National Irrigation Commission
Ministry of Water and Irrigation
The United Republic of Tanzania

The Project on the Revision of National Irrigation Master Plan in the United Republic of Tanzania

Final Report

Volume-I

Main Report

July 2018

Japan International Cooperation Agency (JICA)

Nippon Koei Co., Ltd.
International Development Center of Japan Inc.

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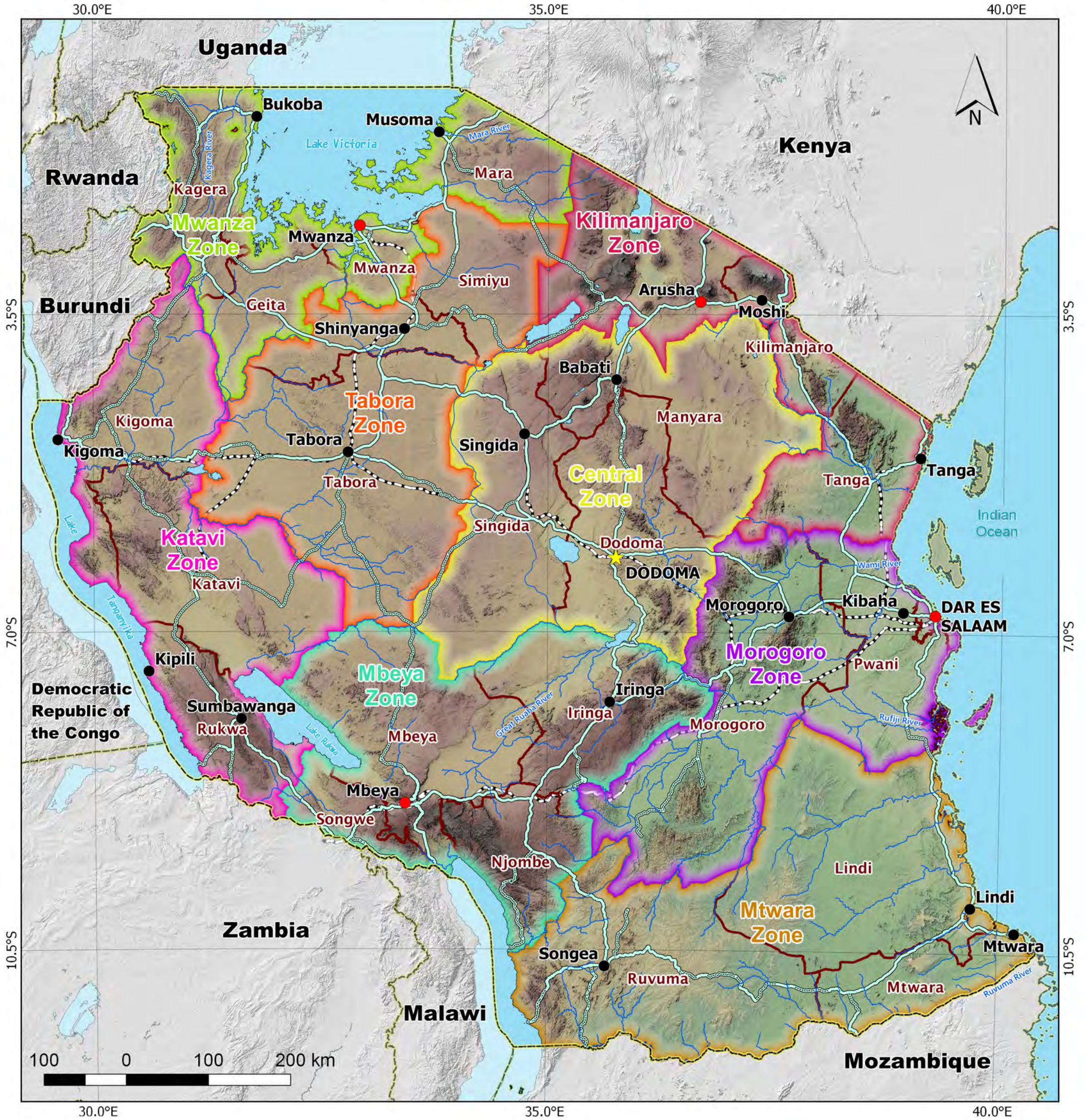
Irrigation Zonal Map
in the United Republic of Tanzania



Legend

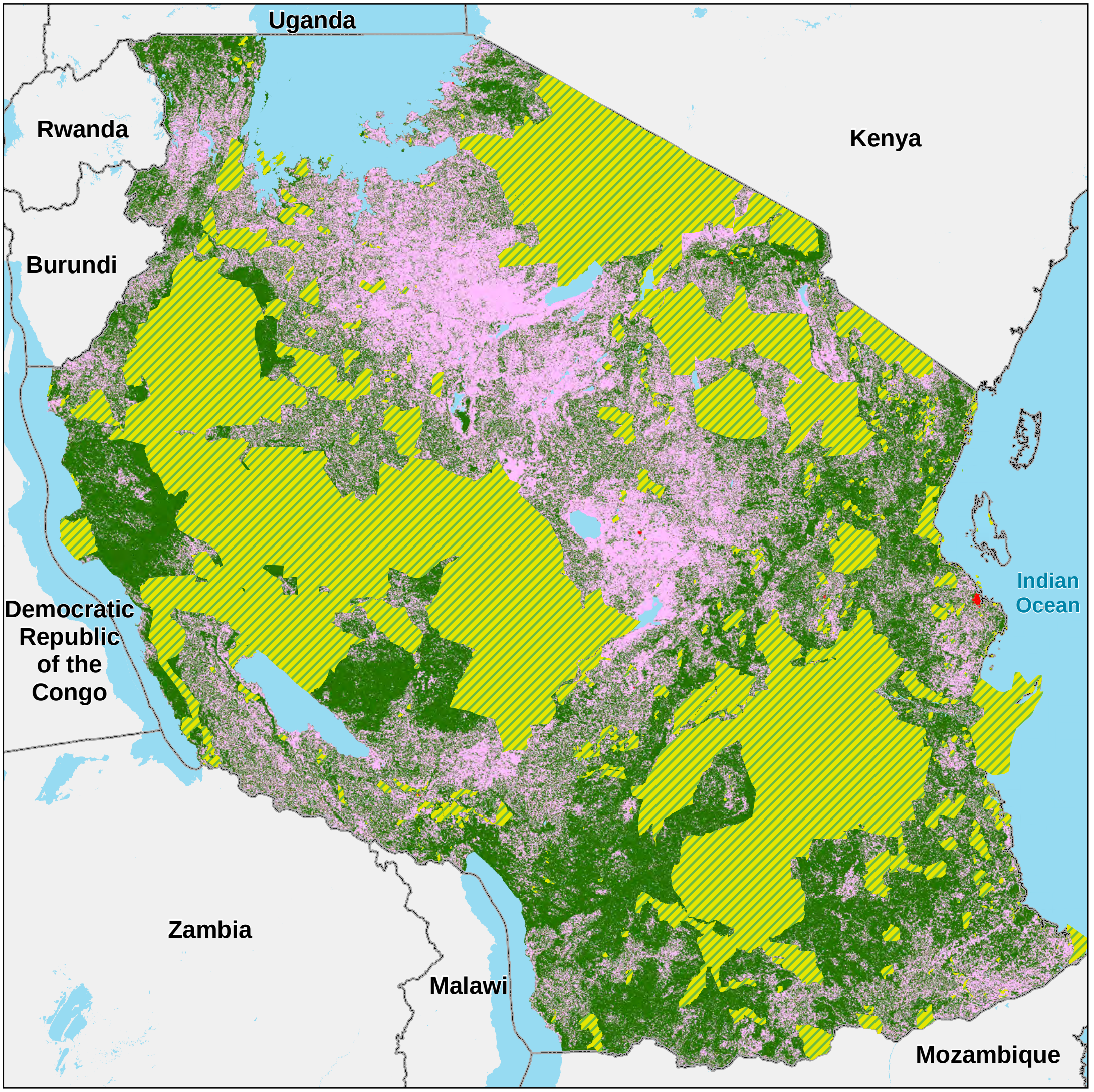
Urban Center
- City
- Capital
- Town

Trunk (Paved)
Trunk (Unpaved)
Railway
River
Water Body
Region Boundary
Zonal Boundary
Political Boundary

Elevation (m)
- 200 >
- 200
- 400
- 600
- 800
- 1000
- 1200
- 1400
- 1600
- 1800
- 2000
- 2200
- 2200 <

Source: Prepared by JICA Project Team based on
Elevation: Shuttle Radar Topography Mission (SRTM) data,
Zonal boundary: NIRC,
Roads: Tanroads
Urban Center: Natural Earth
River: Ministry of Water and Irrigation
Water Body: ESRI
Region Boundary and Political Boundary: GADM

General Land Use Map
in the Republic of Tanzania



Legend

General Land Use

- Forest
- Agriculture Potential Area
- Urban
- Protected Area
- Water Body
- Political Boundary

Class	Area (Km^2)	Area (%)
Forest	302,396	32.3
Agriculture Potential Area	255,637	27.3
Urban	151	0.02
Protected Area	319,093	34.0
Water	60,284	6.4
Total	**937,561**	**100.0**

N

0 100 200 400 km

Source:
Land use: Global Map-Global Land Cover (GLCNMO) Version-2
Protected Area: UNEP-WCMC (Feb/2017), The World Database on Protected Areas (WDPA), Cambridge, UK: UNEP-WCMC.
Available at: www.protectedplanet.net

PHOTO ALBUM (1/6)

01. Buigiri Dam Irrigation Scheme, Chamwino District, Dodoma Zone

02. Ulyanyama Dam Irrigation Scheme, Sikonge District, Tabora Zone

03. Mahiga Dam Irrigation Scheme, Kwimba District, Mwanza Zone

Source: JICA Project Team

PHOTO ALBUM (2/6)

04. Irienyi Dam Irrigation Scheme, Rorya District, Mwanza Zone

05. Lower Moshi Weir Irrigation Scheme, Moshi District, Kilimanjaro Zone

Source: JICA Project Team

PHOTO ALBUM (3/6)

06. Dakawa Pump Irrigation Scheme, Mvomero District, Morogoro Zone

07. Centre Pivot Irrigation Scheme, Kilombero Plantation Ltd (KPL), Kilombero District, Morogoro Zone

08. Serengeti Lake Water Irrigation Scheme, Bunda District, Mwanza Zone

Source: JICA Project Team

PHOTO ALBUM (4/6)

08. Serengeti Lake Water Irrigation Scheme, Bunda District, Mwanza Zone

09. Drip Irrigation Scheme, CHABUMA Cooperative, Chamwino District, Dodoma Zone

10. Kitere Groundwater Irrigation Scheme, Mtwara District, Mtwara Zone

Source: JICA Project Team

PHOTO ALBUM (5/6)



11. Irrigated Paddy, Mombo Irrigation Scheme, Korogwe District, Kilimanjaro Zone


12. Upland Rainfed Paddy Farming, Kyela District, Mbeya



13. Tomato Cultivation with Irrigation in Mkomazi-Mombo, Korogwe District, Kilimanjaro Zone



14. Onion Cultivation with irrigation in Iringa District, Mbeya Zone



15. Workshop on Irrigation Database Updates at Morogoro District, Morogoro Zone (7th to 11th November 2016)

Source: JICA Project Team

PHOTO ALBUM (6/6)






