated using irrigation water during this period (after end of July) is a great advantage for farmers' income.

6.7.4 Facility Layout Plan

(1) Basic Policy

The facility layout is planned following the same policy as in the Muzhwi-Mushandike area (see 6.6.4 for the detail).

(2) Facility Layout

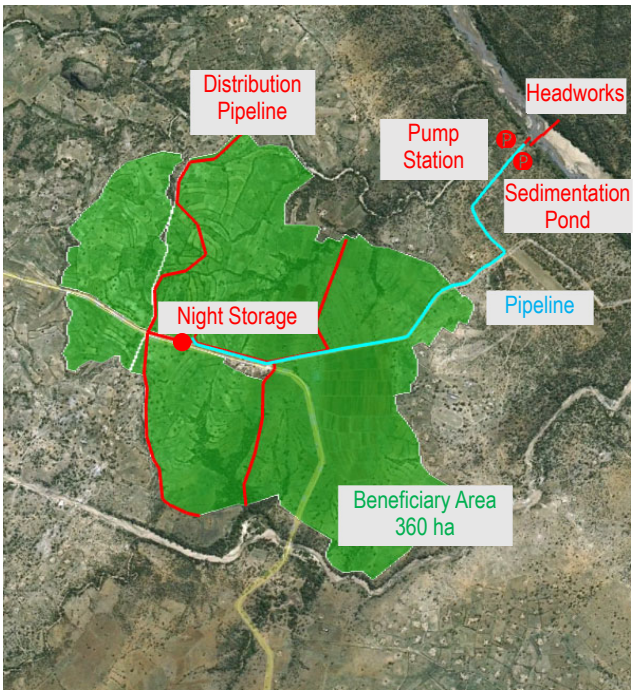


Figure 6.7.6 Facility Layout Plan

Table 6.7.7 Specification of the Facilities

Facilities	Specification
Headworks	H＝3 m B＝240 m
Sedimentation Pond	1 unit
Pumps	132 kW x 4 units
Pipeline	Φ=500 mm、L=3.0 km
Night Storage	V= 14,000 m3
Distribution Pipeline	Φ=250~300 mm L=6.6 km
Beneficiary Area	Under Surface Irrigation: 360 ha Under Water-saving irrigation: 360 ha * The 360 ha is the maximum area defined by topographical conditions and cannot be increased by introducing water-saving irrigation.

The noted points to plan the facility layout is shown in Table 6.7.8.

Table 6.7.8 Points to be Noted for Facility Layout

Target Facilities	The Direction of Facilities Layout Plan
Headworks: 1 place (Mwenezi River)	The location of headworks is where the rock foundation of the headworks is exposed, and river width is narrow enabling the crest length short is selected.
Sedimentation Pond: 1 unit	Due to the riverbed condition of the Mwenezi River, sediment control measures are necessary, thus a sedimentation pond is arranged at the pump station.
Pump Station: 1 unit (2 pump systems)	A pump station is arranged next to the sedimentation pond.

Target Facilities	The Direction of Facility Layout Plan
  Current Situation of intake facilities installed under CESVI project (Dysfunctional)	
Pipeline: L=3.00 km	The existing pathway, which makes construction of the pipeline and land acquisition for the construction easy, is used as the route.
Night Storage: 1 unit	The night storage is arranged near the beneficiary area with higher elevation.
 Current status of night storage constructed under CESVI project	
Distribution Pipeline: L=6.60 km	The distribution pipeline is arranged along the route with highest elevation that can distribute water to all the beneficiary area.
  Current status of distribution pipeline installed under CESVI project	

(3) Related Facilities

Following the same policy as in the Muzhwi-Mushandike Area, a standby generator and storage house are planned to be installed (see 6.6.4 for the detail).

6.7.5 Environmental and Social Consideration

(1) Natural Environment Aspects

The source of water for the new irrigation scheme will be Mwenezi River which is the downstream of Manyuchi Dam. The Manyuchi Dam currently discharges water into the Mwenezi River for agricultural purpose and river maintenance purposes. The Gonarezou National Park (505,300 ha) is located at 120 km downstream of Manyuchi Dam and 100 km downstream of the planned irrigation scheme. It is evaluated the impacts on the Gonarezou National Park by the project is not significant since the water intake for the planned irrigation scheme is not large scale and the location of the scheme is 100 km far from national park.

The planned irrigation scheme will consist of the Headworks - Sedimentation pond - Pump station - Night storage – Distribution pipeline - Beneficiary areas. All of the proposed construction sites are located in woodlands (shrubs, bushes, etc.) or agricultural lands where human activities are already carried out. Also, there are no protected areas and important biodiversity areas (Ramsar wetlands, IBAs) in and around the project area.

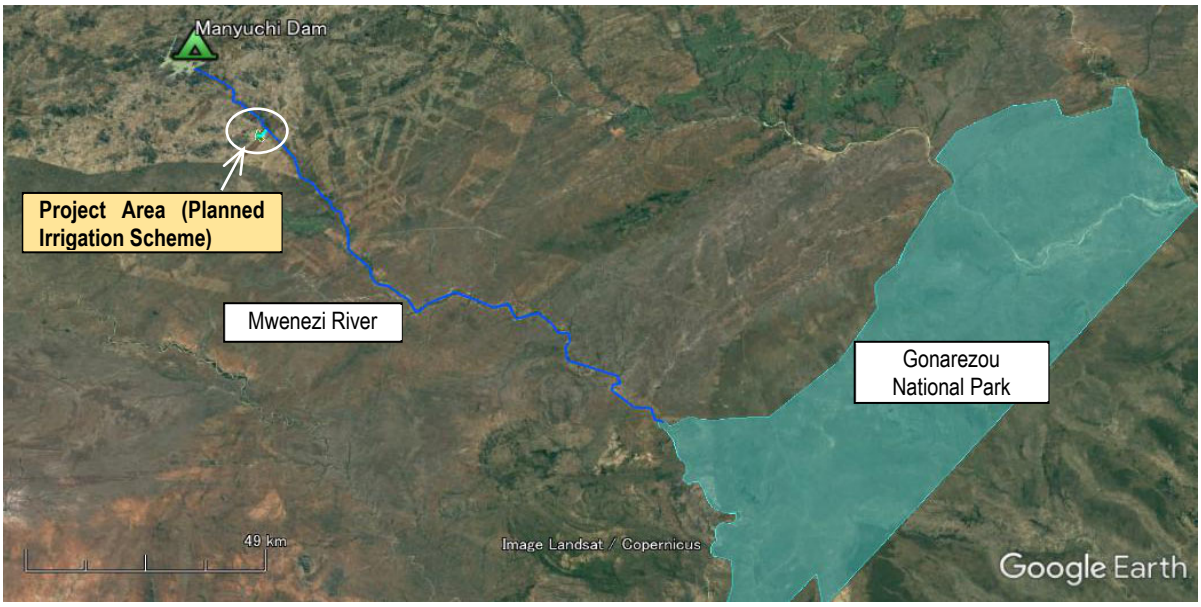


Figure 6.7.7 Location of the Gonarezou National Park (Protected Area) and Planned Irrigation Scheme

(2) Social Environment Aspects

The beneficiary area of the planned irrigation scheme is named as Dinhe Region which is located in the Communal Land. The name of the Communal Land is Maranda Communal Land. The Communal Land has been a Tribe Trust Land since around 1930, when people of African descent were forcibly relocated to the area and have lived there ever since. Historically, Communal Land has been allocated to the areas with poor farming conditions, where most of farmers are smallholder and generally subsistence farmers. Farmers in Communal Land strongly desire irrigational agriculture because its advantages in production and productivity against rainfed agriculture.

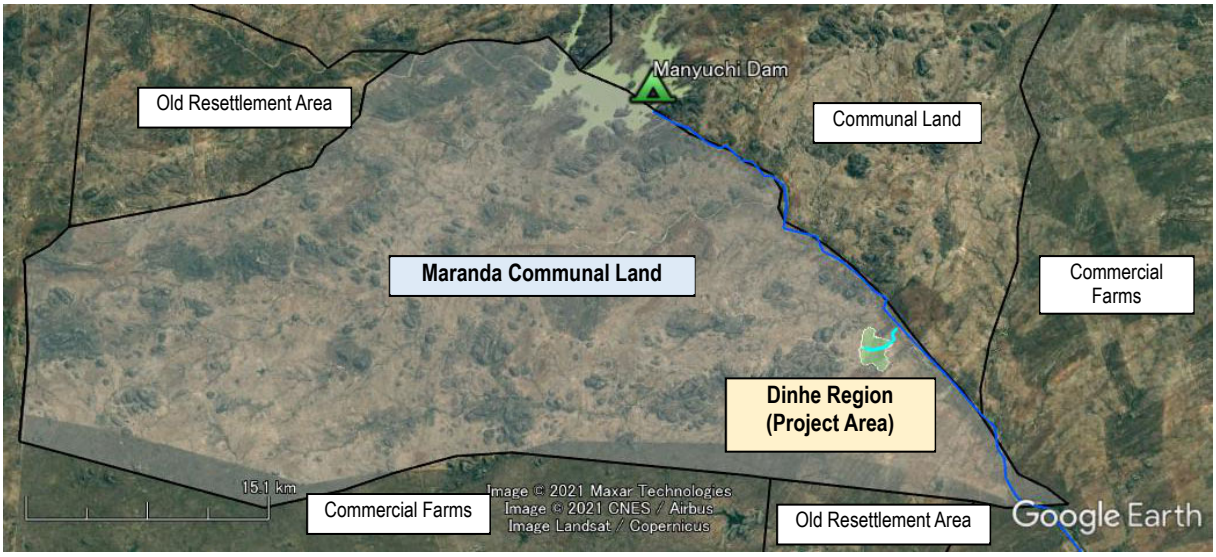


Figure 6.7.9 Land Category around the Project Area (Dinhe Region)

In the Dinhe Region, there are 30 ha of farming plots which have already been developed by CESVI, an Italian international NGO project. New irrigation scheme will be developed with integration of this existing farming plots. It will therefore require coordination and integration with the existing IMC for managing developed irrigation scheme.

Figure 6.7.8 Existing Farming Plots Developed by CESVI (30 ha)

In case of the new irrigation scheme development, the plots of farmlands will be allocated equally to the beneficiary farmers of the Region, including the current land users. The allocation of plots will be carried out under the management of Traditional Leaders and District Councils (see 3.6.1 for the detail).

The acquisition of lands for the proposed construction sites will be taken from the state lands since land ownership of the Communal Land belong to the state and land use is managed by Traditional Leaders and District Council. In case of the land acquisition, coordination with those traditional decision-making organizations will be necessary.

(3) Scoping

Preliminary evaluation (scoping) of the environmental and social impacts on the planned new irrigation scheme development project is examined with reference to the general features of the irrigation project in Zimbabwe and the site conditions. The scoping result is shown in the table below.