16. Workshop on Irrigation Scheme Mapping with GPS device (February to March 2017)


17. 1st JCC Meeting at Dar es Salaam (6th Dec. 2016)

18. 1st SCM at Dar es Salaam (7th Dec. 2016)


19. 2nd JCC Meeting at Dodoma (21st Sept. 2017)

20. 2nd SCM at Dar es Salaam (27th Sept. 2017)


21. 3rd JCC Meeting at Dodoma (4th April 2018)

22. 3rd SCM at Dar es Salaam (9th April 2018)

Source: JICA Project Team

The Project on the Revision of National Irrigation Master Plan in the United Republic of Tanzania

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Executive Summary

July 2018

1.1 Project Outlines

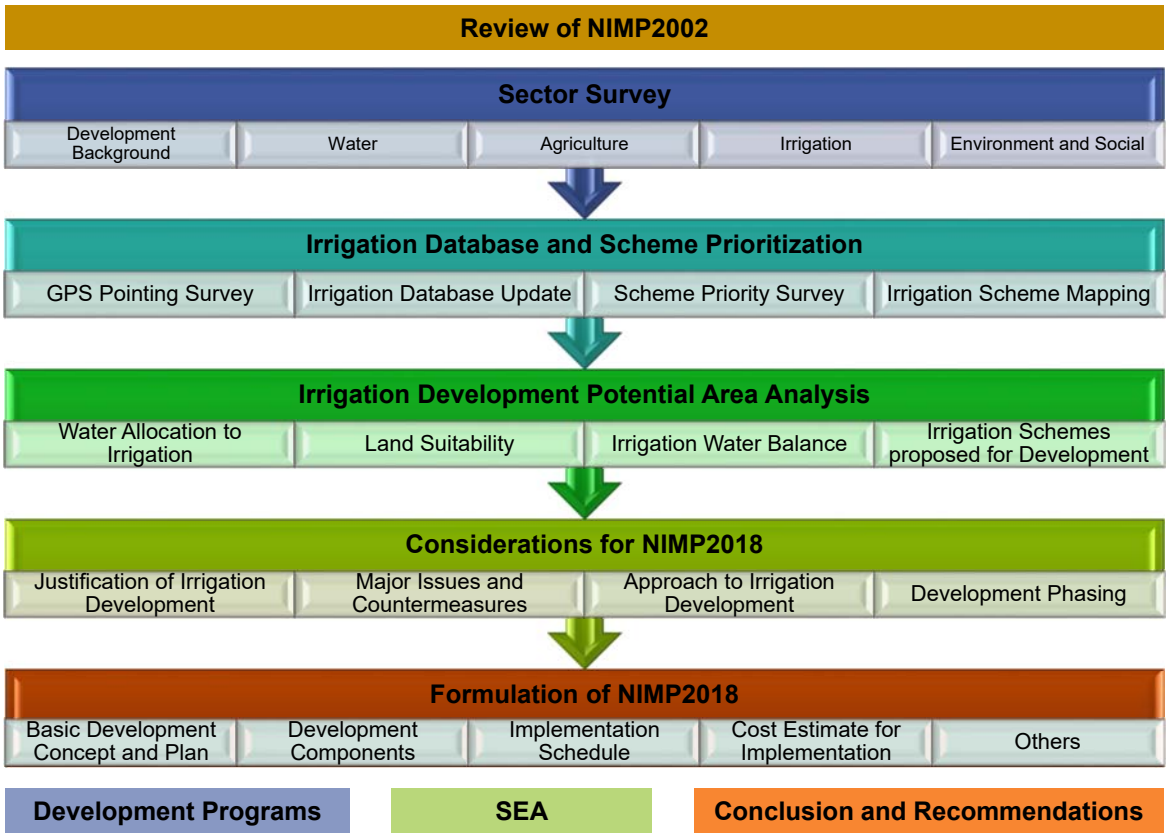
Project Background	◆ More than 15 years have passed since the formulation of the current NIMP2002, and the circumstances around irrigation development have changed, ◆ Need of further efforts for poverty reduction, and ◆ Increasing demands for more sustainable irrigation development.
Project Goal	Irrigation development under National Irrigation Commission (NIRC) is sustainably enhanced.
Project Outputs	Output 1: National Irrigation Master Plan is revised. Output 2: Action Plan is established.
Project Objectives	◆ To revise the NIMP2002 in view of contributing to poverty reduction and addressing the climate change, ◆ To enhance the capacity of NIRC, and hence ◆ To strengthen the sustainable irrigation development of Tanzania.

1.2 Counterpart Agency and Relevant Organisations

Counterpart Agency	National Irrigation Commission (NIRC)
Relevant Government Organisations (Members of JCC)	Ministry of Water and Irrigation (MoWI) Ministry of Agriculture (MoA)*1 Ministry of Finance and Planning (MoFP) Ministry of Energy and Minerals (MEM) Ministry of Natural Resources and Tourism (MNRT) Ministry of Lands, Housing and Human Settlements Development (MLHH) President's Office, Regional Administration and Local Government (PO-RALG), Vice President's Office-Union Affairs and Environment (VPO-DOE), etc.
Stakeholders (Members of SCM)	Development Partners (Donors), Embassies, Private Sector, NGOs, etc..

Note: *1= Ministry of Agriculture, Livestock, and Fisheries (MALF) was split into the Ministry of Agriculture (MoA) and Ministry of Livestock and Fisheries (MoLF) in October 2017.

1.3 General Work Flow



1.4 Achievements of NIMP2002

NIMP2002 was formulated in 2002. With respect to the hardware aspect, NIMP2002 proposed to develop 626 irrigation schemes with total irrigated area of 405,400 ha (counted on accumulation basis), while in terms of software aspect, it proposed 37 reform plans to address various issues.

(1) Accumulated Irrigation Development Area (High, Base, Low Scenarios and Actual)

F.Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
High	218	229	239	250	265	276	281	294	312	325	337	352	372	387	405
Base	218	228	236	243	254	264	271	278	290	304	316	325	335	351	362
Low	218	222	234	240	248	261	268	274	287	296	306	321	328	337	350
Actual			264	274	289	311	331	346	355	364	450	461	461	NA	NA

The actual irrigation development area by 2015 was 461,000 ha which is bigger than the area projected in the NIMP2002.

(2) Achievement of Subject-wise Improvement Programs

Category	Action has been taken				No Action
Number of Programs (%)	27 (73%)				10 (27%)
Score Range of Progress	80-100%	50-80%	20-50%	1-20%	
Number of Programs (%)	4 (15%)	14 (52%)	4 (15%)	5 (18%)	

Out of 37 programs, 27 programs are now in progress, especially the CGL* is being disseminated to the large section of stakeholders.

Note: * CGL: Comprehensive Guidelines for Irrigation Scheme Development under District Agricultural Development Plan

2.1 (1) Development Background

(1) Demography of Tanzania

Item	Land Area (thousand km^2)	Population 2002 Census	Population 2012 Census	Population Density (persons/km^2) (2012 Census)	Inter-census Growth Rate (%)	Population 2015*
Tanzania Mainland	945	33,461,849	43,625,354	49	2.7	47,351,275

Note: 2015* is projection

(2) GDP and Its Share by Sector

Economic Activity	2008	2009	2010	2011	2012	2013	2014r	2015p
GDP Per Capita (USD)	584	702	749	785	896	991	1043	964
Agriculture, Forestry and Fishing (%)	26.8	27.2	26.3	25.2	24.8	23.8	23.0	22.0
Industry and Construction (%)	20.2	20.0	20.5	21.3	21.1	21.5	22.2	23.1
Services (%)	47.4	47.0	47.6	47.8	48.8	48.7	48.8	48.8
Balance (%)	5.6	5.8	5.6	5.7	5.3	6.0	6.0	6.1

(3) Poverty Trend of Tanzania

Year	Region	% of Population below Food Poverty line	% of Population below Basic Needs Poverty line	% of Female Headed Households
2007	Dar es Salaam	3.2	14.1	24.4
	Other Urban	8.9	22.7	30.1
	Rural	13.5	39.4	23.0
	Total	11.8	34.4	24.5
2011/12	Dar es Salaam	1.0	4.1	22.5
	Other Urban	8.7	21.7	27.6
	Rural	11.3	33.3	24.3
	Total	9.7	28.2	24.7

2.1 (2) Development Background

(4) Government Development Policy and Plan

Document	Target Period	Characteristics
Five Year Development Plan II (FYDP II) - Nurturing an Industrial Economy	2016/17 – 20/21 (5 years)	· Focus on economic growth · Flagship projects with large investments · Strategic consideration of geographic position (Corridor approach and area focus) · Improving business and investment environment
Agricultural Sector Development Programme 2 (ASDP2)	2016/17 – 25/26 (10 years)	· Focus on commercialization of agriculture · Promotion of value chain and value addition · Prioritized intervention (Commodity and area focus) · Private sector mobilization (Business promotion)
National Irrigation Policy (NIP)	February 2010 – Present	· Formulated to "provide a baseline for a focused development of irrigation sector. · A general guidance for interventions. · Guidance is structured with respect to the types of irrigation scheme (Traditional, improved, smallholders', or commercial, etc.) and key issues in relation to irrigation such as research, appropriate technology, production, capacity, etc. · For each subject, issue, objective, policy statements are given.
National Irrigation Act (NIA)	2013 – Present	· This is a law specifically enacted to facilitate irrigation development of the country. · It has provision of establishing the National Irrigation Commission. · It provides definitions of many terms pertinent to irrigation. · It facilitates improvement of irrigation facility construction and operation by legally demanding particularities of actions to be taken.

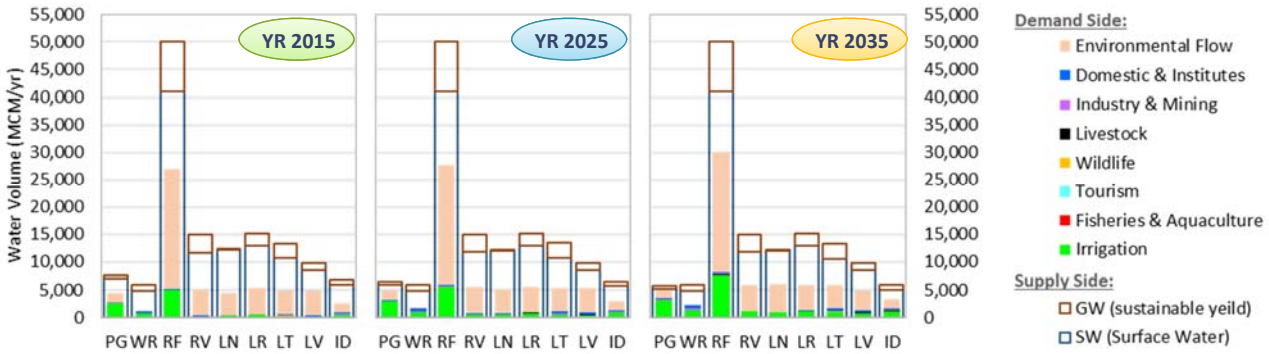
2.2 (1) Water Resources – Approach & IWRMDPs

(a) Basic Approach for Water Resources Study

- Tanzania Mainland is divided into 9 basins and further divided into 71 sub-basins. Water resources assessment is to be done on a monthly and sub-basin basis.
- MoWI has been formulating the IWRMDP* for the respective 9 basins (as of September 2017, assessment completed for 8 basins, planning completed for 6 basins). From the standpoint of harmonization with the relevant plans, due consideration to the IWRMDPs will be required.

(b) Estimation by IWRMDP & LVBC : Water Resources (SW+GW), Water Demands by Sector, EFR

- Irrigation water demand account for more than 80% of total demand (except for EFR).
- Projected irrigation area: 490,000ha in 2015 / 720,000ha in 2025 / 1,050,000ha in 2035
- In NAWAPO (2002), higher priority is given to Basic Human Needs and EFR.

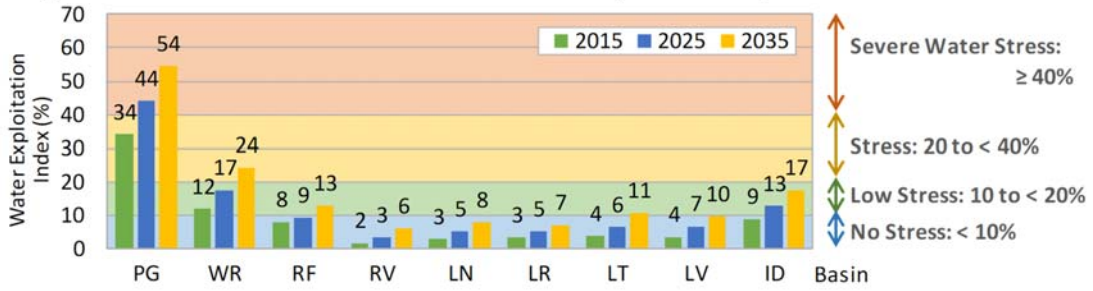


Note: * IWRMDP: Integrated Water Resources Management and Development Plan

2.2 (2) Water Resources – Water Stress & Irrigation Water

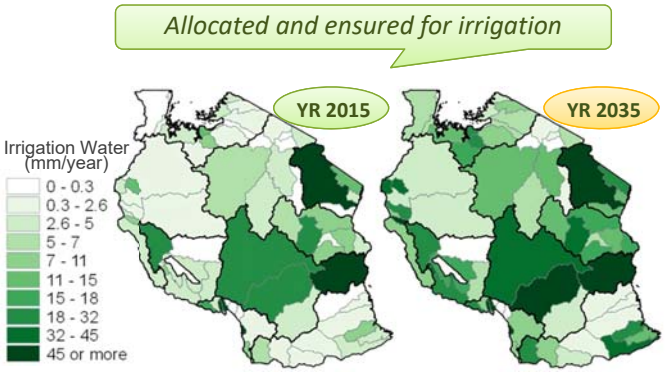
(c) WEI (Water Exploitation Index): Percentage of total consumptive water demands to IRWR*

- Pangani is under stress even in current condition, and Wami/Ruvu will be stressed soon.



(d) Allocated Water for Irrigation

- Basically, allocations of irrigation water have been determined by IWRMDPs.
- Water demands estimated by IWRMDPs were reviewed and adjusted if the demands exceeded available water.
- <u>Finalized amounts of irrigation water (shown in the figures) are used for irrigation areas to be proposed by the NIMP2018.</u>



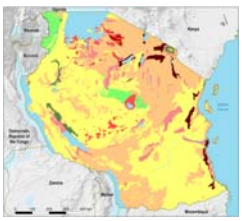
Note: * IRWR: Internal Renewable Water Resources (comprising surface runoff and GW recharge)

2.3 (1) Land Resources – Land Suitability Analysis

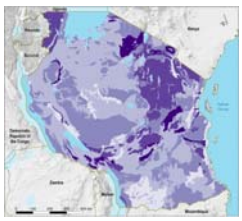
(1) Topographic Wetness Index

(2) Land use

(3) Temperature

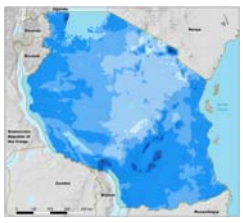


(4) Soil pH



(5) Soil Organic Carbon

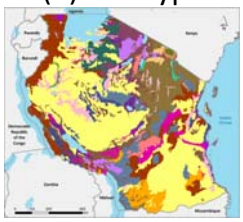
Land suitability analysis was conducted using Analytical Hierarchy Process (AHP)*.



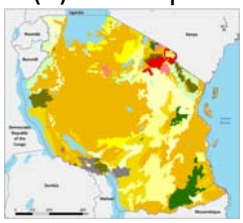
(11) Precipitation

(6) Elevation

(7) Soil Type

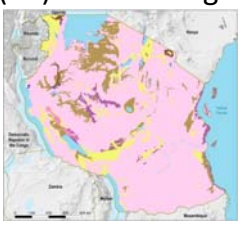


(8) Soil Depth



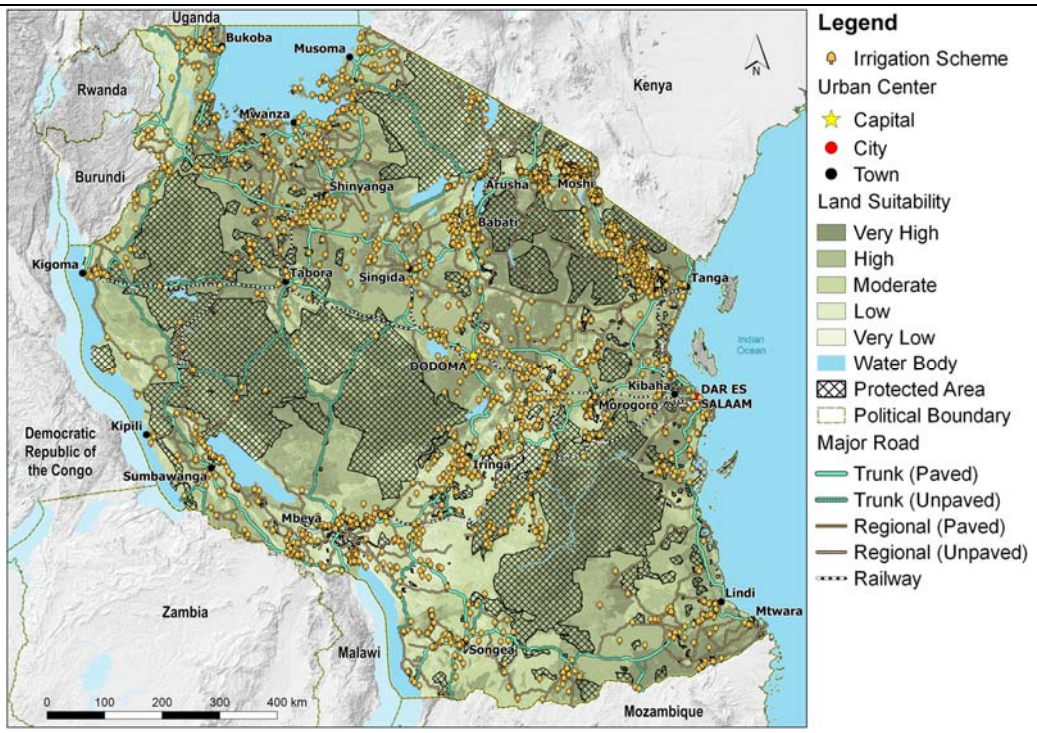
(9) Slope

(10) Soil Drainage



Note: * AHP: A structured technique for organising and analyzing complex decisions, based on mathematics and psychology

2.3 (2) Land Resources – Land Suitability for Agriculture

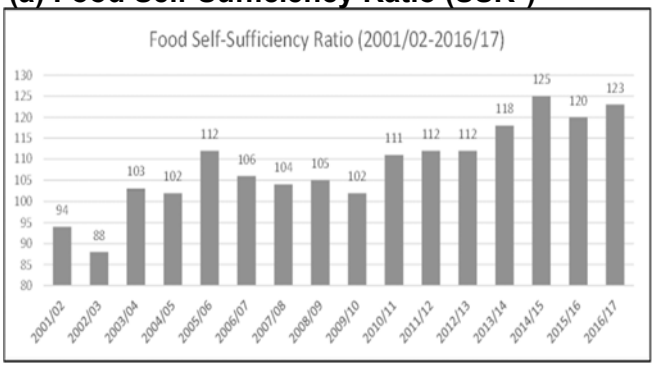


Potential agriculture lands are limited to approximately 25.6 million ha or only 27% of the total land area of Tanzania Mainland. A part of protected area (31.9 million ha or 34% of the total lands) is suitable for agriculture but currently not permitted for the development.

Note: Land use consists of forest (32%), agriculture potential area (27%), protected area (34%), water body (6%) and others (1%).

2.4 Agriculture

(a) Food Self-Sufficiency Ratio (SSR*)



Paradigm Shift for Agriculture In Tanzania

Tanzania has achieved SSR over 110% since 2010/11. Major challenges in agriculture sector are storage, distribution, processing and export. Taking advantage of rich natural resources in the country, Tanzania should become a food basket for East African countries and beyond.

Note: * SSR : Self-Sufficiency Ratio announced by Tanzania Government (Ratio between the total food supply (grain-equivalent conversion of major cereals subtracted by non-food use) and total food demand (650g/person-day x population x 365 days))

(b) Target Crops for Irrigation

Type of Crops for Irrigation Planning	Target Crops	Features
High water demanding crops (60%)	Paddy, Maize, Sugarcane	**(Low Risk, Low Returns)** ● Less production cost ● Less labour intensive ● No large fluctuation in price ● Long storable (except sugarcane) ● Need for extension services, etc.
Low water demanding crops (40%)	Tomatoes, Onions, Oil Crops (Sunflower, Sesame), Beans, Cotton, Grapes, Bananas, Papaya and other crops	**(High Risk, High Returns)** ● Higher production cost ● Labour intensive ● Large fluctuation in price ● Perishable (except oil crops and cotton) ● Need for intensive extension services, etc.

2.5 Irrigation Human Resources

(a) Allocation of Irrigation Engineers and Technicians in NIRC (as of February 2018)

	NIRC-HQ	Dodoma	Kiliman.	Mbeya	Morog.	Mtwara	Mwanza	Tabora	Katavi
Irrigation/ Agricultural Engineer	10	9	6	14	12	8	8	7	1
Irrigation Technician	0	5	5	0	4	1	3	4	0
Others	54	15	20	14	18	4	10	9	4
Total	64	29	31	28	34	13	21	20	5

NIRC/ZIOs need to increase the number of irrigation engineers and technicians to implement NIMP2018.

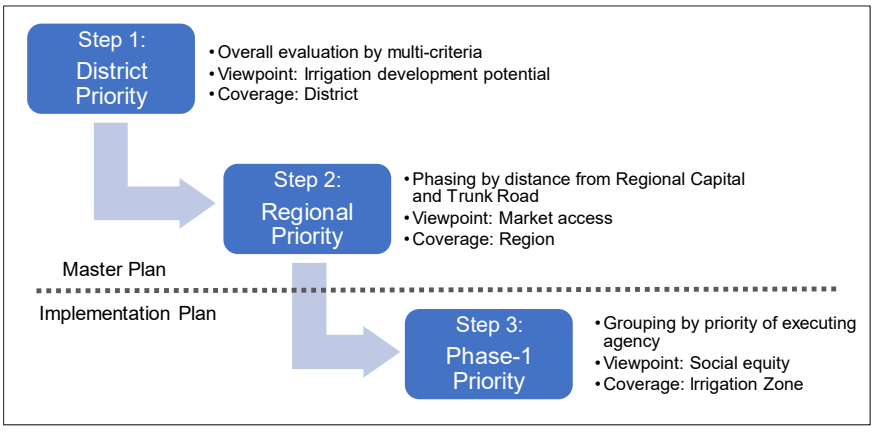
(b) Allocation of Irrigation Engineers and Technicians in LGAs (as of February 2017)

	Dodoma	Kiliman.	Mbeya	Morog.	Mtwara	Mwanza	Tabora	Katavi
Number of LGAs	22	25	22	20	23	31	20	17
Irrigation/ Agricultural/ Civil Engineer	14	13	13	14	10	14	7	8
Irrigation Technician	12	48	35	21	15	22	8	14

LGAs are the main implementers of small-scale irrigation development. Yet they are understaffed with technical officers in the irrigation sector. For instance, 37% of all LGAs (66 out of 180 LGAs) do not have either irrigation/agricultural engineer or irrigation technician. With regard to engineers, 116 out of 180 LGAs (64%) have no irrigation/agriculture engineers.