Table 6.7.9 Scoping Result for the Irrigation Scheme Development Plan in Manyuchi Area

Category	No.	Environmental Item	Scoping Result		Reason
			Construction Stage	Operation Stage	
Pollution	1	Air Quality	B-	D	**Construction stage:** Exhausts from the construction machineries and vehicles can be the causes of air pollution in the neighboring area of construction work, temporarily. Mitigation measures such as proper maintenance of heavy machineries and so on are required. **Operation stage:** Although the pump equipment will be operated, but the electrical driven pump will be selected. Therefore, air pollution in the operation stage is not anticipated.
	2	Water Quality	B-	D	**Construction stage:** It is anticipated the adverse impact on water quality of the river during headworks construction work. Proper countermeasures such as installing silt fence are necessary in order to minimize water pollution in the river. **Operation stage:** Impacts are not anticipated.
	3	Waste/ Garbage	B-	D	**Construction stage:** Generation of the construction wastes by the removal work of existing structures, removal sand by the excavation work, and garbage from workers camp and so on., are anticipated. Proper treatment of such wastes is required. **Operation stage:** Impacts are not anticipated.
	4	Soil Contamination	B-	D	**Construction stage:** Leakage of the oils from construction machinery can be the cause of soil contamination. Mitigation measures such as proper maintenance of heavy machineries are required. **Operation stage:** Impacts are not anticipated.
	5	Noise and Vibration	B-	B-	**Construction stage:** Impacts of noise and vibration around construction sites are anticipated. Considerations for the neighboring area of construction sites are necessary such as avoiding nighttime construction works, and so on. **Operation stage:** Impacts are not anticipated.
	6	Subsidence	D	D	The works affecting to land subsidence are not anticipated.
	7	Odor	D	D	The works generating odor are not anticipated.
	8	Sediment	B-	B-	**Construction stage:** During the construction work of the intake weir, proper coffering work should be selected to secure the flow of sands from upstream to downstream. **Operation stage:** Installment of scour gate, sedimentation pond at the headworks is necessary as the countermeasures of sedimentation of rivers.
Natural environment	9	Protected Areas	D	D	There are no protected areas for habitats such as national protection areas, Ramsar convention wetlands, Important Bird Areas (IBAs) in the project area.
	10	Ecosystem	C	D	**Construction stage:** Minor impacts on river works are expected, but large scale impacts on ecosystems are unlikely. **Operation stage:** Although the National Park is located downstream, it is not expected to be affected by the abstraction of water for irrigation scheme as the park is located 100km far from the scheme.
	11	Hydrology	B-	D	**Construction stage:** During the construction work of the headworks, proper coffering work should be selected to secure the water flow from upstream to downstream. **Operation stage:** Impacts are not anticipated.
	12	Topography and Geology	D	D	The works affecting to the existing topography and geology in the area are not anticipated since large scale earth filling and cutting works is not planned.

Category	No.	Environmental Item	Scoping Result		Reason
			Construction Stage	Operation Stage	
Social environment	13	Resettlement	C	C	**Construction and Operation stage**: Land acquisitions are expected at the locations of planned construction sites such as pipelines, night storage. Lands will be acquired from state lands and coordination with the local traditional decision-making organizations is necessary during acquisition process. It is necessary to avoid or minimize the impact of house relocation with considering the facility layouts to avoid the existing settlements.
	14	The poor	B^+	A^+	**Construction stage:** Positive impacts are expected since the project may create job opportunities for construction works. **Operation stage:** Positive impacts are expected since the project contributes to the beneficiary farmers' livelihood including poor people through the conversion from rainfed agriculture to irrigated agriculture.
	15	Ethnic Minorities and Indigenous Peoples	D	D	There are no ethnic minorities and indigenous people in the project area.
	16	Livelihood/ local economy	B^+	A^+	**Construction stage:** Positive impacts are expected since the project may create job opportunities for construction works. **Operation stage:** Positive impacts are expected since the project contributes to the beneficiaries' livelihood including poor people through the conversion from rainfed agriculture to irrigated agriculture.
	17	Land use and local resource utilization	B^-	D	**Construction stage:** In case the land development is included in the project component, construction works affect to the existing land use of farmlands. Mitigation measures are necessary such as implementing construction work during agricultural off-season. **Operation stage:** Impacts are not anticipated.
	18	Water Usage or Water Rights and Rights of Common	B^-	A^+	**Construction stage:** River work may impact on the existing water use of neighboring people such as for livestock drinking. Mitigation measures are necessary such as the provision of livestock watering space and so on. **Operation stage:** Positive impacts are expected among the beneficiary farmers for stable water use for irrigational agriculture.
	19	Existing social infrastructures and services	B^-	D	**Construction stage:** Due to the increasing of construction vehicles, local transportation around construction area may be affected. Mitigation measures are necessary such as proper allocation of traffic guards, and so on. **Operation stage:** Impacts are not anticipated.
	20	Social institutions	C	C	**Construction stage:** Land acquisitions are expected at the locations of planned construction sites such as pipelines, night storage. Coordination with the local traditional decision-making organizations is necessary during acquisition process. **Operation stage:** In case the land development is included in the project component, allocation of farmland plots will be managed by the traditional decision-making organizations. It will be necessary to coordinate with theses traditional organizations in the process of support to beneficiary farmers including the establishment of Irrigation Management Committees (IMCs).

Category	No.	Environmental Item	Scoping Result		Reason
			Construction Stage	Operation Stage	
	21	Misdistribution of benefit and damage	C	C	**Construction stage:** In case the land development is included in the project component, it is expected the construction works will affect to the existing agricultural activities during construction period. Consideration should be given to the allocation of farmland plots after land development such as prioritization to the existing farmers. **Operation stage:** In case the land development is included in the project component, allocation of farmland plots will be managed by the traditional decision-making organizations. In the case of similar projects in Zimbabwe, farmland plots are allocated equally to the beneficiary farmers. Same consideration should be given in the project.
	22	Conflict			
	23	Cultural heritage	D	D	There are no cultural heritages around project area.
	24	Land scape	D	D	There are no project components affecting land scape.
	25	Gender	D	D	No impacts are expected during both construction and operation stages.
	26	Rights of the Child	D	D	No impacts are expected during both construction and operation stages.
	27	Hazards (Risk), Infectious diseases such as HIV/AIDS	B-	D	**Construction stage:** There are risks of spreading infection diseases such as HIV due to the entering of construction workers into the area. **Operation stage:** Impacts are not anticipated.
	28	Work environment (including safety)	B-	D	**Construction stage:** Safety and health of construction workers shall be considered during construction work. **Operation stage:** Impacts are not anticipated.
Others	29	Accident	B-	D	**Construction stage:** There are risks of accidents by operating construction machineries, vehicles and so on, during construction work. **Operation stage:** Impacts are not anticipated.
	30	Transboundary impact, climate change	D	A+	**Construction stage:** Impacts are not anticipated. **Operation stage:** Positive impacts are significantly expected. The development of irrigation scheme will lead to the shift from rainfed agriculture to stable irrigated agriculture. This will have a significant positive impact on the livelihoods of beneficiary farmers, who have been vulnerable to climate change.

A+/-: Significant positive/negative impact is expected. B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. D: No impact is expected.

(4) Evaluation of the Environmental Category (Proposed)

Detail examinations for environmental and social impact assessments, mitigation measures and monitoring plan formulations for new irrigation project need to be carried out by further surveys in the later stage.

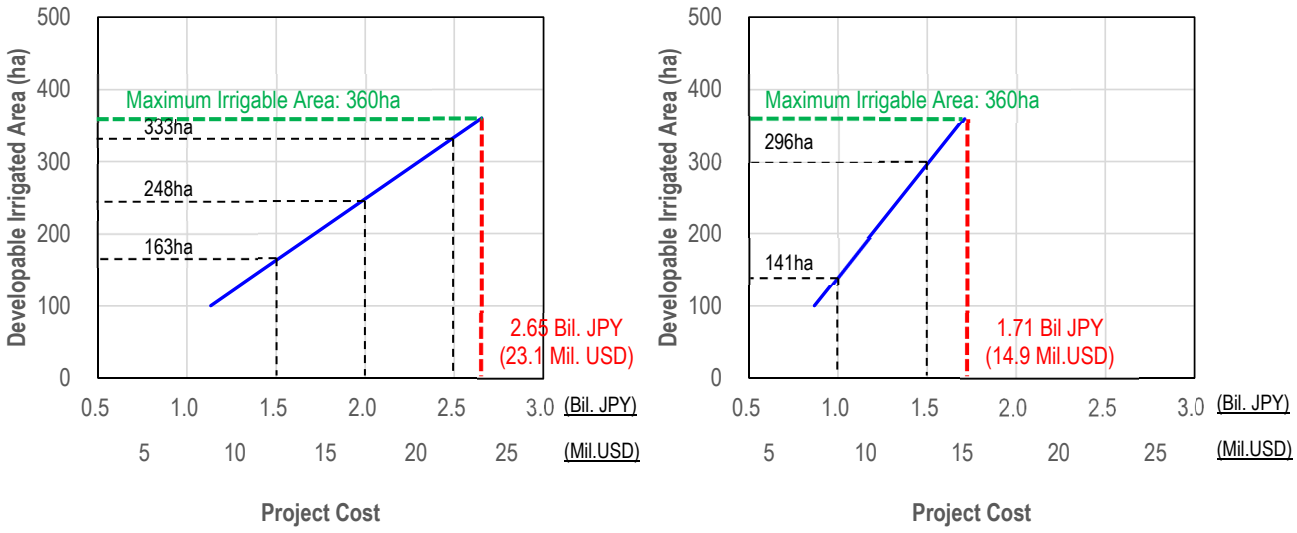
As the result of preliminary evaluation at screening stage, it is assumed the project will fall under Category B in the category classification of JICA environmental and social consideration guideline with the reasons of 1) the project area is not located in sensitive area such as national protected areas and other important biodiversity areas, 2) large scale involuntary resettlement and/or land acquisition are not expected and the 3) project scale and components of new project are similar to past JICA irrigation project (Nyakomba Irrigation Scheme Development Project) with Category B.

6.7.6 Project Cost

Project costs are calculated following the same policy as in the Muzhwi-Mushandike area (see 6.6.6 for the detail).

The results of the calculations are shown in Figure 6.7.10. Cost for on-farm facilities is in case of water-saving irrigation.

The total area of 360 ha can be irrigated for approximately 2.65 billion JPY (=23.1 million USD) in case the on-farm facilities and land development are implemented under the Grant Aid Project, and for approximately 1.71 billion JPY (= 14.9 million USD) in case they are implemented by Zimbabwean side. However, due to topographical conditions, the irrigated area cannot be increased beyond 360 ha.



1) In case on-farm facilities and land development are implemented by Grant Aid Project.

2) In case on-farm facilities and land development are implemented by Zimbabwean side

Figure 6.7.10 Relation between Project Costs and Developable Irrigated Area

6.8 NEW IRRIGATION DEVELOPMENT PLAN (MUNDI MATAGA AREA)

6.8.1 Outline of the Water Resources Development Plan

The Mundi Mataga Dam, the source of water for the Area, is on the same river as the Manyuchi Dam and provides 145 ha of irrigation and urban water supply.

Based on the available water for irrigation at the Mundi Mataga Dam, it is estimated that 855 ha can be irrigated by surface irrigation. However, as approximately 550 ha are planned for development by Zimbabwe side, the total area available for new development is approximately 300 ha (= 1,000 ha - 145 ha - 550 ha). Mundi Mataga Dam does not have the storage capacity aiming to supply to the Manyuchi dam (= Mundi Mataga Dam does not act as a water source of Manyuchi Dam), and therefore, all the water at the Mundi Mataga Dam can be utilised for the development of Mundi Mataga Area.