2.6 (1) Prioritization Process of Irrigation Schemes

(a) Prioritization Process of Irrigation Schemes



Irrigation Development

Existing*1:	461,000 ha
Phase 1:	248,120 ha
Phase 2:	312,110 ha
Sub-total:	1,021,230 ha
Private:	222,000 ha
Total:	1,243,230 ha

Note: *1= 189,828 ha out of 461,000 ha is target for Improvement (no expansion).

(b) Results of Scheme Prioritization by Step 1 and Step 2

Total Number of Schemes identified	Phase 1 (2018-2025)		Phase 2 (2026-2035)	
	Selected Schemes by Step 1	Selected Schemes by Step 2	Selected Schemes by Step 1	Selected Schemes by Step 2
2,947	918	469	1,112	643
	Area Expansion →	248,120 ha	Area Expansion →	312,110 ha

In addition to the above table, large scale commercial irrigation farms are planned for implementation, 54,000 ha by 3 projects in Phase 1 and 168,000 ha by 5 projects in Phase 2.

2.6 (2) Irrigation Scheme Prioritization at District Level

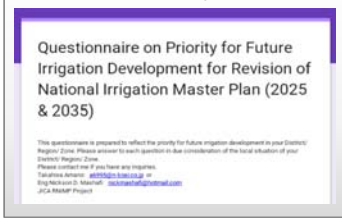
1. National Irrigation Database

4. Water Resources Analysis

Calculate the water amount allocated for irrigation in IWRMDPs.

Scheme Selection based on the water resource limitation

2. District Priority



3. Prioritization Analysis

Scheme aspect values × District priority weight vectors

Priority Ranking

5. Phasing for Implementation Plan/Master Plan, Program

Other Spatial Analysis with GIS

Calculation of Priority Score

scheme aspects

Scheme	Area			Slope			Distance from markets			Rain			Total	Priority Ranking	Selec-tion
	ha	Class	Value	degree	Class	Value	km	Class	Value	mm	Class	Value	Value		
AAA Scheme	1,200	3	0.6	3	3	0.9	10	3	0.6	600	2	0.2	2.3	1	Yes
BBB Scheme	1,500	3	0.6	1	3	0.9	40	1	0.2	1,000	3	0.3	2	2	Yes
CCC Scheme	250	2	0.4	7	1	0.3	5	3	0.6	800	3	0.3	1.6	3	Yes
DDD Scheme	100	1	0.2	5	2	0.6	20	2	0.4	700	2	0.2	1.4	4	No

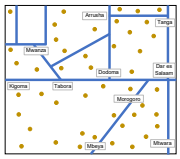
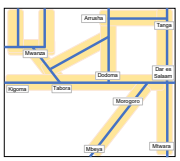
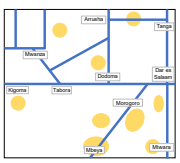
physical values

Classification

Multiply weight

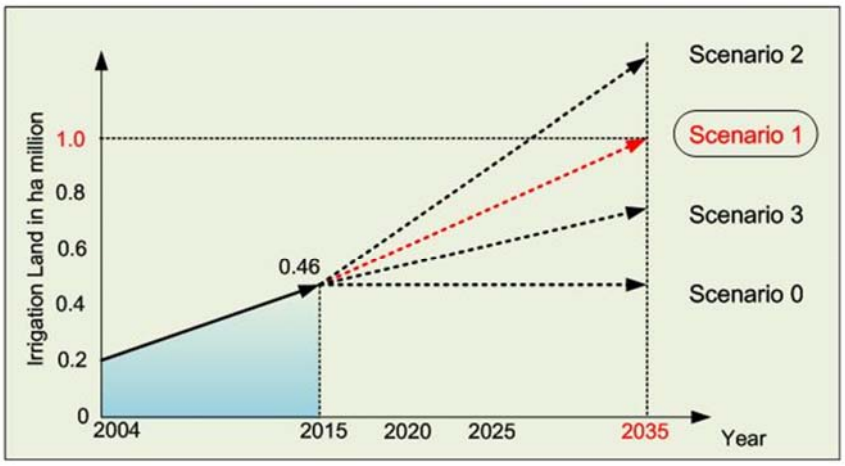
Integrate priority values

2.6 (3) Irrigation Scheme Prioritization at Regional Level

Plan	Phasing Concept	Merit	Demerit
Original 	**Focus on irrigation potential:** Irrigation schemes are classified into Phase 1 and Phase 2 according to the development priority order.	It is most reasonable from the viewpoint of irrigation development potential.	Low cooperation with agricultural development.
Alternative 1 	**Focus on development corridor:** Irrigation schemes along major trunk roads that make up the economic corridor are classified into Phase 1, and others are Phase 2.	High cooperation with the ASDP2, which aims to develop a value chain.	Low priority of the irrigation scheme located at the remote places
Alternative 2 	**Focus on district cluster:** Irrigation scheme is located within the cluster specified in ASDP2 are classified into Phase 1, and others in Phase 2.	High affinity with ASDP2 aiming for cluster agricultural development.	- Regionally concentrated - Imbalance among regions
Alternative 3 	**Focus on major cities and market access:** Irrigation schemes located within specified threshold distance will be conducted in Phase 1 and others in Phase 2.	It will support the value chain suggested in ASDP2 and helps making an economic corridor that serves domestic and international markets	It will reduce the potential of selecting irrigation schemes located in villages and along minor roads.

Note: JICA Project Team proposed Alternative 3 and it was approved by JCC.

2.7 Development Scenarios



Senario 0: NIMP2018 is not implemented.

Scenario 1: New irrigation schemes are developed in addition to improvement and expansion of existing irrigation schemes.

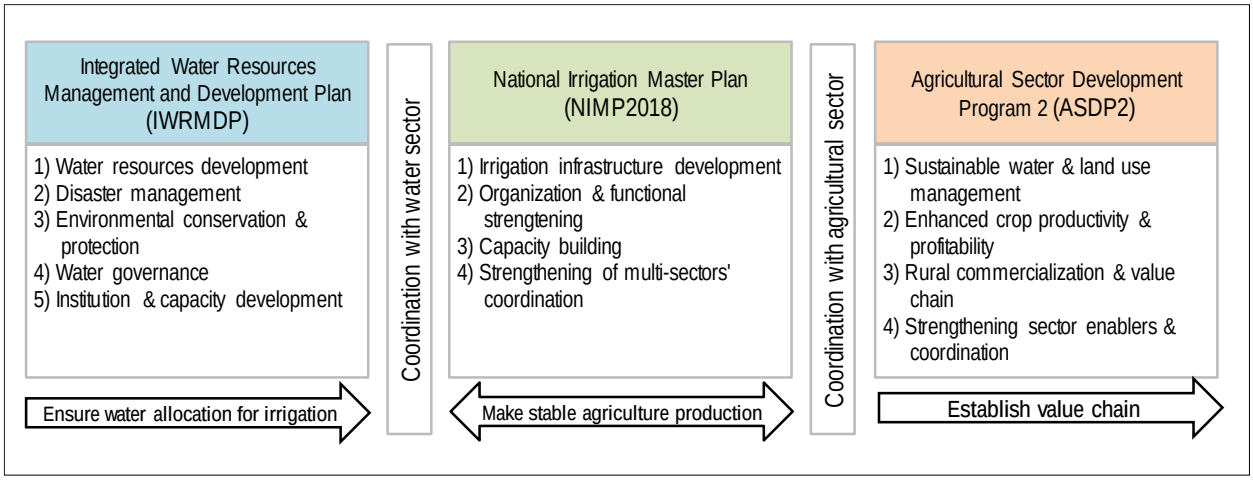
Scenario 2: Large-scale commercial irrigation schemes are developed in addition to Scenario 1.

Scenario 3: Only existing irrigation schemes are improved and expanded.

The government approval and implementation of NIMP2018 as planned are prerequisites for realizing Scenario 1. The following shall be considered in implementing NIMP2018.

1) IWRMDP and ARDP2 are implemented as planned in addition to NIMP2018.
2) Development funds for the item 1 are secured.
3) Organisational set-up for irrigation development and management specified by the National Irrigation Act 2013 is established in addition to increasing the number of irrigation staff.
4) Technical and management capacities of irrigation staff and IOs are strengthened.
5) Coordination among the relevant ministries and agencies is made for cross-cutting issues related to irrigation development.

2.8 Coordination of IWRMDP, NIMP2018 and ASDP2



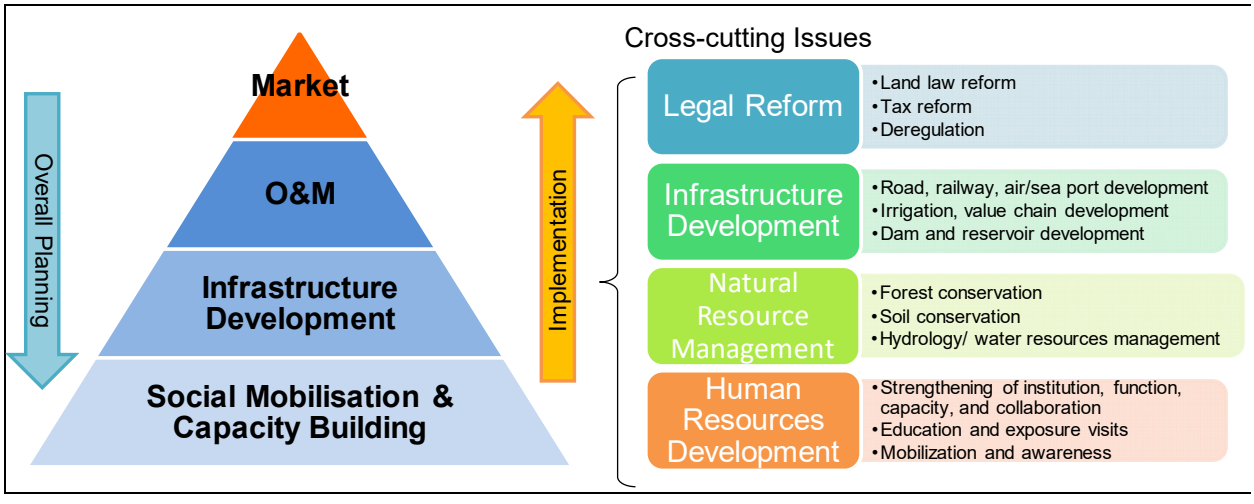
It is important for irrigation sector to make a good coordination especially with water sector (IWRMDP) to secure water allocation for irrigation through river basin management and soil conservation in the upper catchment areas and agriculture sector (ASDP2) to strengthen the agricultural extension services and agricultural value chain enhancing crop productivity and profitability.

2.9 Basic Framework of NIMP2018

		Phase 1 (P1)	Phase 2 (P2)
Overall Goal		Contribution to Agriculture GDP Growth and Rural Poverty Reduction	
Project Purpose		Strengthening of NIRC in a Sustainable Manner	
Development Strategy		• Irrigation Development consistent with National Development Plans • Irrigation Development based on Water Allocation estimated by IWRMDP • Irrigation Development in collaboration with ASDP2	
Hard Component	Development Target	Improvement of Irrigation Efficiency and Expansion of Irrigation Area	
	Development Approach	1) On-going projects with priority 2) More matured projects with priority 3) Development priority of executing agencies 4) Formulation of P2 projects	1) Projects formulated in P1 with priority 2) Projects carried over from previous P1 with priority
	Major Activities	• Development of small scale irrigation systems (Improvement, Expansion, New Development) • Development of medium to large scale irrigation systems (Improvement, Expansion, New Development) • Promotion of storage-type irrigation development (small dams and ponds) • Promotion of lake water irrigation development • Promotion of water saving irrigation development (Drip, Sprinkler), etc.	
Soft Components	Development Target	Quality Improvement in Irrigation	
	Development Approach	1) Institutional and functional strengthening for smooth implementation of projects 2) Capacity building of government staffs for quality irrigation development 3) Capacity building of irrigators' organization for sustainable O&M in participatory manner 4) Strengthening of coordination with relevant ministries and private sector	
	Major Activities	• Organization and function: Unified management of irrigation development, etc. • Capacity building: Human resource development for sustainable irrigation development • Coordination: Strengthen efforts towards cross-sectoral issues, and encourage private sector participation	
Scope	NIMP2018	Phase 1 and Phase 2	
	Implementation Plan	Phase 1	To be prepared by NIRC

3.1 Development Concept of NIMP2018

Target irrigation schemes will be selected considering the comparative superiority of market access (domestic distribution and export).



It is not easy for NIRC alone to deal with the cross-cutting issues, coordination and cooperation with other ministries are indispensable.

3.2 Approach to NIMP2018

Approach	Methodology
Irrigation scheme prioritization in a scientific manner	➢ Water allocation to irrigation on a monthly basis in 71 sub-basins ➢ Land resources potential analysis by AHP method ➢ Irrigation development potential area by monthly water balance calculation ➢ Updating irrigation database ➢ GIS spatial analysis ➢ Prioritization of irrigation schemes with priority weight vectors
Consideration of export-oriented agriculture development	➢ Crop selection for irrigation
Phasing development plan enabling a linkage with value chain development by ASDP2	➢ Comparison of an original plan with various alternative plans
Irrigation infrastructure development with locally available water resources (Effective use of water for irrigation)	➢ Completion of uncompleted irrigation systems ➢ Promotion of water harvesting irrigation with pond (small dam) ➢ Promotion of large-scale commercial irrigation farms
Focus on full development of irrigation schemes	➢ Costs for water intake structures, main and secondary canals, O&M roads, drainage canals
Strengthening of supporting system for irrigation infrastructure development	➢ Irrigation organisation and functions ➢ Capacity building of irrigation staff and IOs ➢ Coordination with other sectors

3.3 Development Plan of NIMP2018

Item	Description
1. Overall Goal	➢ To contribute to the achievement of KPIs* for ASDP2 *- Agriculture GDP annual growth rate (6%)* *- Rural poverty rate (24% or below)* *- Food poverty rate (5% or below)*
2. Objective	➢ To contribute to national economy and food security by improving agricultural productivity and profitability through irrigation development, consequently reducing rural poverty and strengthening climate change resilience.
3. Development Target	➢ Irrigation developed area (One million ha), Number of beneficiary farmers (more than 600,000 FHHs), Crop yield (5 ton/ha for paddy, 40 ton/ha for tomatoes and 10 ton/ha for onions), Incremental net farm income (TZS 3 to 4 million/ha/ year on average)
4. Target Year	➢ 2035 - Phase I: 2025 (2018-2025) - Phase II: 2035 (2026-2035) ** The same target year with IWRMDP*

Note: * KPIs= Key Performance Indicators

3.4 Development Components of NIMP2018

	SN	Development Strategy	Development Plan
Hard Component (HC)	HC1	Increase irrigation area through sustainable water use	(1) Dodoma Zonal Irrigation Development Plan (2) Kilimanjaro Zonal Irrigation Development Plan (3) Mbeya Zonal Irrigation Development Plan (4) Morogoro Zonal Irrigation Development Plan (5) Mtwara Zonal Irrigation Development Plan (6) Mwanza Zonal Irrigation Development Plan (7) Tabora Zonal Irrigation Development Plan (8) Katavi Zonal Irrigation Development Plan (9) Large-scale Commercial Irrigation Development Plan
Soft Component (SC)	SC1	Organisation and Functional Strengthening	(1) Establishment of RIOs and strengthening of DIDTs/DIDs (2) Improvement of NIRC function (human resources, equipment, facilities) (3) IO registration (4) Establishment of project performance monitoring and evaluation system (5) Establishment of public relations system (6) Research and development for irrigation
	SC2	Capacity Building	(1) Capacity development training for irrigation staff in ZIOs/RIOs (2) Capacity development training for irrigation staff in LGAs (DIDTs/DIDs) (3) Capacity development training for IOs (4) Establishment of design standards for irrigation in Tanzania (5) Establishment of training modules for irrigation development (6) Promotion of private contractors and enhancement of their engineering capacities
	SC3	Strengthening of Coordination	(1) Coordination with private sector for irrigation investment (2) Coordination with relevant institutions for crosscutting issues (water and land conflict, etc.)

3.5 Implementation Schedule of NIMP2018

Implementation Schedule of NIMP2018

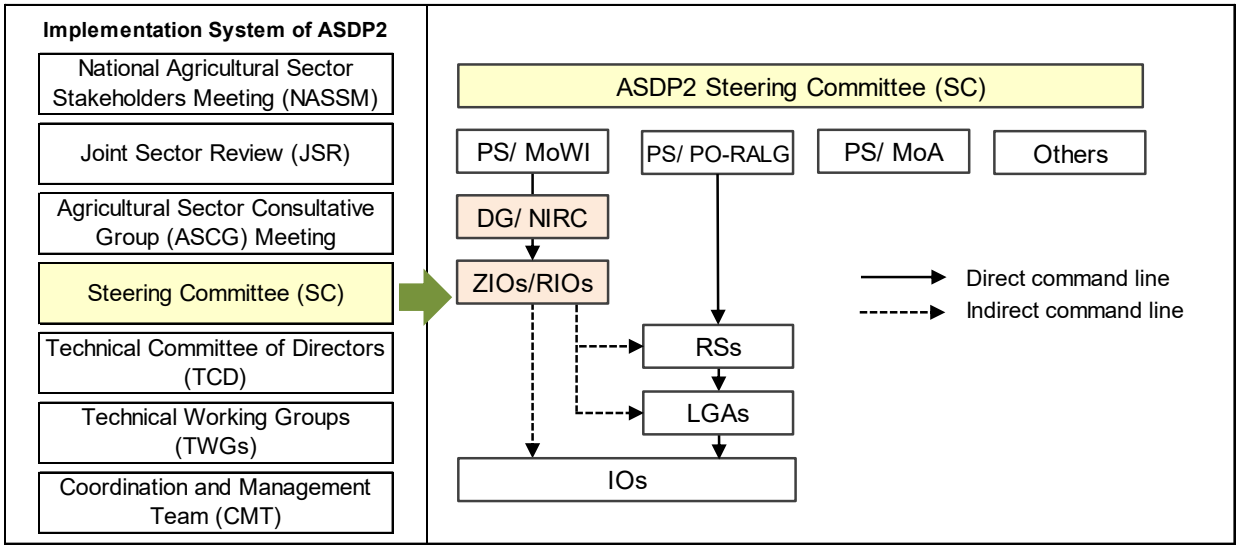
	Phase	Phase I (2018-25)								Phase II (2026-35)									
	Year	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	9	10
Hard Component (HC)	**[HC 1] Effective use of water for irrigation (all types of irrigation development)**																		
	(1) Small scale irrigation scheme																		
	(2) Medium scale irrigation scheme																		
	(3) Large scale irrigation scheme																		
Soft Component (SC)	**[SC 1] Organization and functional strengthening**																		
	(1) Establishment of RIOs and strengthening of DIDTs/DIDs																		
	(2) Improvement of NIRC function (human resources, equipment, facilities)																		
	(3) IO registration																		
	(4) Establishment of project performance monitoring and evaluation system																		
	(5) Establishment of public relation system																		
	(6) Research and development for irrigation																		
	[SC 2] Capacity building																		
	(1) Capacity development training for irriagtion staff in ZIOs/RIOs																		
	(2) Capacity development training for irrigation staff in LGAs (DIDTs/DIDs)																		
	(3) Capacity deveopment training for IOs																		
	(4) Establishment of design standards for irrigation in Tanzania																		
	(5) Establishment of training modules for irrigation development																		
	(6) Promotion of private contractors and enhancement of their engineering capacities																		
	[SC 3] Strengthening of coordiantion																		
	(1) Coordination with private sector for irrigaiton investment																		
	(2) Coordination with relevant institutions for crosscutting issues																		

Legend: Study, design and tender; Continuous activities; Time-bound activities (construction, preparation of plan, training modules, manuals, etc.)

NIMP2018 will be executed by stage-wise approach so as to make use of experiences in Phase 1 into Phase 2 implementation.

3.6 (1) Organisational Arrangement for Implementation

(1) Alignment with ASDP2 Implementation System



NIRC shall be a member of ASDP2 Steering Committee and seeks to share policies and information by participating in various conferences and committees.

3.6 (2) Organisational Arrangement for Implementation

(2) Responsibility Matrix among Stakeholders by Component

Development Component	NIRC	ZIO	LGA	IO	Consultant	University/ Institute	Contractor	NGO
HC: Irrigation Infrastructure Development								
Irrigation Infrastructure Development (Small Scale)	○	○	●	○	●		●	
Irrigation Infrastructure Development (Medium/Large Scale)	●	●	○	○	●		●	
SC-1: Organisation and Functional Strengthening								
Establishment of RIOs and strengthening of DIDTs/DIDs	●	●	●					
Improvement of NIRC function (HR, equipment, facilities)	●	●						
Registration of IOs	●	○	○	●				
Establishment of project performance monitoring and evaluation system	●	○	●	○				
Establishment of public relations system	●	○						
Research and development for irrigation	●	○				●		
SC-2: Capacity Building								
Capacity development training for irrigation staff (Level 1)	●	●						
Capacity development training for irrigation staff (Level 2)	○	●	●					
Capacity development training for IOs (Level 3)	○	○	●	●		●		○
Establishment of irrigation technical manuals and checklists	●	○			●			
Establishment of training modules for irrigation development	●	○				●		○
Promotion of private contractors/ consultants	●	○			●		●	
SC-3: Strengthening of Coordination								
Coordination with private sector	●	○						
Coordination with relevant institutions	●	○						

Note: ● = Main Player, ○ = Sub Player

3.7 Investment Costs

(1) Investment Costs for NIMP2018 (Phase 1 and Phase 2)

No.	Component	PHASE-1 Cost (USD in Million)	PHASE-2 Cost (USD in Million)	Total Cost (USD in Million)	Total Cost equivalent (TZS in Billion)
1	**Hard Component:** 1. Irrigation Infrastructure Development	2,026	2,423	4,449	9,965
2	**Soft Components:** 1. Organisation & Functional Strengthening 2. Capacity Building 3. Strengthening of Coordination	27	14	41	94
	Total	2,053	2,437	4,490	10,059

Notes: - Exchange rate of USD 1.0 = TZS 2,240 as of July 2017
- All figures in the table include VAT (18%).