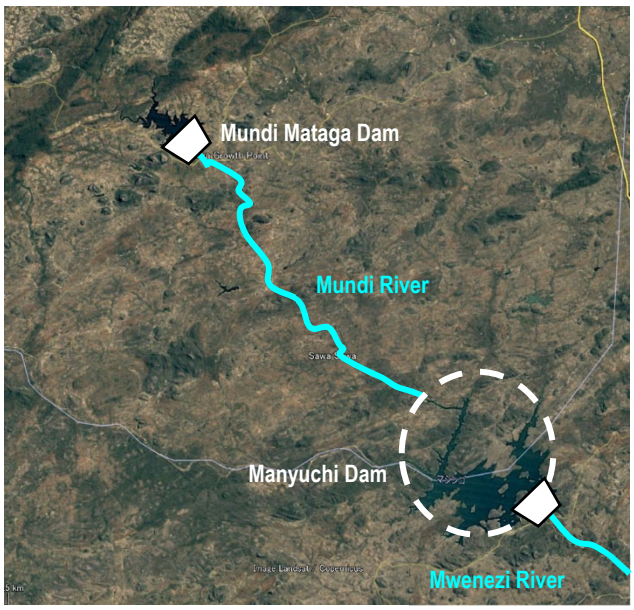


Figure 6.8.1 Location of the Mundi Mataga Dam and Manyuchi Dam

6.8.2 Selection of a Region for Irrigation Scheme Development

DOI recommended the irrigation scheme development in the region between Musume and Sawasawa (hereinafter referred to as the "Musume Region"), which is about 13 km downstream in a straight line from Mundi Mataga Dam. While, the Survey team considered that the Funye Region near Mundi Mataga Dam had advantages for the development. Therefore, a comparison of the two regions is made.

Since two types of methods to deliver water from dam to the Musume Region are considered, 1) pipeline water supply from the dam to the Musume Region and 2) once discharge into the river and take thorough headworks newly constructed, three plans are compared. As a result of a comparative study, the Funye Region is selected as the target Region, mainly because of its advantage in terms of construction and O&M costs (see Table 6.8.1)

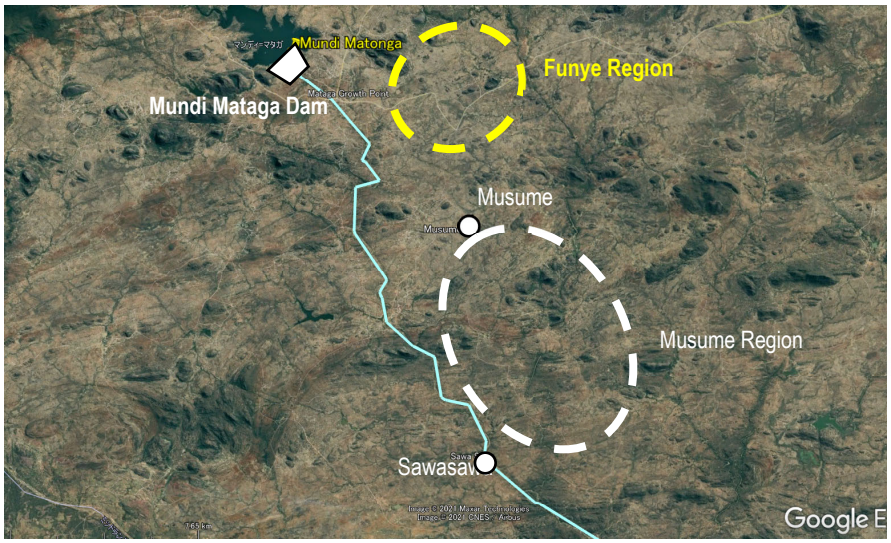
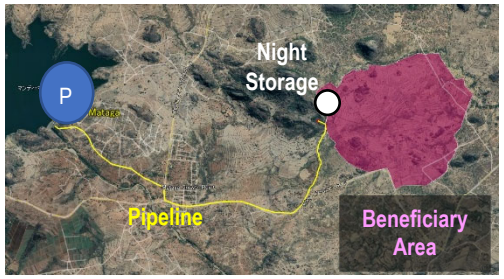
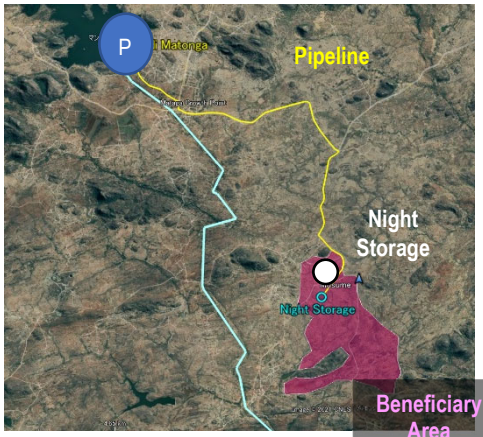
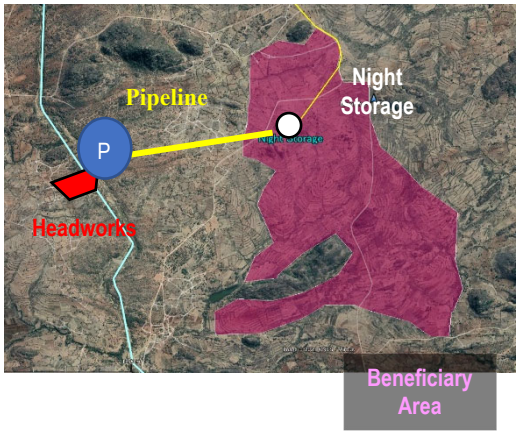


Figure 6.8.2 Location of the Potential Regions

Table 6.8.1 Comparative Table of Potential Regions for Irrigation Scheme Development

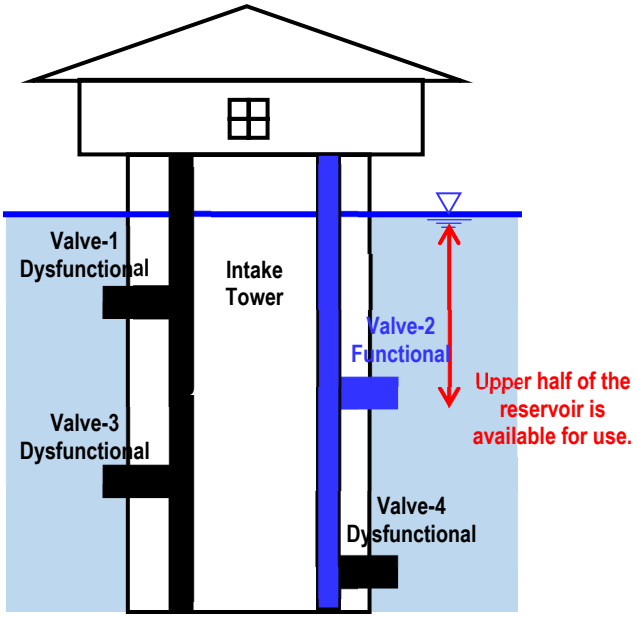
	Plan-A: Funye Region	Plan-B: Musume Region-1 (Water is supplied from the dam by pipeline)	Plan-C: Musume Region-2 (Water is taken from the headworks)
Facility layout overview map			
Gravity irrigation	Not possible	Not possible	Not possible
Pipeline extension	7 km	14 km	5 km
Headworks	Unnecessary	Unnecessary	Required
Sedimentation Pond	Unnecessary	Unnecessary	Required
Construction costs	Low	High	More than Plan A and less than Plan B
O&M costs	Relatively low	Relatively low	Relatively high *Continuous sediment removal from headworks and sedimentation pond is required.
Development Priority	1	3	2

Most dominant of the three plans Second dominant of the three plans Most inferior of the three plans

6.8.3 Current Status of the Irrigation Scheme Development Target Region

(1) Water Body Structures (Dam and Related Facilities)

The Mundi Mataga Dam intake tower has a two systems of vertical intake pipes, each with two valves at different elevations. Only one out of these four valves is in operation and only the upper half of the reservoir is available for use. Therefore, in order to supply irrigation water to the entire beneficiary area of 1,000 ha, including the target region in this Survey, it is necessary to replace the inactive three valves.



Schematic Diagram of Valves

Figure 6.8.3 Status of Intake Valves

(2) Farming Activities

1) Non-irrigated area

The main cultivated crops are maize, sorghum, ground nuts, millet and finger millet in the non-irrigated area in Mundi Mataga Area. The farmers in this area can plant the crops only during rainy season (Summer). The typical crop planting period is as shown in Figure 6.8.4.

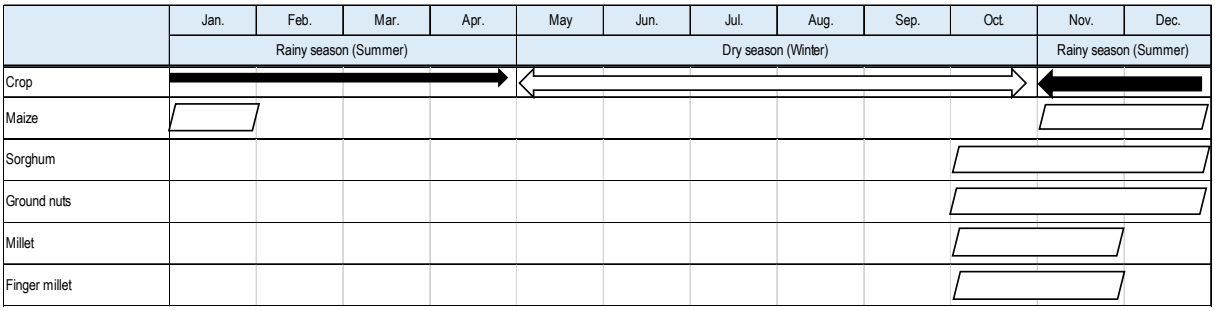


Figure 6.8.4 Crop Planting Period of the Typical Crops (Non-Irrigated Area)

Although the average area (ha) of farmland per one farmer is 4 ha, the average area (ha) of the agricultural products planted area is 1.1 ha since the farmland is mainly used for cultivating of livestock pastures. Major cultivated crops and area are 0.2 ha of maize, 0.2 ha of finger millet, 0.3 ha of sorghum, 0.3 ha of millet and 0.1 ha of ground nuts. The farmer's gross income is calculated based on this ha, yield of each crop and the selling price. The calculation results are as shown in Table 6.8.2.

Table 6.8.2 The Estimated Farmer's Gross Income（Non-irrigation Area）

Crop	Cultivated Area (ha)	Yield / Area (ton/ha)	Yield (ton)	Self-Consumption (ton/household)	Yield – Self-Consumption (ton)	Sales Price (USD/ton)	Gross Income (USD)
Maize	0.2	0.8	0.16	0.75	▲ 0.59	250.0	▲ 147.5
Sorghum	0.3	0.9	0.27	-	-	250.0	67.5
Ground nuts	0.1	0.6	0.06	-	-	300.0	18.0
Millet	0.3	0.8	0.24	-	-	250.0	60.0
Finger millet	0.2	0.5	0.10	-	-	500.0	50.0
Total	1.1	-	-	-	-	-	48.0

The production of maize does not reach the amount of self-consumption, so the shortfall is assumed to have been purchased, and the purchase amount is deducted from the gross income. The average of annual farmer's gross income is at 48.0 USD. It shows farmer's gross income is very low. The farmers also have income from sales of livestock (chicken, goat, pig, cow, etc.) other than agriculture. In addition, the farmers plant small amount of vegetable in their garden as home garden for their own consumption. Also, there is almost no work even for casual worker in this area, so the farmers can hardly expect to get income other than the agriculture and livestock.

2) Irrigated area

The survey for Biri Extension irrigation scheme (existing irrigation scheme) in Mundi Mataga Area was conducted to examine the assumed situation after irrigation scheme is developed. The beneficiary farmers in this area have farmland of 0.5 ha (0.25ha / plot x 2 plots) per one beneficiary farmer. The beneficiary farmers use these two plots and are carrying out the crop rotation. The main cultivated crops are maize, sugar beans and wheat.

The example of crop rotation is as follows.

Block A：**(First Year) Sugar beans →Wheat → Maize**、(Second Year) Maize → Sugar beans → Maize

Block B：(First Year) Maize → Sugar beans → Maize、**(Second Year) Sugar beans → Wheat → Maize**

As mentioned above, the planting patterns (crop rotation) in the plot of block A and B are repeated alternately every year. The typical crop planting period is as shown in Figure 6.8.5 (First Year) and Figure 6.8.6 (Second Year).

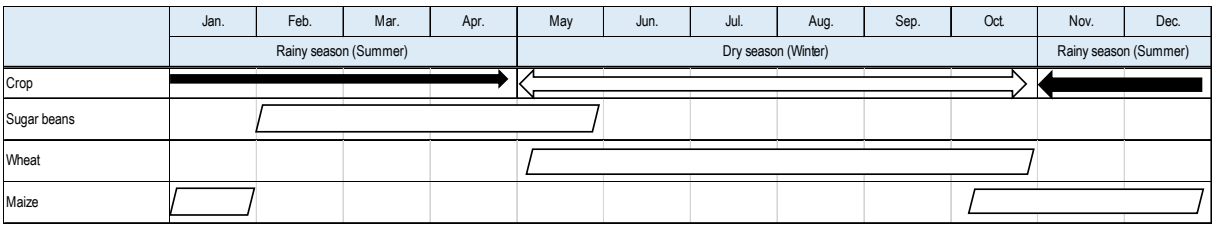


Figure 6.8.5 Crop Planting Period of the Typical Crops (Irrigated Area: First Year)

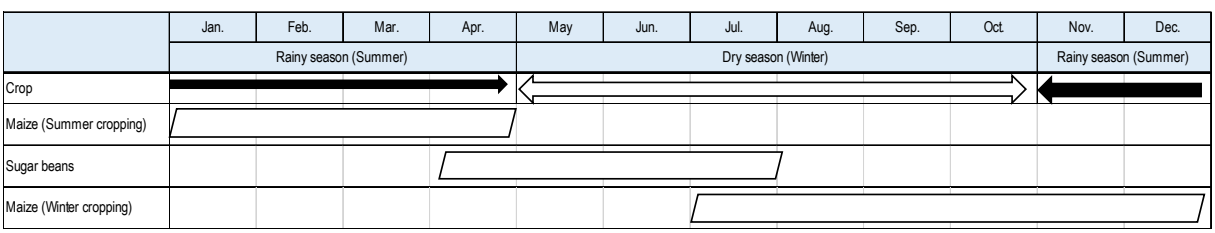


Figure 6.8.6 Crop Planting Period of the Typical Crops (Irrigated Area: Second Year)

The beneficiary farmers cultivate sugar beans 0.25 ha and wheat 0.25 ha in crop rotation. Although maize (Summer cropping) is planted 0.25 ha in first year, it is cultivated in second year as double cropping (2 times cultivation, Summer and Winter cropping, 0.25 ha per 1 time) for a total of 0.5 ha. The estimates of changes in farmland use ratio before and after irrigation are as shown in Figure 6.8.3.

Table 6.8.3 The Estimating Changes in Farmland Use Ratio before and after Irrigation

Crop	Cultivated Area before Irrigation (ha)	Cultivated Area after Irrigation (ha) *	Increased Farmland Use Ratio (%)
Maize	0.2	0.375	-
Sorghum	0.3	0.000	
Ground nuts	0.1	0.000	-
Millet	0.3	0.000	-
Finger millet	0.2	0.000	-
Sugar beans	0.0	0.250	
Wheat	0.0	0.125	-
Total	1.1	0.750	68.2

Note: The cultivated area after irrigation was calculated for an average per two years

Although the land use ratio in this area has decreased to 68.2% compared to before irrigation, it is noteworthy that it is possible to produce high-sales priced sugar beans and wheat. The estimation of beneficiary farmer's gross income per year in this area are shown in Table 6.8.4

Table 6.8.4 The Estimated Farmer's Gross Income（Irrigated area）

Crop	Cultivated Area (ha) *	Yield / Area (ton/ha)	Yield (ton)	Self-Consumption (ton/household)	Yield – Self-Consumption (ton)	Sales Price (USD/ton)	Gross Income (USD)
Maize	0.375	3.5	1.31	0.75	0.56	392.5	219.8
Sugar beans	0.250	1.5	0.38	-	-	900.0	342.0
Wheat	0.125	3.5	0.44	-	-	784.9	345.4
Total	0.750	-	-	-	-	-	907.2

Note: The cultivated area after irrigation was calculated for an average per two years

Comparing to non-irrigated area, the unit yield (yield/area) has increased (maize: 0.8 ton/ha → 3.5 ton/ha). Although the total cultivated area per year is smaller than non-irrigated area (non-irrigated area: 1.1 ha → irrigated area: 0.75 ha), the farmer's gross income in irrigated area has increased about 18.9 times compared with that in non-irrigated area (non-irrigated area: 48.0 USD → irrigated area: 907.2 USD). The irrigation development is expected to have a significant impact to the agricultural situation. As a result of irrigation scheme development, the agricultural water is available at any time through the year, crop growth becomes stable, and highly profitable cash crops (wheat, sugar beans) can be cultivated even in the dry season.

6.8.4 Facility Layout Plan

(1) Basic Policy

The facility layout is planned following the same policy as in the Muzhwi-Mushandike area (see 6.6.4 for the detail).

(2) Facility Layout

Since water is delivered directly from dam to the beneficiary area through pipeline, headworks and sedimentation pond are not required.

Two steps pump system with a balancing reservoir is planned since total pump head is over 80 m.

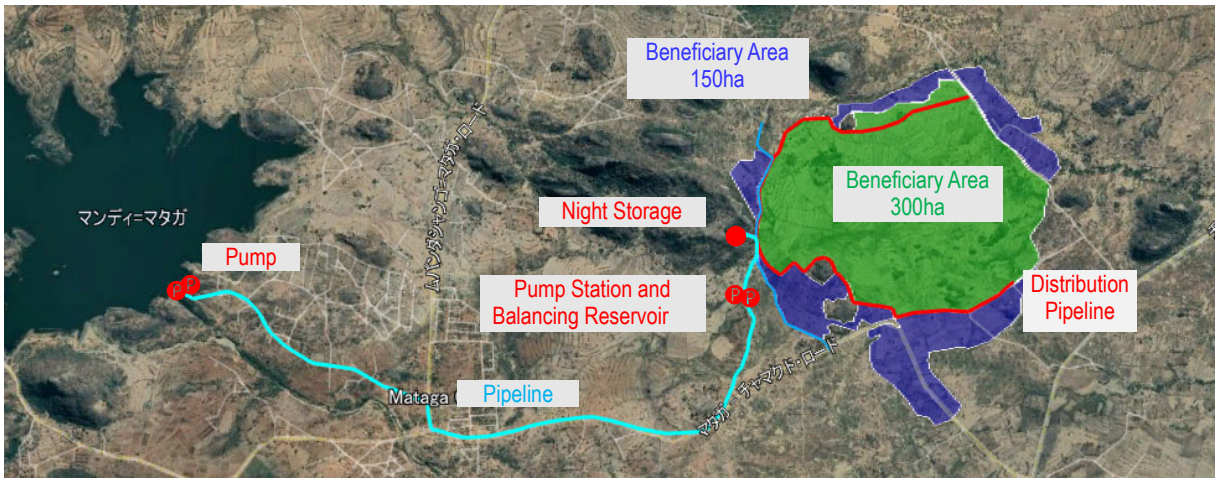


Figure 6.8.7 Facility Layout Plan

Table 6.8.5 Specification of the Facilities

Facilities	Specification
Headworks	Nil
Sedimentation Pond	Nil
Pump	110 kW x 12 units (6 units for each step)
Pipeline	Φ=500 mm、L=6.9 km
Balancing Reservoir	H=3.0 m, D=10.0 m, B=10.0m
Night Storage	V=14,000 m3
Distribution Pipeline	Φ=500 mm、L=5.8 km
Beneficiary Area	Under surface irrigation: 300ha (green zone in Figure 6.8.7) Under water-saving irrigation: 450ha (green + blue zone in Figure 6.8.7) *The 300 ha is the maximum area defined by the amount of water available at the dam. The irrigated area can be expanded 1.5 doubled with the introduction of water-saving irrigation.

The noted points to plan the facility layout is shown in Table 6.8.6.

Table 6.8.6 Points to be noted for Facility Layout

Target Facilities	The Direction of Facility Layout Plan
Pump Station: 1 unit (2 pump systems) (Just downstream of dam)	Sine there is no space to install new pumps in the existing pump station, the pump station is newly constructed just besides the existing pump station.

Current situation of the existing pump station

Target Facilities	The Direction of Facility Layout Plan
Pipeline: L=6.90 km	The existing road, which makes construction of the pipeline and land acquisition for the construction easy, is used as the route.
  Existing road	
Pump Station: 1 unit (2 systems) Balancing Reservoir: 1 unit	Since total pump head is over 80 m, a balancing reservoir is set at the middle in elevation between the suction pump and the night storage.
Night Storage: 1 unit	The night storage is arranged near the beneficiary area with higher elevation and foundation rock exposure.
 Proposed site for night storage	
Distribution Pipeline: L=5.80 km	The distribution pipeline is arranged along the existing road with highest elevation that can distribute water to all the beneficiary area.
 Proposed alignment of the distribution pipeline	

(3) Related Facilities

Following the same policy as in the Muzhwi-Mushandike Area, a standby generator and storage house are planned to be installed (see 6.6.4 for the detail).

6.8.5 Environmental and Social Consideration

(1) Natural Environment Aspects

The source of water for the new irrigation scheme is stored water in the reservoir of Mundi Mataga Dam. Water is directly delivered from Mundi Mataga Dam via pump stations through pipelines to the night storage located near beneficiary areas. Existing pump station utilised for the existing irrigation schemes in the Area is expanded as a pump station for new irrigation scheme. There will be no direct impact on the downstream river since no water will be taken from the river.

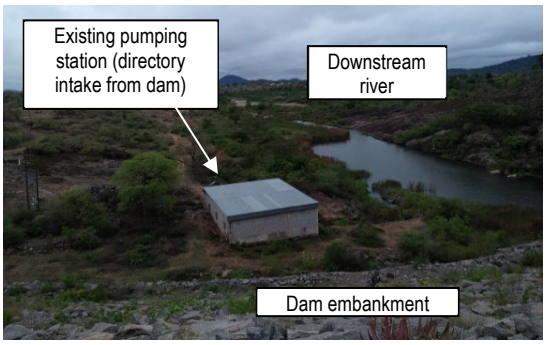


Figure 6.8.8 Facility Layout at Downstream of Dam (View from Downstream Slope of the Embankment)

The planned irrigation scheme will consist of the Pumping stations – Pipelines- Balancing Reservoir - Night storage - Beneficiary areas. All of the proposed construction sites are located in woodlands (shrubs, bushes, etc.) or agricultural lands where human activities are already carried out. There are no protected areas and important biodiversity areas (Ramsar wetlands, IBAs) in and around the project area.