(2) Annual Financial Mobilization during NIMP2018 Period (USD in Million)

Financial Demand and Supply (annual amount)		Phase 1: 8 years (2018 – 2025)	Phase 2: 10 years (2026 – 2035)
Financial demand (annual)		217	206
Public	Government	52	41
	DPs	100	85
Private	IO contribution	10	10
	Private Investment	40	40
	Large scale PPP	10	20
	Small scale PPP	5	10

3.8 (1/2) Project Evaluation

(1) Financial Benefits

< Assumption for Farm Budget Analysis >

Crop	Rainfed/ Irrigation	Present (ton/ ha)	Future (without Project) (ton/ ha)	Future (with Project) (ton/ ha)	Crop Intensity
Rice/ Paddy	Rainfed	1.85	1.85	5.00	0.782
	Irrigation	2.50	2.50	5.00	
Tomato	Rainfed	5.00	5.00	40.00	0.065
	Irrigation	20.00	20.00	40.00	
Onion	Rainfed	2.00	2.00	10.00	0.456
	Irrigation	7.00	7.00	10.00	

Note: Total crop intensity is 1.303 with 1.000 in rainy season and 0.303 in dry season.

< Farm Budget Analysis >

Change of Production Mode	Rainfed to Irrigation* (TZS / ha)			Existing Irrigation to Irrigation* (TZS/ farmer)		
	Without	With	Net benefit	Without	With	Net benefit
Present rainfed to irrigation cultivation	▲307,754	3,922,448	4,230,202	805,754	3,922,448	3,116,695
Present irrigation to improved irrigation cultivation	▲492,406	6,257,917	6,768,323	1,289,206	6,257,917	4,986,711

Notes: * Irrigation by NIMP2018
* National average farm land area is 1.6 ha/ farmer (2014/15 Annual Agricultural Sample Survey)

3.8 (2/2) Project Evaluation

(2) Economic Assessment and Sensitivity Analysis

For the assessment of the economic value of the Mater Plan, benefits and costs are adjusted by the following conversion factors.

Conversion factor	Value	Note
Shadow wage	0.65	Applied to unskilled labor such as farm labor, reflecting employment conditions.
Standard conversion factor	0.96	Applied to tradable goods such as machines and fertilizer, reflecting the foreign exchange conditions.

Economic analysis gives following prospect for the Master Plan (2018-2035).

Net Present Value (NPV)	TZS 1,468 Billion
Benefit / Cost Ratio (B/C)	1.40
Economic Internal Rate of Return (EIRR)	16.4%

Benefit	Cost		
	Base	+5%	+10%
Base	16.4%	15.7%	15.1%
-5%	15.7%	15.0%	14.4%
-10%	14.9%	14.3%	13.7%

3.9 Monitoring and Evaluation

Item	Major Indicator	Target		Supporting Units and Divisions of NIRC
		Phase 1	Phase 2	
Impact to National Level	1) Agriculture sector GDP growth rate (Annual %) 2) Reduction in rural poverty (%) 3) Reduction in food poverty (%)	6 ≤ 24 ≤ 5	- - -	Environmental Social Management Unit
Impact to Irrigation Sector (Irrigation Schemes only)	1) Irrigated area accumulated (ha) 2) Number of benefited farm households, accumulated 3) Unit yield (ton/ha) - Paddy - Tomato - Onion 4) Annual incremental net return (TZS/ha) – mixed average	700,000 400,000 5.0 40.0 10.0 3 -4 mil.	1,000,000 600,000 5.0 40.0 10.0 3-4 mil.	Operation and Support Services Division
Output 1 (Hard Component)	1) to 8) Zone Irrigation Development Plans (ha) 9) Private Sector Commercial Irrigation Development Plan	248,120 54,000	312,110 168,000	Planning, Design and Private Sector Coordination Division
Output 2 (Soft Component-1)	1) New establishment of RIO (nos.) 2) Workshop for district implementation system (nos.) 3) Increase in number of irrigation staff (persons) 4) Registered IOs (nos.)	6 3 163 469	12 4 55 643	Information Communication Technology Unit
Output 3 (Soft Component-2)	1) Development of irrigation design manuals (kinds) 2) Development of irrigation checklist (kinds) 3) Development of training modules (kinds) 4) Trainings to ZIOs/RIOs staff (times) 5) Trainings to LGAs staff (times) 6) Trainings to IOs (times)	1 1 1 4 78 78	1 1 1 5 104 104	Research and Technology Promotion Division
Output 4 (Soft Component-3)	1) Investment by private sector (TZS) 2) Cooperation and collaboration for cross-sectoral issues (nos.)	4 4	5 5	Planning, Design and Private Sector Coordination Division

3.10 Risk Assessment and Mitigation Measures

S/N	Risk	Contents	Mitigation Measures
1	Shortage of financial resources for irrigation development	Irrigation development will be delayed due to shortage of financial resources.	NIRC should make every possible effort to secure necessary resources, including defending government budget, expanding DPs contributions, and attracting private sector, etc. Also, it should work hard to find new found sources such as the establishment of the Irrigation Development Fund, new PPP arrangements and enhancement of IOs' access to financial sector.
2	Shortage of human resources for irrigation development	Irrigation development will be delayed due to shortage of manpower and human resources (both in public and private sectors).	NIRC should promote 1) increase of technical staff in the public sector in accordance with NIMP2018 progress, 2) further involvement of local engineering firms and contractors in irrigation projects, 3) practical training (OJT) along the project cycle guided by the CGL.
3	Lower than expected involvement of private sector.	Progress of irrigation development is hampered by limited participation and investment contribution of private sector.	NIRC should widely share information relevant to irrigation. Furthermore, NIRC, without delay, should carry out necessary study on the effective PPP arrangement for irrigation development, and legalize the approach with close consultation with private sector.
4	Capacity development of irrigators' organisations goes so slow that irrigation facilities are left unattended without proper O&M.	Due to lack of proper O&M, many irrigation facilities are left not-functioning. Therefore, irrigation development stagnates.	NIRC should carry out training to and monitoring of irrigators' organisations with close collaboration of LGA's cooperative officers. On the other hand, the zonal irrigation offices should distribute the CGL to all LGAs and irrigators' organisations, and make sure they are referred to in daily operation.
5	Social and environmental conditions surrounding irrigation development deteriorates.	Socio-environmental conditions around irrigation development deteriorate. For example, conflicts surges between livestock keepers and crop farmers, or resistance of neighbouring residents intensifies against irrigation water use.	NIRC should properly conduct the environmental and social assessment study with which stakeholders identify likely problems and agree with possible countermeasures. When any serious issue emerges after operation begins, there should immediately be meetings for discussion and conflict solving among relevant parties.

4.1 (1) Action Plan 1: Hard Components (Phase 1)

(1) New Development of Irrigation Schemes by Zone and Size in Phase 1

Irrigation Zone	Small Scale		Medium Scale		Large Scale		Total	
	No. of Schemes	New Area (ha)	No. of Schemes	New Area (ha)	No. of Schemes	New Area (ha)	No. of Schemes	New Area (ha)
Dodoma	13	2,617	4	2,820	1	500	18	5,937
Kilimanjaro	44	3,491	12	7,001	3	5,650	59	16,142
Mbeya	18	2,111	5	3,610	2	7,660	25	13,381
Morogoro	7	1,281	15	9,493	6	25,600	28	36,374
Mtwara	12	1,297	4	2,793	1	2,710	17	6,800
Mwanza	12	1,755	10	8,412	4	18,500	26	28,667
Tabora	8	1,470	8	4,737	2	4,280	18	10,487
Katavi	9	1,350	5	4,500	3	13,290	17	19,140
Sub-Total	123	15,372	63	43,366	22	78,190	208	136,928
Private Sector	-	-	-	-	3	54,000	3	54,000
Total	123	15,372	63	43,366	25	132,190	211	190,928

(2) Improvement and Expansion of Irrigation Schemes by Zone and Size in Phase 1

Development Phase	Small Scale			Medium Scale			Large Scale			Total		
	No.	Imp. Area	Exp. Area	No.	Imp. Area	Exp. Area	No.	Imp. Area	Exp. Area	No.	Imp Area	Exp. Area
Dodoma	29	5,473	2,177	13	5,045	5,263	3	7,065	6,435	45	17,583	13,875
Kilimanjaro	28	7,557	2,361	4	6,357	1,870	1	3,380	1,900	33	17,294	6,131
Mbeya	37	3,881	4,492	14	5,454	5,198	6	10,155	20,258	57	19,450	29,948
Morogoro	26	2,150	4,009	9	4,453	6,658	2	1,901	6,564	37	8,504	17,231
Mtwara	25	2,546	3,104	7	1,821	4,546	1*	290	-	32	4,567	7,650
Mwanza	15	3,016	1,568	4	1,899	2,954	1	1,040	5,000	20	5,955	9,522
Tabora	12	1,420	2,238	7	2,725	5,146	1	1,850	2,370	20	5,955	9,754
Katavi	7	1,585	1,165	5	2,373	3,125	5	12,883	12,791	17	16,841	17,081
Total	179	27,628	21,114	63	30,127	34,760	19	38,524	55,318	261	96,279	111,192

Notes: "No." means number of schemes, "Imp. Area" means improved area (ha), "Exp. Area" means expansion area (ha).
Scheme number with as asterisk (*) is counted as a new development scheme.

4.1 (2) Action Plan 1: Hard Components (Phase 1)

(2) Action Plan 1: Irrigation Infrastructure Development

No.	Action	Executing Agency	Supporter	Phase 1 2018	2019	2020	2021	2022	2023	2024	2025
1	**Small Scale Irrigation Development**										
(1)	Study	LGA	Consultant	Preparation period							
(2)	Design	LGA	Consultant								
(3)	Tender	LGA	-								
(4)	Construction supervision	LGA	Consultant								
2	**Medium Scale Irrigation Development**										
(1)	Study	NIRC/ZIO	Consultant	Preparation period							
(2)	Design	NIRC/ZIO	Consultant								
(3)	Tender	NIRC/ZIO	-								
(4)	Construction supervision	NIRC/ZIO	Consultant								
3	**Large Scale Irrigation Development**										
(1)	Study	NIRC/ZIO	Consultant	Preparation period							
(2)	Design	NIRC/ZIO	Consultant								
(3)	Tender	NIRC/ZIO	-								
(4)	Construction supervision	NIRC/ZIO	Consultant								

(3) Breakdown of Irrigation Schemes in Number by Zone and Size-Group

Irrigation Zone	Small Scale S1	S2	S3	Medium Scale M1	M2	Large Scale L1	Total
Dodoma	14	14	14	8	9	4	63
Kilimanjaro	24	24	24	8	8	4	92
Mbeya	18	18	19	9	10	8	82
Morogoro	11	11	11	12	12	8	65
Mtwara	12	12	13	5	6	1	49
Mwanza	9	9	9	7	7	5	46
Tabora	6	7	7	7	8	3	38
Katavi	5	5	6	5	5	8	34
Total	99	100	103	61	65	41	469

Note: Action plan is defined as an implementation plan of each project component within a time frame of NIMP2018.

4.2 Action Plans 2 to 4: Soft Components (Phase 1)

(1) Action Plans 2 to 4: Soft Components

		Activity	2018	2019	2020	2021	2022	2023	2024	2025
HC	AP 1	Small-scale irrigation scheme	Preparation Period	S1		S2		S3		
		Medium-scale irrigation scheme		M1			M2			
		Large-scale irrigation scheme		L1						
SC	AP 2	(1)-1 RIO establishment								
		(1)-2 DID/DIDT strengthening								
		(2) Improvement of NIRC function								
		(3) IO registration								
		(4) M&E system								
		(5) Public relations								
		(6) Research and development								
	AP 3	(1) Capacity development of NIRC *								
		(2) Capacity development of LGA *								
		(3) Capacity development of IO								
		(4) Preparation of technical manuals								
		(5) Preparation of training modules								
		(6) Capacity development of contractors								
	AP 4	(1) Coordination with the private sector								
		(2) Coordination with relevant institutions								

*Note: * Practical / on-the-job training is continuous along project cycle.*

Action Plan 2: Organisational and Functional Strengthening
Action Plan 3: Capacity Building
Action Plan 4: Coordination Activities

4.3 Development Programs (Phase 1)

Development Programs for Phase 1

Development Program	AP1 (HC)	AP2 (SC1)	AP3 (SC2)	AP4 (SC3)	Developed Area *1 (ha)	F. Cost*2 (USD in Million)	EIRR (%)
0. NIRC HQ	●	●	●	●	-	5.5	-
1. Dodoma Zone Irrigation	●	●	●	-	19,812	209.3	16.7
2. Kilimanjaro Zone Irrigation	●	●	●	-	22,274	229.5	15.4
3. Mbeya Zone Irrigation	●	●	●	-	43,329	320.4	16.0
4. Morogoro Zone Irrigation	●	●	●	-	53,605	406.2	18.3
5. Mtwara Zone Irrigation	●	●	●	-	14,450	110.7	18.3
6. Mwanza Zone Irrigation	●	●	●	-	38,189	302.3	18.0
7. Tabora Zone Irrigation	●	●	●	-	20,241	169.0	15.0
8. Katavi Zone Irrigation	●	●	●	-	36,221	300.0	15.2
Sub-Total 1 to 8	-	-	-	-	248,120	2,053	16.4
9. Large Commercial Irrigation	-	-	-	●	54,000	-	-
Total				-	302,120	-	-

Notes: *1= New development and expansion areas, *2= Financial Cost (VAT inclusive)
Development program is defined as a combination of action plans.

5.1 (1) Strategic Environmental Assessment (SEA)

(1) Alternatives

Alternative 0: Do not implement the strategic measures and plans in the NIMP 2018

Alternative I: Promote improvement of traditional irrigation schemes only

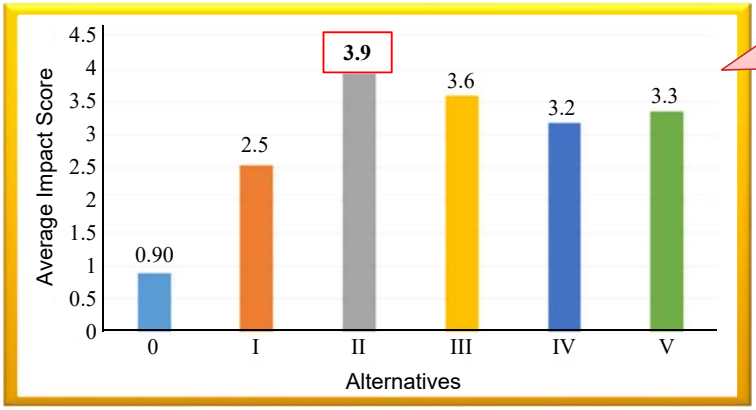
Alternative II: Promote all types of existing irrigation schemes concurrently with new smallholders and commercial irrigation schemes of all scales (i.e. small, medium and large) which are accessible

Alternative III: Government plays coordination and policy roles and the private sector manages irrigation

Alternative IV: Promote Public Private Partnership (PPP) in irrigation investment and management

Alternative V: Promote sharing of O&M such that IOs manage tertiary canals and below while government does the rest.

(2) Scoping Evaluation Result of Each Alternative



Alternative II (3.9) has a largest positive impact among other alternatives.

Note: The higher average impact score means the more positive impact (effect) in each alternative.

5.1 (2) Strategic Environmental Assessment (SEA)

(3) Summary of SEA and Monitoring Plan with High Priority (1/2)

No.	Issues and Concerns	Monitoring Indicators	Monitoring Frequency	Responsible Institution	Time Frame
Regulatory Framework and Institutional Strengthening					
1	Unclear institutional setup and line of command in irrigation services provision	· A well functioning institutional setup established and working	Once	GoT MoWI	2018 to 2025
2	Insufficient human resources at all levels and low capacity in managing irrigation development	· No. of staff recruited and trained · No. of furnished office · No. of vehicles procured · No. of in-service staff trained · No. of retooling, training and outreach activities conducted	Annually	Ministry responsible for irrigation	2019 to 2030
5	Inadequately established Irrigators' Organisations	· No. of registered IOs · Amount of funds set aside for O&M · No. of operating irrigation schemes	Annually	NIRC LGAs	2018 to 2025
6	Inadequate incentives for the private sector to participate in irrigation	· No. of investors in irrigation	Annually	NIRC TIC	2018 to 2025
7	Inefficient marketing systems for agricultural products	· No. of small holder marketing associations established and trained · No. of training conducted	Annually	MoA	2018 to 2025
Financing Mechanism and funding support for Irrigation Development					
8	Inadequate funding and delays in disbursement	· No. of trained accountants · Amount of funds allocated · Development Fund established	Quarterly	LGAs Responsible Ministry	2018 to 2025
Land tenure and ownership rights					
14	Limited understanding of land governing policies, laws and regulations	· No. of training conducted	Annually	LGAs	2018 to 2025

5.1 (3) Strategic Environmental Assessment (SEA)

(3) Summary of SEA and Monitoring Plan with High Priority (2/2)

No.	Issues and concerns	Monitoring indicators	Monitoring Frequency	Responsible Institution	Time Frame
Irrigation Water Resources Development					
15	Inadequacy of reliable and sustainable surface water resources for irrigation	· No. of developed water sources	Annually	ZIU, NIRC	2018 to 2035
17	Reduction in environmental flows and its implications on aquatic and water sensitive biodiversity and wildlife habitats	· % change in the number observed bio-indicators · % change in area of vegetated riparian zones that receive periodic inundation · Quantities of water discharge in the rivers	Seasonal Seasonal Daily	BWOs	2018 to 2035
18	Uncertainty of water supplies due to climate change	· No. of established weather monitoring stations · % of farmers using weather forecast information · % of farmers adopting water saving technologies · % of farmers adopting drought resistant crops	Annually	TMA Ministry responsible for agriculture LGAs	2018 to 2025
Development and Management of Irrigation Schemes					
21	Deficient criteria for establishment of irrigation potential areas in the NIMP	· NIMP2018	Once	NIRC	2018 to 2020
22	Issuance of water use permits which does not conform to available water	· Established quantities of water demand per sector	Annually	Ministry responsible for water research institutions	2018 to 2025
24	Inadequate farm management, operation and maintenance (O&M) skills	· Farm productivity · No. of IOs trained in O&M	Annually	LGAs Responsible Ministry	2018 to 2025
31	Sedimentation from catchment and within irrigation schemes	· Sediment load in canal, rivers and reservoirs · Presence of stable river banks · Intact riparian zones · Incidences of large-scale erosion denuding landscapes · Incidences of excessive fine-scale sediment deposition in river channel	Quarterly	BWO	2018 to 2035
36	Degradation of river catchments and riparian ecosystems including ecologically sensitive areas	· Species composition · No. of rivers with clearly demarcated buffer zones · No. of protected areas	Annually	LGAs Ministry responsible for environment	2018 to 2025

Note: Listed the High Priority only. As a whole, 15 items are categorized as high priority, 18 items as medium and 7 items as low.

6.1 Conclusion

Evaluation Principle	Conclusion
Relevance	(1) Consistency with National Development Goals and Policies (2) Consistency with Development Needs (3) Consistency with Development Partners' Aid Policies
Effectiveness	(1) Enhancement of Crop Productivity with Irrigation (2) Quick Project Effects by Full Development of Irrigation Infrastructure (3) Irrigation Potential Analysis based on Assessment of Water Resources and Land Resources (4) Realistic Irrigation Development Plan by Using a Comprehensive Information System (5) Irrigation Development Plan linking with Agricultural Value Chain
Efficiency	(1) Project Management and Monitoring & Evaluation Systems with a Central Focus on NIRC/ZIOs (2) Smooth Project Operation and Management through Capacity Building of Irrigation Staff in NIRC/ZIOs and LGAs (3) Efficient Project Operation and Management through Strengthening of Coordination with Other Relevant Sectors
Impact	(1) Increases in Agricultural Incomes (2) Becoming Food Basket of East Africa (3) Irrigation Development as Adaptation Measures for Climate Change
Sustainability	(1) Sustainable Irrigation Development through Capacity Building to Irrigation Staff in NIRC/NIOs and LGAs (2) Securing Sustainable Irrigation Schemes through Capacity Building to IOs (3) Motivation to Beneficiary Farmers through Increasing Agricultural Incomes

6.2 Recommendations

Relevant Ministries	Recommendations
MoFP	(a) Securing financial resources for implementation of IWRMDP, NIMP2018 and ASDP2 (b) Full disbursement of approved annual budgets of NIRC
NIRC	(a) Implementation of NIMP2018 (b) Improvement of communication using ICT (c) Development of design standard for irrigation in Tanzania (d) Development of support system for IOs (e) Strengthening of cooperation with relevant government ministries and private sector
MoWI	<u>For Implementation of the NIMP2018</u> (a) Implementation of IWRMDPs (b) Early Formulation of the remaining IWRMDPs (c) Review of EFR for Rufiji Basin (d) Necessary actions for transboundary water use <u>For Better Water Resources Management</u> (e) Accumulation of hydrological data (f) Consideration of reliability of water utilization (g) Collection of water fee
MoA	(a) Implementation of ASDP2 with firm commitment (b) Facilitating private sector in undertaking development of large-scale irrigation schemes (c) Providing extension services timely to those who have less experience of irrigation farming (d) Developing and promoting water-saving agricultural technologies (e) Promoting value chains with attention to the private sector involvement (f) Promoting export of irrigation products to neighboring countries (g) Promoting farmers' access to financial resources in concert with TADB (Tanzania Agricultural Development Bank)
PO-RALG	(a) Overall coordination between the NIRC and LGAs through RS (b) Promotion of proper staff allocation and organisational arrangement (c) Promotion of sufficient budget allocation (d) Support for irrigation data collection

Note: Please refer to the main report for the recommendations for Environmental and Social Considerations.