(2) Social Environment Aspects

The beneficiary area of the planned irrigation scheme is named as Funye Region which is located in the Communal Land. The name of the Communal Land is Mberengwa Communal Land. The Communal Land has been a Tribe Trust Land since around 1930, when people of African descent were forcibly relocated to the area and have lived there ever since. Historically, Communal Land has been allocated to the areas with poor farming conditions, where most of farmers are smallholder and generally subsistence farmers. Farmers in Communal Land strongly desire irrigational agriculture because its advantages in production and productivity against rainfed agriculture.

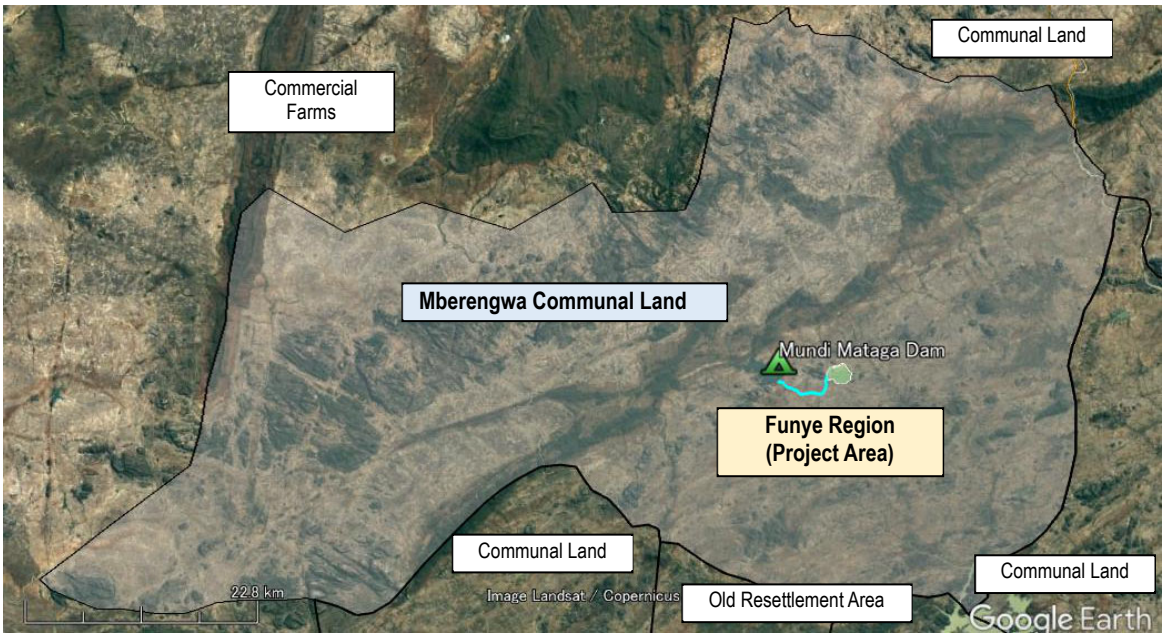


Figure 6.8.9 Land Category around the Project Area (Funye Region)

A local development centre, which is called as Mataga Growth Point, is located near beneficiary areas. Mataga Growth Point is the centre of the local economy, with housing and retail outlets. The roads around Mataga Growth Point are paved with asphalt and are easily accessible. The pipeline is planned to be laid along the existing road. During construction activities of the pipeline instalment, careful consideration should be given to minimize adverse impacts to the existing local transportation.

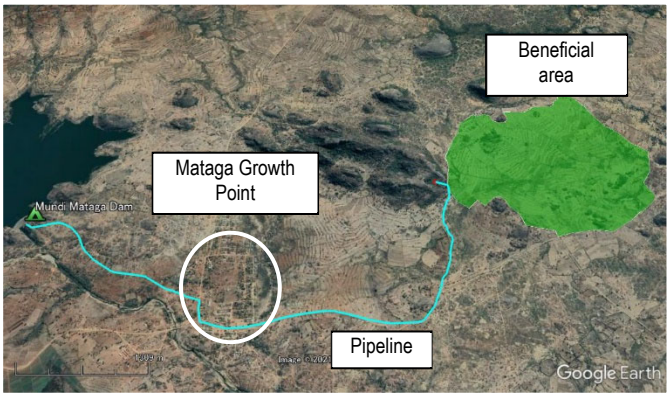


Figure 6.8.10 Loction of the Mataga Glowth Point and Beneficiary Area

In case of the development of new irrigation scheme, the plots of agricultural fields will be allocated equally to the beneficiary farmers of the Region, including the current land users. The allocation of plots will be carried out under the management of Traditional Leaders and District Councils (see Chapter 3.6.1 for the detail).

The acquisition of lands for the proposed construction sites will be taken from the state lands since land ownership of the Communal Land belong to the state and land use is managed by Traditional Leaders and District Council. In case of the land acquisition, coordination with those traditional decision-making organizations will be necessary.

(3) Scoping

Preliminary evaluation (scoping) of the environmental and social impacts on the planned new irrigation scheme development project in Mundi Mataga Area was examined with reference to the general features of the irrigation project in Zimbabwe and the site conditions. The scoping result is shown in Table 6.8.7.

Table 6.8.7 Scoping Result for the Irrigation Scheme Development Plan in Mundi Mataga Area

Category	No.	Environmental Item	Scoping Result		Reason
			Construction stage	Operation stage	
Pollution	1	Air Quality	B-	D	**Construction stage:** Exhausts from the construction machineries and vehicles can be the causes of air pollution in the neighboring area of construction work, temporarily. Mitigation measures such as proper maintenance of heavy machineries and so on are required. **Operation stage:** Although the pump equipment will be operated, but the electrical driven pump will be selected. Therefore, air pollution in the operation stage is not anticipated.
	2	Water Quality	D	D	**Construction stage:** Adverse impacts on the river are not expected since the construction work in the river is not planned. **Operation stage:** Impacts are not anticipated.
	3	Waste/ Garbage	B-	D	**Construction stage:** Generation of the construction wastes by the removal work of existing structures, removal sand by the excavation work, and garbage from workers camp and so on., are anticipated. Proper treatment of such wastes is required. **Operation stage:** Impacts are not anticipated.

Category	No.	Environmental Item	Scoping Result		Reason
			Construction Stage	Operation Stage	
	4	Soil Contamination	B-	D	**Construction stage:** Leakage of the oils from construction machinery can be the cause of soil contamination. Mitigation measures such as proper maintenance of heavy machineries are required. **Operation stage:** Impacts are not anticipated.
	5	Noise and Vibration	B-	B-	**Construction stage:** Impacts of noise and vibration around construction sites are anticipated. Considerations for the neighboring area of construction sites are necessary such as avoiding nighttime construction works, and so on. **Operation stage:** Impacts are not anticipated.
	6	Subsidence	D	D	The works affecting to land subsidence are not anticipated.
	7	Odor	D	D	The works generating odor are not anticipated.
	8	Sediment	D	D	The works affecting to sediments are not anticipated.
Natural environment	9	Protected Areas	D	D	There are no protected areas for habitats such as national protection areas, Ramsar convention wetlands, Important Bird Areas (IBAs) in the project area.
	10	Ecosystem	D	D	Large scale impacts on ecosystems are unlikely.
	11	Hydrology	D	D	The works affecting to hydrology are not anticipated.
	12	Topography and Geology	D	D	The works affecting to the existing topography and geology in the area are not anticipated since large scale earth filling and cutting works is not planned.
Social environment	13	Resettlement	C	C	**Construction and Operation stage**: Land acquisitions are expected at the locations of planned construction sites such as pipelines, night storage. Lands will be acquired from state lands and coordination with the local traditional decision-making organizations is necessary during acquisition process. It is necessary to avoid or minimize the impact of house relocation with considering the facility layouts to avoid the existing settlements.
	14	The poor	B+	A+	**Construction stage:** Positive impacts are expected since the project may create job opportunities for construction works. **Operation stage:** Positive impacts are expected since the project contributes to the beneficiary farmers' livelihood including poor people through the conversion from rainfed agriculture to irrigated agriculture.
	15	Ethnic Minorities and Indigenous Peoples	D	D	There are no ethnic minorities and indigenous people in the project area.
	16	Livelihood/ local economy	B+	A+	**Construction stage:** Positive impacts are expected since the project may create job opportunities for construction works. **Operation stage:** Positive impacts are expected since the project contributes to the beneficiary farmers' livelihood including poor people through the conversion from rainfed agriculture to irrigated agriculture.
	17	Land use and local resource utilization	B-	D	**Construction stage:** In case the land development is included in the project component, construction works affect to the existing land use of farmlands. Mitigation measures are necessary such as implementing construction work during agricultural off-season. **Operation stage:** Impacts are not anticipated.
	18	Water Usage or Water Rights and Rights of Common	D	A+	**Construction stage:** Impacts are not anticipated. **Operation stage:** Positive impacts are expected among beneficiary farmers for stable water use for irrigational agriculture.

Category	No.	Environmental Item	Scoping Result		Reason
			Construction Stage	Operation Stage	
	19	Existing social infrastructures and services	B-	D	**Construction stage:** Due to the increasing of construction vehicles, local transportation around construction area may be affected. Careful consideration should be required since the pipeline works will be planned at near the Mataga Growth Point. Mitigation measures are necessary such as proper allocation of traffic guards, and so on. **Operation stage:** Impacts are not anticipated.
	20	Social institutions	C	C	**Construction stage:** Land acquisitions are expected at the locations of planned construction sites such as pipelines, night storage. Coordination with the local traditional decision-making organizations is necessary during acquisition process. **Operation stage:** In case the land development is included in the project component, allocation of farmland plots will be managed by the traditional decision-making organizations. It will be necessary to coordinate with theses traditional organizations in the process of support to beneficial farmers including the establishment of Irrigation Management Committees (IMCs).
	21	Misdistribution of benefit and damage	C	C	**Construction stage:** In case the land development is included in the project component, it is expected the construction works will affect to the existing agricultural activities during construction period. Consideration should be given to the allocation of farmland plots after land development such as prioritization to the existing farmers. **Operation stage:** In case the land development is included in the project component, allocation of farmland plots will be managed by the traditional decision-making organizations. In the case of similar projects in Zimbabwe, farmland plots are allocated equally to the beneficiary farmers. Same consideration should be given in the project.
	22	Conflict			
	23	Cultural heritage	D	D	There are no cultural heritages around project area.
	24	Land scape	D	D	There are no project components affecting land scape.
	25	Gender	D	D	No impacts are expected during both construction and operation stages.
	26	Rights of the Child	D	D	No impacts are expected during both construction and operation stages.
	27	Hazards (Risk), Infectious diseases such as HIV/AIDS	B-	D	**Construction stage:** There are risks of spreading infection diseases such as HIV due to the entering of construction workers into the area. **Operation stage:** Impacts are not anticipated.
	28	Work environment (including safety)	B-	D	**Construction stage:** Safety and health of construction workers shall be considered during construction work. **Operation stage:** Impacts are not anticipated.
Others	29	Accident	B-	D	**Construction stage:** There are risks of accidents by operating construction machineries, vehicles and so on, during construction work. **Operation stage:** Impacts are not anticipated.
	30	Transboundary impact, climate change	D	A+	**Construction stage:** Impacts are not anticipated. **Operation stage:** Positive impacts are significantly expected. The development of irrigation scheme will lead to the shift from rainfed agriculture to stable irrigated agriculture. This will have a significant positive impact on the livelihoods of beneficiary farmers, who have been vulnerable to climate change.

A+/-: Significant positive/negative impact is expected. B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. D: No impact is expected.

(4) Evaluation of the Environmental Category (Proposed)

Detail examinations for environmental and social impact assessments, mitigation measures and monitoring plan formulations for new irrigation project need to be carried out by further surveys in the later stage.

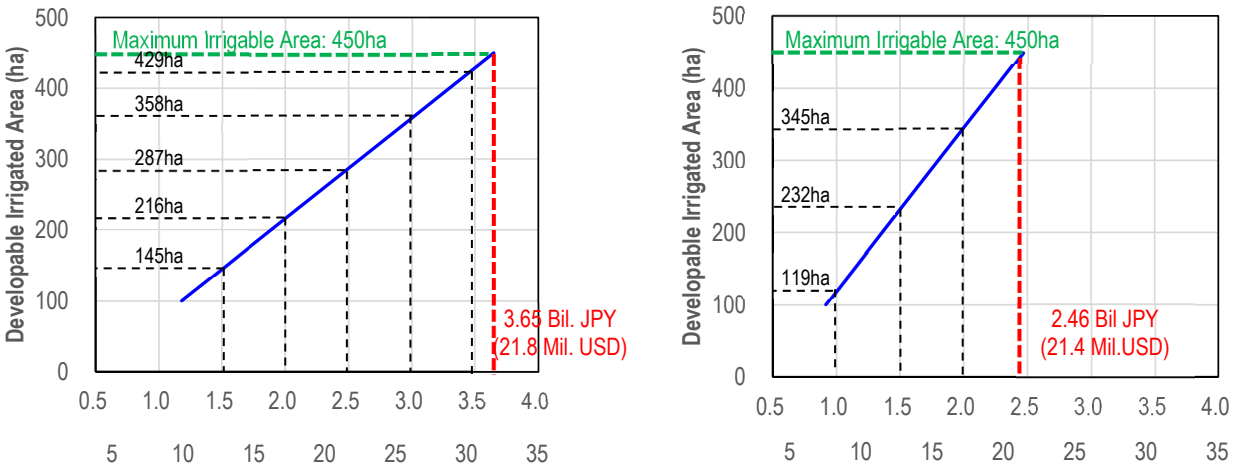
As the result of preliminary evaluation at screening stage, it is assumed the project will fall under Category B in the category classification of JICA environmental and social consideration guideline with the reasons of 1) the project area is not located in sensitive area such as national protected areas and other important biodiversity areas, 2) large scale involuntary resettlement and/or land acquisition are not expected and the 3) project scale and components of new project are similar to past JICA irrigation project (Nyakomba Irrigation Scheme Development Project) with Category B.

6.8.6 Project Cost

Project costs are calculated following the same policy as in the Muzhwi-Mushandike area (see 6.6.6 for the detail).

The results of the calculations are shown in Figure 6.8.11. The project cost includes the cost of replacing the valves of the dam intake tower. Also, cost for on-farm facilities is in case of water-saving irrigation.

The total area of 450 ha can be irrigated for approximately 3.65 billion JPY (=31.8 million USD) in case the on-farm facilities and land development are implemented under the Grant Aid Project, and for approximately 2.46 billion JPY (= 21.4 million USD) in case they are implemented by Zimbabwean side.



1) In case on-farm facilities and land development are implemented by Grant Aid Project

2) In case on-farm facilities and land development are implemented by Zimbabwean Side

Figure 6.8.11 Relation between Project Costs and Developable Irrigated Area

6.9 Implementation Priority

The results of the prioritization of irrigation scheme development through comparison of conditions in the above three Regions are shown in Table 6.9.1. The benefits are calculated on the assumption that maize and wheat are planted in the same area as same in the facility layout plan, assumed unit yield and garden price in each region. In case of Plan-1 and Plan-2, it is assumed that the headworks and sedimentation ponds will be buried by large amount of sediment and irrigation will be stopped in about 1/10 years. Therefore, benefit for 27 years is adopted.

The parts in blue letters in the table indicate the most dominant of the three plans in each item. The Funye Region in the Mundi Mataga Area is given first priority mainly because of the following reasons.

- It is possible to irrigate the largest area in the three Regions.
- The economic impact is the highest of all the three regions.
- There is no need to pay for sediment removal at the intake point for maintenance.
- There is no risk of the pump failing due to sediment, making it impossible to take water.

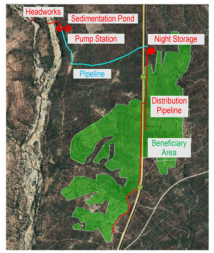
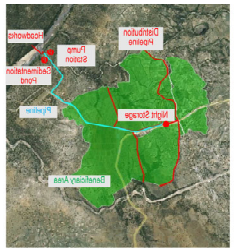
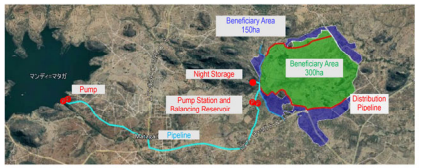
[Problem of sediments in water abstraction from rivers]

Of the existing irrigation schemes visited, it was observed that all the schemes that take water from the river are subject to water abstraction problems due to sediment run-off during floods. During floods, a large amount of sediment flows down the river and fills the front of the pump, making it impossible to withdraw water. When this happens, attempts are made to remove the sediment and restart the water intake, but sometimes the pump fails and the irrigation itself cannot be carried out.

During floods, the water intake point is filled with sediment, making it difficult to take water. In addition, the pump is currently dysfunctional.

Figure 6.9.1 Dinhe Region Intake Point

Table 6.9.1 Prioritization of irrigation scheme development

Target Region	Plan-1_Mushandike Resettlement Area Village 17C, 18A, 19B		Plan-2_Dinhe Region		Plan-3_Funye Region	
Water Source	Muzhwi Dam		Manyuchi Dam		Mundi Mataga Dam	
Facility Layout						
Maximum irrigated area under Grant Aid Project*	200ha		360ha		**450ha**	
Project Cost*	1.54 Bil. JPY 7.7 Mil. JPY/ha	(1.01 Bil. JPY) (5.1 Mil JPY/ha)	2.65 Bil. JPY **7.4 Mil. JPY/ha**	(1.71 Bil. JPY) **(4.8 Mil. JPY/ha)**	3.65 Bil JPY 8.1 Mil. JPY/ha	(2.46 Bil JPY) (5.5 Mil. JPY/ha
(Benefit for 30 years) / Project Cost*	1.68	(2.58)	1.42	(2.19)	**2.25**	**(3.36)**
O&M Fee	High It is necessary to remove the sediment deposited in the sedimentation pond and headworks after every flood. Also, there is a high possibility of pump failure due to sediment.		Same as on the left		**Low** No sediment removal is required (no sediment removal costs) as the dam acts as a sedimentation pond and the dam has a sedimentation capacity.	
Market Access	**Easy** The storage house installed allows GMB to come and buy the product.		**Same as on the left**		**Same as on the left**	
Environmental and Socia Consideration	**Category -B** - The permanent release of water into the river is expected to have a positive impact on the river environment and aquatic life from the dam to the intake point. - Any measures for farmers operating agriculture in at the sandbank is required.		**Category -B** - There is a possibility that abstraction from the river will reduce the amount of water released to the nature park downstream, but this is not expected to be significant. - Some of the beneficiary areas have been developed by the CESVI project but are currently not functioning. If this area is to be included, it will be necessary to restructure the IMC.		**Category -B** - As the water is taken directly from the dam, the environment of the downstream river remains unchanged. - As the facility is located along a major road in the area, the construction must not affect traffic.	
Implementation Priority	3		2		1	
	[Reasons for selecting the Funye Region] - It is possible to irrigate the largest area in the three regions. - The economic impact is the highest of all the three regions. - There is no need to pay for sediment removal at the intake point. Also, there is no risk of the pump failing due to sediment, making it impossible to take water.					

*The values in case on-farm facilities and land development are implemented under Grant Aid Project. (Values in parentheses are in case those are implemented by Zimbabwean side)

6.10 OPERATION AND MAINTENANCE PLAN

Planning and implementation of the following O&M measures are recommended to ensure sustainable operation of the developed irrigation scheme.

6.10.1 Pump Operation Plan

The pumps are operated in alternating two systems. A pump system is operated for a period of 24 hours (nighttime 16 hrs + daytime 8 hrs) and then 24 hrs deactivated. The following day, another pump system is operated in the same way.

The 2/3 of the daily irrigation water requirement Qd is stored in the night storage during the nighttime (16:00 - 8:00: 16 hrs). After that, the pumps continuously work through the daytime and deliver Qd/3. Together with the water delivered from pumps and discharge from the night storage, the irrigation water requirement Qd is supplied to the beneficiary area.

1) Nighttime (16:00 - 8:00: 16 hours) **2) Daytime (8:00 - 16:00: 8 hours)**

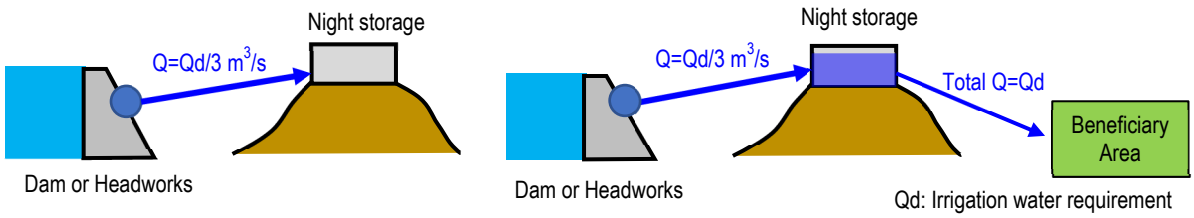


Figure 6.10.1 Pump Operation Plan

Under these two pump systems, even if a pump system fails, the irrigation water supply is not be interrupted since the required irrigation water volume can be supplied by another system. Also, the failure can be repaired while another system is in operation and no stand-by pump is needed.

6.10.2 Water-Saving Irrigation Facility O&M Plan

The introduction of water-saving irrigation can increase the irrigated area compared to surface irrigation. This can lead to the creation of more beneficiary areas and beneficiary farmers. On the other hand, a larger irrigated area has advantages in terms of O&M as well.

Experience in Zimbabwe has shown that the power output of the pumps should be kept below 1.5 hp/ha. If the pumps power is larger than 1.5 hp/ha, the cost per beneficiary farmer of the electricity required to operate the pump systems becomes too high and some of the beneficiary farmers may not be able to pay the O&M fee. And therefore, the sustainable maintenance of the irrigation scheme may be difficult.

The approximate pump output power per hectare under surface irrigation by new irrigation schemes is shown as below. Funye Region in Mundi Mataga Area has value with a near upper limit of 1.5 hp/ha.

[Required pump output power under surface irrigation]

Muzhwi Mushandike Area	(Village 17-19)	(200 ha): 0.737 hp/ha
Manyuchi Area	(Dinhe Region)	(360 ha): 0.983 hp/ha
Mundi Mataga Area	(Funye Region)	(300 ha): 1.485 hp/ha

On the other hand, if water-saving irrigation system is adopted, the irrigated area can be increased without changing the pump output power. The calculated pump power per hectare in Funye Region assuming a 1.5 doubling of the irrigated area with the introduction of water-saving irrigation is shown as below. The value drops to about 2/3 of the upper limit of 1.5 hp/ha, which would increase the ability of beneficiary farmers to pay O&M fee on a sustainable basis.

[Required pump output power under water-saving irrigation]

Mundi Mataga area (Funye Region) (450 ha): 0.990 hp/ha

Thus, the introduction of water-saving irrigation is necessary from the point of view of O&M, especially to reduce the cost of electricity for pump operation per beneficiary farmer and to ensure the collection of O&M fees.

In the three target Regions for irrigation scheme development, rainfed agriculture is currently practiced and the beneficiary farmers have no experience in water-saving irrigation. Therefore, in order to ensure sustainable operation of the facilities, training on maintenance of water-saving irrigation facilities (including not only operation of the facilities but also water use and water management) and on farming under water-saving irrigation is necessary.

6.10.3 Strategic Farmers' Income Increasing Plan

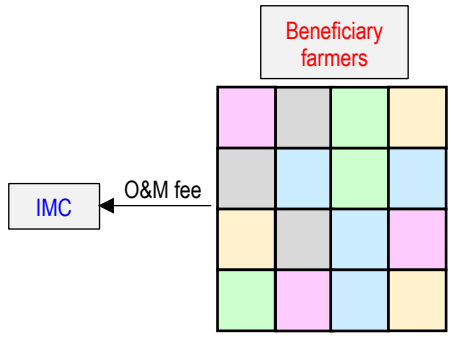
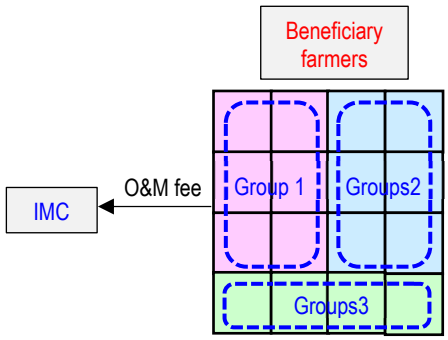
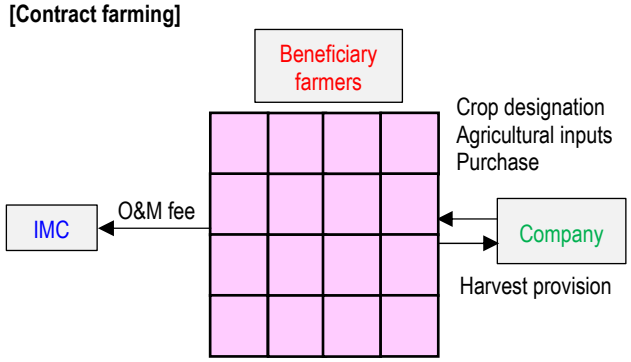
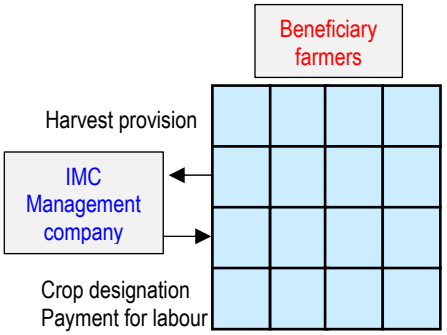
As mentioned in 2.3.1, the following matters have occurred in the Nyakomba Irrigation Scheme implemented by JICA as a Grant Aid Project.

- The project has been in operation for about four years since its completion. However, several beneficiary farmers have been unable to pay O&M fee during these four years.
- The reason for this was that the income of the beneficiary farmers after the development of the irrigation scheme was less than expected. This was due to the fact that the beneficiary farmers did not carry out market research and instead selected the crops they wanted to grow, resulting they could not sell the surplus in the market due to less demand.
- ZIM-SHEP is currently being implemented in the area, which has improved beneficiary farmers' incomes.

These situations imply that beneficiary farmers may not be able pay enough O&M fee sustainably unless their income increases as planned (or more) through irrigation agriculture. The lack of O&M fee may cause the difficulty of sustainable irrigation scheme management.

Therefore, it is necessary to implement strategic farmers' income increasing projects after developing the irrigation scheme to secure the increase of farmers' income as planned. Possible projects at present are shown in Table 6.10.1.

Table 6.10.1 Strategic Farmers' Income Increasing Projects

Project overview	Project description	Remarks
[Current Status] 	- Each beneficiary farmer selects, grows and sells the crops he or she wants to grow without market research. - Beneficiary farmers pay O&M fee to IMC. - IMC operates and manages the irrigation schemes. * Lessons learned from Nyakomba irrigation scheme, it may be difficult to collect sustainable O&M fees under this condition.	
[SHEP] 	- Multiple beneficiary farmers form a farmer groups. - SHEP experts carried out the market research training to farmer groups. - A farmer group selects the target crop(s) based on market research. - Beneficiary farmers pay O&M fee to IMC. - IMC operates and manages the irrigation schemes.	Currently being implemented under the Nyakomba Irrigation Scheme etc.
[Contract farming] 	- All the beneficiary farmers make contract with the company. - The company designate the crops to be grown (in some cases with the assistance of agricultural inputs). - The company purchases of agricultural products from beneficiary farmers at contracted prices. - Beneficiary farmers pay O&M fee to IMC. - IMC operates and manages the irrigation schemes.	Currently being implemented in Murove Irrigation Scheme and Chizumba Irrigation Scheme in Manyuchi Area etc.
[Establishment of a management company by farmers] 	- A management company is established with IMC as its parent company (employing management experts). - The management company designate the crops to be grown. - The management company collect agriculture products from beneficiary farmers and sale those in the market. - The management company pays labour fee to the beneficiary farmers. * Beneficiary farmers are engaged in farming as workers of the management company - IMC operates and manages the irrigation schemes. * The management company pay labour fee to the beneficiary farmers after deducting the O&M fee, thus O&M fee collection from the beneficiary farmers is not needed.	IFAD recommended model

6.10.4 O&M Implementation Structure

Under the current system, the demarcation on O&M by facilities after the development of the irrigation scheme may be as upper figure in Figure 6.10.2. However, the scale of pumps and night storage to be installed under the New Irrigation Development may be too large to be managed by IMC even with the support by DOI. Therefore, as shown in the lower figure in Figure 6.10.2, it is recommended to establish a structure in which ZINWA manages the large scale facilities from dam up to the night storage, and IMC manages the branch canals and on-farm facilities after the night storage, but ZINWA provides support to IMC.

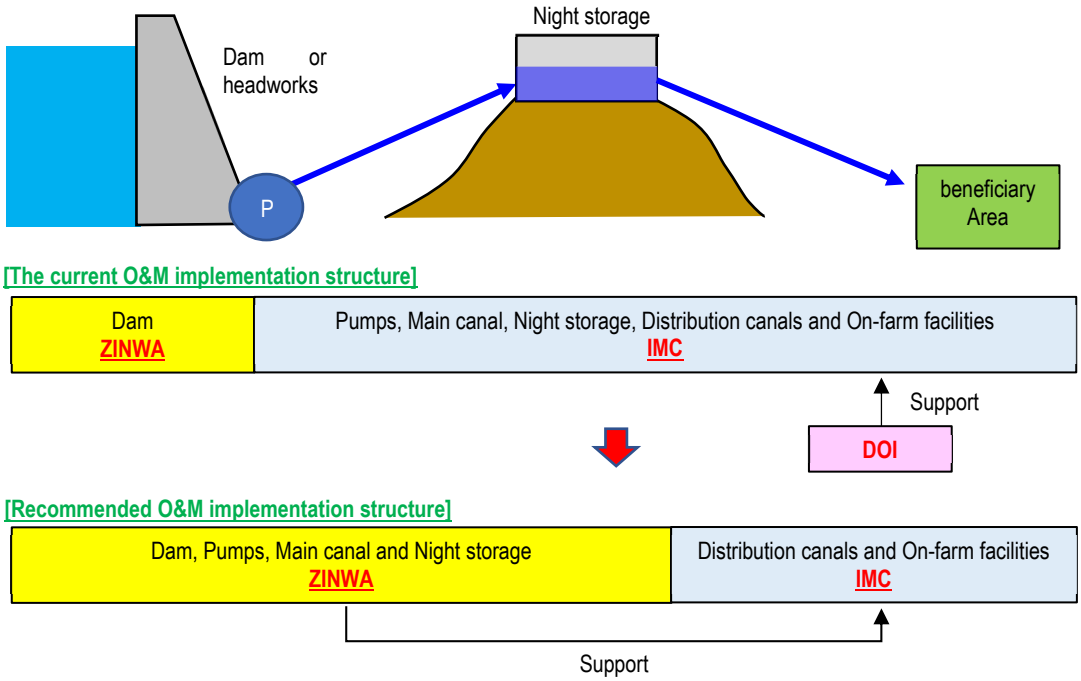


Figure 6.10.2 Recommeded New Irrigation Development Management Structure

This recommended structure is also in line with the MLAFWRR's intentions. The Ministry intends to make ZINWA as a responsible agency for a series of irrigation development (plan, survey, design, construction, supervision and O&M) (see 4.1). This is due to the fact that the development of dams as a water source has taken precedence over the development of irrigation schemes, and as a result, the water stored in the dams have not been utilized effectively. The Ministry intends to establish a structure which dams and irrigation schemes are managed by an agency and both are developed at the same time.

However, ZINWA does not have enough irrigation engineers in the organization as the irrigation development has been out of their mandate. As actual, DOI is responsible for a series of irrigation-related matters, and it is planned to gradually transfer some of DOI's mandate in respect to irrigation development to ZINWA.

If the New Irrigation Development is carried out as a Grant Aid Project, it is a good opportunity for ZINWA to start O&M of the irrigation scheme as ZINWA will be able to receive training on the operation of the scheme from Japanese soft component expert.

CHAPTER 7 OVERALL EVALUATION

7.1 VALIDITY OF IRRIGATION DEVELOPMENT IN ZIMBABWE

7.1.1 Consistency with the Zimbabwe National Development Policy

(1) Vision2030

Overall goal of Vision 2030, the present Zimbabwe's national development policy, is "To foster inclusive economic growth and address poverty resolutely, thereby transforming Zimbabwe into an industrialising, knowledge based upper middle-income country that provides a high quality of life to all its citizens by 2030".

In this Vision, "To create a self-sufficient and food surplus economy that will see the re-emergence of Zimbabwe as the 'Bread Basket' of Southern Africa" is stated as agriculture and irrigation sector's goal. In order to achieve this sector goal, below activities in irrigation sector are planned to be implemented.

- Resuscitation of horticulture production of the small scale farmers and exports
- Rehabilitation and establishment of smallholder farmer irrigation facilities covering 200 ha per Administrative District, per year for the next 10 years through implementation of an Irrigation Master Plan

Land use of the Regions for New Irrigation Development is Communal Land and/or Old Resettlement Area, and beneficiary farmers are smallholder farmers. Also New Irrigation Development contributes to increase the irrigated area.

(2) National Development Strategy 1

NDS-1, the first 5-year medium-term plan aiming to realise the Vision 2030, prioritizes "Increased economic growth and stability". Also, achieving 1) Average GDP above 5% per annum and 2) GNI to 3,200 USD until 2025" are state as the goals. NDS-1 aims to achieve these goals through growth of agriculture, mining, manufacturing and tourism sectors.

Additionally, food and nutrition security are stated as an important national level challenge as well. NDS-1 aims to improve food security through 1) Increasing food self-sufficiency and 2) reducing food insecurity.

To achieve goals above, "Expansion of 350,000 ha farmland" and "Intensifying the design construction and rehabilitation of irrigation infrastructure with clearly defined sustainability mechanisms to ensure continuity, further enhance irrigation scheme management and collaborative public service delivery models to irrigation schemes" are planned to be implemented.

On the other hand, disaster intensity of cyclone and drought has been being serious and any measure to strength the resilience against disaster are required to achieve the goals above. The following measures under irrigation sector are planned to be implemented.

- Irrigation rehabilitation and expansion, promotion and adoption of research that improves productivity of seed and animal varieties, upscaling of climate smart agriculture and capacitation of extension services in order to drought proof agriculture
- Upscale and expedite irrigation rehabilitation and expansion utilising existing and new water bodies
- Development of the National Dam Safety Plan and its implementation, strengthening existing

capacities for water resources management and the further development of water resources to cater for existing and future demand as well as reducing hydrological and climatic vulnerability

- Inspection programme for all major dams in the country to assess risks to public safety, extent of water losses, and extent of siltation

The development of irrigation schemes through New Irrigation Development leads to the increasing of irrigated area, increasing agricultural production, and improvement of farmers' income, resulting to contribute to the GDP growth rate and improve food security. Also, New Irrigation Development is a project utilizing existing dams, which can be considered as utilization of existing water resources. In addition, the shift from rainfed agriculture to irrigated agriculture strengthen resilience against drought.

On the other hand, it can be said that Emergency Repairing and Dam Improvement are a part of strengthening resilience, and a part of the aforementioned dam safety plan and dam inspection programme are implemented in this Survey although it is the study team's own method.

(3) Validity of Irrigation Development in Zimbabwe

It can be said that the Emergency Repairing, Dam Improvement and New Irrigation Development are all in line with the national development policy of Zimbabwe. In particular, the increasing of irrigated area by the New Irrigation Development would make a significant contribution to GDP growth, food security, and drought resilience by increasing agricultural productivity and resuming agricultural exports.

7.1.2 Consistency with Japan's Development Cooperation Policy for Zimbabwe

In the "Policy for Development Cooperation with the Republic of Zimbabwe" (December 2020) issued by the Ministry of Foreign Affairs of Japan, Zimbabwe is evaluated as "a country having vast and fertile plains, where development, including the revival of the agricultural sector, can be expected".

In addition, in the priority field (medium-term target) (2) Effective utilization of abundant resources, Zimbabwe is evaluated as "a country having vast plateaus and fertile soils suitable for cultivation of maize, wheat, and cash crops such as fruits and vegetables, as well as abundant human resources with a high level of education. In order to ensure that these abundant resources are properly and effectively utilized and lead to the solid economic development of Zimbabwe, Japan will support the development of human resources that contribute to the strengthening of industry, agricultural and rural development through the promotion of market-oriented agriculture and the effective utilization of irrigation facilities, and the promotion of the tourism sector".

Also, "The project development plan for Zimbabwe" states the "It is necessary to develop human resources to make effective use of the country's abundant resources and to create an environment that will serve as the basis for industrial development". In respect for the agricultural sector, the plan states "Promotion of agriculture, rural development, and tourism will be supported. Also, support will be provided for the development of infrastructure to support agricultural development."

Emergency Repairing, Dam Improvement, and New Irrigation Development are in line with the above policy of Japan's development cooperation, "Support for agriculture and rural development through effective utilization of irrigation facilities" and "Support for infrastructure development to support agricultural development". Also, from the interviews with ZIM-SHEP, it is clear that the promotion of market-oriented agriculture is targeted at areas where irrigation is already in place. Therefore, New Irrigation Development can be stated as an infrastructure development to contribute to the promotion of market-oriented agriculture.

7.1.3 Contribution to the Achievement of SDGs

"The Sustainable Development Report 2021", a report published in June 2021 by the Bertelsmann Stiftung in Germany and the Sustainable Development Solutions Network, ranks Zimbabwe only 125th out of 165 countries in achieving the SDGs. Also, the report shows the current status and trends of each SDG target for Zimbabwe (see Table 7.1.1).

Table 7.1.1 Zimbabwe's Current Status and Trend of each SDGs Target

Goal		Current Status	Trend
1	No Poverty	Information unavailable	Information unavailable
2	Zero Hunger	Major Challenges	Stagnating
3	Good Health and Well-Being	Major Challenges	Moderately improving
4	Quality Education	Significant Challenges	Information unavailable
5	Gender Equality	Challenges remain	Moderately improving
6	Clear Water and Sanitation	Major Challenges	Stagnating
7	Affordable and Clean Energy	Major Challenges	Stagnating
8	Decent Work and Economic Growth	Major Challenges	Moderately improving
9	Industry, Innovation, and Infrastructure	Major Challenges	Stagnating
10	Reduced Inequalities	Major Challenges	Information unavailable
11	Sustainable Cities and Communities	Major Challenges	Decreasing
12	Responsible Consumption and Production	SDG Achieved	Information unavailable
13	Climate Action	SDG Achieved	On track or maintaining SDG achievement
14	Life below Water	Information unavailable	Information unavailable
15	Life on Land	Significant Challenges	Decreasing
16	Peace, Justice and Strong Institution	Major Challenges	Stagnating
17	Partnerships for the Goals	Significant Challenges	Moderately improving

Source: The Sustainable Development Report 2021", 2021, the Bertelsmann Stiftung in Germany and the Sustainable Development Solutions Network

Cereal yield (ton/ha), which is one of the indicators for "Goal 2: Zero Hunger" is the main target for the agricultural sector, however it is rated as "a major challenge whose improvement is stagnant". This indicator may be the most important indicator to achieve the Goal 2. Emergency Repairing and Dam Improvement ensure the existing agricultural productivity, and New Irrigation Development contributes to the improvement of agricultural productivity by shifting from rainfed to irrigated agriculture, resulting to contribute to the achievement of this indicator and its higher target, Goal 2.

7.1.4 Verification of the Validity of Irrigation Development in Zimbabwe

As the results, it can be said that all the Emergency Repairing, Dam Improvement, and New Irrigation Development are 1) consistent with Zimbabwe's national development policies, 2) consistent with Japan's development cooperation policy for Zimbabwe and 3) to contribute to the achievement of the SDGs. Therefore, the implementation of irrigation development in Zimbabwe is considered appropriate.

7.2 POINTS TO BE NOTED IN PLANS IMPLEMENTATION

7.2.1 Emergency Repairing Plan (for Deteriorations/Damages Evaluated as "A")

The deteriorations/damages evaluated as "A" requires immediately measures from a humanitarian perspective because it could lead to a disaster that may cause loss of life if left unattended. However, according to the results of a survey to each agency, there is only one agency, ZINWA, who may implement the measure but they may target only PKG-1. The effect of PKG-1 is to slow down the rates of erosion and collapse on the side walls by redirecting the flood flow downstream. It should be noted that PKG-1 alone does not prevent erosion and collapse itself, as no countermeasures are taken on the collapse portion. In addition, the rate of erosion and collapse after PKG-1 is implemented is greatly affected by rainfall intensity. Therefore, it should be noted that erosion and collapse may proceed faster

than at present depending on the rainfall intensity.

Therefore, it is necessary to ensure the reliable implementation of PKG-1 by ZINWA and to find an implementing agency for the other PKG-2 - 5 as soon as possible.

In addition, during the period between the implementation of PKG-1 and the implementation of other PKGs (or between now and the implementation of all PKGs in case ZINWA does not implement PKG-1 at an early stage), it is necessary to monitor collapsed portions mainly by visual inspection to identify signs of collapse of the embankment in particular. If such signs are identified, any measures to avoid collapse shall be taken (Refer Appendix-5 for the monitoring plan).

7.2.2 Dam Improvement Plan (for Deteriorations/Damages Evaluated as "B")

(1) Validity to Implement by Japanese Grant Aid Project

The total cost of rehabilitation of all the six dams would be around 6.4 billion yen. Taking into account the cost scale of recent Grant Aid Projects, it is difficult to rehabilitate all the six dams by a Grant Aid Project and it is necessary to set priorities.

On the other hand, 30 years have passed since the completion of construction of the six dams. Although some deteriorations/damages have been observed, the dams are functioning well and will continue to function for the foreseeable future. In addition, it is considered possible to carry out rehabilitation work only after identifying the sign/trend which may affect dam functions. Also, it is judged that the rehabilitation works can be carried out by the Zimbabwean contractor.

Additionally, the main benefit of this plan is to extend the service life of the dams, and only Mashoko Dam has the potential to increase the irrigated area (described later). Therefore, before setting the priority on the dams, it is necessary to examine the benefits and the necessary cost, and to re-examine the necessity of implementing the plan as Grant Aid Project.

(2) Increase of Irrigated Area through Raising up the Embankment Height

Mashoko Dam is the only dam that has the potential to increase its storage capacity and irrigated area. The feasibility study carried out in this Survey is a preliminary study based on visual inspection and meteorological analysis with short-term rainfall data. Therefore, it is necessary to conduct a topographic survey to re-evaluate the possibility of raising the embankment height according to the topographic conditions, and meteorological analysis with long-term rainfall data to evaluate the possibility of expanding the irrigated area according to the water resources (whether the inflow can meet the increased storage capacity).

(3) Construction Planning for Rehabilitation works

There are two possible methods to rehabilitate the embankment 1) with the reservoir empty, or 2) with water in the reservoir (under operating). Depending on which method is chosen, the scale of the temporary works required varies greatly and affects the project cost. It is therefore necessary to take this into account for construction planning of the rehabilitation works.

The method of implementation of the plan should be fully discussed and agreed with the Zimbabwean side and the beneficiary farmers. In particular, it is necessary to inform and agree with the Zimbabwean side that if the plan is to be implemented with the reservoir empty, irrigated agriculture cannot not be possible for the relevant year (and possibly for several years thereafter), and that the GoZ needs compensation to the beneficiary farmers.

7.2.3 New Irrigation Development Plan

(1) Construction Planning for Valve Replacement

There are two possible methods to replace valves in dam intake towers 1) with the reservoir empty, or 2) with water in the reservoir (under operating). Depending on which method is chosen, the scale of the temporary works required varies greatly and affects the project cost. It is therefore necessary to take this into account for construction planning of the rehabilitation works.

The method of implementation of the plan should be fully discussed and agreed with the Zimbabwean side and the beneficiary farmers. In particular, it is necessary to inform and agree with the Zimbabwean side that if the plan is to be implemented with the reservoir empty, irrigated agriculture cannot not be possible for the relevant year (and possibly for several years thereafter), and that the GoZ needs compensation to the beneficial farmers.

(2) Irrigation Planning and Economical Facility Scale

In this Survey, irrigation planning to determine irrigation water requirements is based on the assumption, 1) all the beneficiary areas are planted at the same time, beginning of the dry season and 2) maize and wheat are planted in same scale area. Therefore, it is necessary to develop farming plans and more detail irrigation planning. It is also necessary to consider how to reduce the amount of irrigation water requirement and make the facility more economical, for example by using rotational irrigation and staggered cropping.

(3) Support Programme for O&M

In order to achieve sustainable O&M of the developed irrigation schemes, it is necessary to develop soft component programs such as agricultural extension, income increasing, and organization strength, in addition to the development of the facilities.