The Project on the Revision of National Irrigation Master Plan

in the United Republic of Tanzania

Final Report
Volume-I: Main Report

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Abbreviations

AASS	Annual Agricultural Sample Survey
ACBG	Agricultural Capacity Building Grant
AET	Actual Evapo-Transpiration
AEDG	Agricultural Extension Development Grant
AfDB	African Development Bank
AHP	Analytical Hierarchy Process
ARDS	Agricultural Routine Data System
ASA	Agriculture Seed Agency
ASDP	Agricultural Sector Development Programme
ASDS	Agricultural Sector Development Strategy
ATC	Arusha Technical College
BRN	Big Results Now
BWB	Basin Water Boards
BWO	Basin Water Office
CGIAR	Consultative Group on International Agricultural Research
CGL	Comprehensive Guidelines for Irrigation Scheme Development under District Agricultural Development Plan
CHG	Climate Hazards Group
CHIRPS	Climate Hazards Group InfraRed Precipitation with Station data
CI	Consistency Index
CIF	Cost, Insurance and Freight
CMT	Council Management Team
COWSOs	Coupled Model Intercomparison Project
CR	Consistency Ratio
CRDB	Cooperative and Rural Development Bank
CSA	Climate Smart Agriculture
CSI	Consortium for Spatial Information
D/D	Detailed Design
DADG	District Agricultural Development Grant
DADP	District Agricultural Development Plan
DAEO	District Agriculture Extension Officer
DAICO	District Agricultural, Irrigation and Cooperative Officer
DAO	District Agriculture Officer
DASIP	District Agricultural Sector Investment Project
DC	District Council
DCO	District Cooperative Officer
DCDO	District Community Development Officer
DED	District Executive Director
DEM	Digital Elevation Model
DID	District Irrigation Department
DIDF	District Irrigation Development Fund
DIDT	District Irrigation Development Team
DIE	District Irrigation Engineer
DIT	District Irrigation Technician
DOE	Division of Environment
DP	Development Partner
DPO	District Planning Officer
DSS	Decision Support System
DWT	Dead Weight Tonnes
EA	Environmental Audits
EAC	East African Community
EF	Environmental Flow
EFA	Environmental Flow Assessment
EFR	Environmental Flow Requirement

EIRR	Economic Internal Rate of Return
EIS	Environmental Impact Statement
eGA	e-Government Agency
EIA	Environmental Impact Assessment
EMA	Environmental Management Act
ESMF	Environmental and Social Management Framework
EWR	Environmental Water Requirement
EWURA	Energy and Water Utilities Regulatory Authority
F/S	Feasibility Study
FACF	Food Assistance Counterpart Fund
FAO	Food and Agriculture Organization
FDI	Foreign Direct Investment
FHH	Farm Household
FOB	Free On Board
FSDT	Financial Sector Deepening Trust
FYDP	Five Years Development Plan
GAFSP	The Global Agriculture and Food Security Program
GC	Government Communication
GCM	Global Circulation Model
GDP	Gross Domestic Product
GE	Graduate Engineer
GIS	Geographic Information System
GoT	Government of Tanzania
GPS	Global Positioning System
GRDC	Global Runoff Data Centre
GW	Groundwater
HC	Hard Component
HIV	Human Immunodeficiency Virus
HPP	Hydropower Plant
HQ	Headquarters
HR	Human Resources
ICT	Information Communication Technology
IEE	Initial Environmental Examination
IFAD	International Fund for Agricultural Development
ILFS	Integrated Labour Force Survey
IO	Irrigators' Organisation
IWMI	International Water Management Institute
IWRMDP	Integrated Water Resources Management and Development Plan
JICA	Japan International Cooperation Agency
JCC	Joint Coordination Committee
KPI	Key Performance Indicator
KRC	Korea Rural Community Corporation
LGA	Local Government Authority
LGDG	Local Government Development Grant
LU	Land Use
LS	Land Suitability
LVBC	Lake Victoria Basin Commission
MAFC	Ministry of Agriculture Food Security and Cooperatives
MALF	Ministry of Agriculture, Livestock and Fisheries
MCA	Multi-Criteria-Analysis
MoA	Ministry of Agriculture
MODIS	Moderate Resolution Imaging Spectroradiometer
MoFP	Ministry of Finance and Planning
MoWI	Ministry of Water and Irrigation
NAFCO	National Agriculture and Food Corporation
NAIVS	National Agricultural Input Voucher Scheme

NAP	National Agriculture Policy, 2013
NAWAPO	National Water Policy
NBC	National Bank of Commerce
NBI	Nile Basin Initiative
NBS	National Bureau of Statistics
NEAC	National Environmental Advisory Committee
NELSAP	Nile Equatorial Lakes Subsidiary Action Program
NEMC	National Environment Management Council
NGO	Non-governmental Organisation
NIDF	National Irrigation Development Fund
NIDP	National Irrigation Development Plan
NIDS	National Irrigation Development Strategy
NIMP2002	National Irrigation Master Plan2002
NIMP2018	National Irrigation Master Plan2018
NIP	National Irrigation Policy
NIRC	National Irrigation Commission
NIRTC	National Irrigation Research and Training Centre
NMB	National Microfinance Bank
NRDS	National Rice Development Strategy
NSGRP II	National Strategy for Growth and Reduction of Poverty II
NWSDS	National Water Sector Development Strategy
O&M	Operation and Management
O&OD	Opportunities and Obstacles to Development
PC	Project Committee
PEA	Preliminary Environmental Assessment
PER	Public Expenditure Review
PET	Potential Evapotranspiration
PHRD	Policy and Human Resources Development
PO-RALG	President Office- Regional Administration and Local Government
PPP	Public-Private Partnership
PPRA	Public Procurement Regulatory Authority
PRSP	Poverty Reduction Strategic Paper
PSC	Parliamentary Standing Committee
RAP	Resettlement Action Plan
RAS	Regional Administrative Secretary
RI	Random Index
RIO	Regional Irrigation Office
RPF	Resettlement Policy Framework
RS	Regional Secretariat
RWH	Rainwater Harvesting
SACCOS	Savings and Credit Cooperative Society
SADC	Southern African Development Community
SAGCOT	Southern Agriculture Growth Corridor of Tanzania
SC	Soft Component
SCF	Standard Conversion Factor
SCM	Stakeholder Consulting Meeting
SD	Soil Depth
SDR	Soil Drainage
SEA	Strategic Environmental Assessment
SEAR	Strategic Environmental Assessment Regulation
SEMoP	Strategic Environmental Monitoring Plan
SEMP	Strategic Environmental Management Plan
SESA	Strategic Environmental and Social Assessment
SOC	Soil Organic Carbon
SRESA	Strategic Regional Environmental and Social Assessment
SRI	System of Rice Intensification

SSIDP	Small-Scale Irrigation Development Project
SSR	Self-Sufficiency Ratio
ST	Soil Type
SUA	Sokoine University of Agriculture
SUDECO	Suger Development Corporation
SW	Surface Water
SWOT	Strengths, Weakness, Opportunities and Threats
TAC	Technical Advisory Committee
TaCRI	Tanzania Coffee Research Institute
TADB	Tanzania Agricultural Development Bank
TANCAID	Capacity Development for the Promotion of Irrigation Scheme Development under the District Agricultural Development Plans
TANESCO	Tanzania Electric Supply Company Limited
TANRICE	Technical Cooperation in Supporting Service Delivery Systems of Irrigated Agriculture
TANRICE2	Project for Supporting Rice Industry Development in Tanzania
TARI	Tanzania Agricultural Research Institute
TCDC	Tanzania Cooperative Development Commission
TDV2025	Tanzania Development Vision
TIC	Tanzania Investment Centre
TMA	Tanzania Meteorological Agency
TOR	Terms of Reference
TORITA	Tobacco Research Institute of Tanzania
TPRI	Tropical Pesticides Research Institute
TRC	Technical Review Committee
TRIT	Tea Research Institute of Tanzania
TTCL	Tanzania Telecommunication Company Limited
TWI	Topographic Wetness Index
UDSM	University of Dar es Salaam
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
VAEO	Village Agricultural Extension Officer
VC	Value Chain
VDP	Village Development Plan
VPO-DOE	Vice President Office- Department of Environment
WAEO	Ward Agricultural Extension Officer
WB	World Bank
WEI	Water Exploitation Index
WI	Water Institute
WRMA	Water Resources Management Act
WSDP	Water Sector Development Programme
WSSAs	Water Supply and Sanitation Authorities
WUA	Water Users' Association
ZIE	Zonal Irrigation Engineer
ZIO	Zonal Irrigation Office
ZRC	Zonal Review Committee

Unites

	Area		**Volume**
cm^2	Square-centimetre(s)	cm^3	Cubic-centimetre(s)
m^2	Square-metre(s)	m^3	Cubic-metre(s)
km^2	Square-kilometre(s) (1,000,000 m^2)	L	Litre(s) (1,000 cm^3)
ha	Hectare(s) (10,000 m^2)	MCM	Million Cubic Metre (s)
acre	Acre(s) (4,046.8 m2 or 0.40468 ha.)		

	Length		**Mass**
mm	Millimetre(s)	g	Gram(s)
cm	Centimetre(s)	kg	Kilogram(s) (1,000 g)
m	Metre(s)	t, ton	Metric Ton(s) (1,000 kg)
km	Kilometre(s) (1,000 m)		

	Currency		**Time**
USD	United State Dollars	s, sec	Second(s)
JPY	Japanese Yen	m, min	Minute(s) (60 sec.)
TZS	Tanzanian Shilling	h, hr	Hour(s) (60 min.)
	USD1.0 = JPY 112 = TZS 2,240		
	(as of July 2017)		

Chapter 1 Introduction

1.1 Authority

This final report (the Report) was prepared in accordance with the records of discussion on the Project on the Revision of National Irrigation Master Plan[1] (the Project) agreed upon between the Ministry of Water and Irrigation (MoWI) of the United Republic of Tanzania and the Japan International Cooperation Agency (JICA) on 30th June 2016. The Report presents the National Irrigation Master Plan 2018 (NIMP2018) as outputs of the Project executed by the JICA Project Team.

The Report mainly deals with NIMP2018 and the implementation plans for Phase 1. Chapter 9 has formulated the NIMP2018 based on the data collection and analysis discussed in Chapters 1 to 8. Chapter 11 has summarised the implementation plans for Phase 1. Also, as for environmental and social aspects, it shows a summary of environmental and social considerations in Chapter 10 and strategic environmental assessment in Chapter 12.

1.2 Project on the Revision of National Irrigation Master Plan

1.2.1 Background of the Project

(1) Status of Irrigation Development in Tanzania

The National Agricultural Policy of Tanzania (October 2013) recognizes irrigation development as an effective approach to achieve food security and poverty reduction because it improves productivities of crops and assuring stable expansion of agricultural production. In particular, the policy emphasises its importance in addressing the adverse impact on agricultural production resulting from the variations in precipitation and rainfall patterns due to global climate changes.

(2) Past Trend of Irrigation Development in Tanzania

Tanzania began its irrigation development seriously only since 1994. Until then, irrigation development activities were carried out independently by individual Development Partners (DPs). In 1994, the Government of Tanzania (GoT) formulated the National Irrigation Development Plan (NIDP) to achieve more efficient irrigation development by 2014. After the formulation, however, the NIDP was not implemented as planned. For instance, at the end of the first eight years, the progress of the "institutional reform of the irrigation sector", which is one of the key areas of implementation, was just around 30%. On the other hand, it remained less than 30% in the area of the "development of irrigation facilities". The reasons for the low achievements were the lack of basic information such as hydrological and meteorological data, inadequate institutional setting, constraints in human and financial capacities, and selection of uneconomical schemes. Given these challenges and to streamline the plan with other national policies prepared later, GoT requested JICA to conduct a study to review NIDP and to prepare the National Irrigation Master Plan.

[1] Based on the contract with JICA, the Project was executed in two steps which consisted of Phase 1 (from September 2016 to October 2017) and Phase 2 (from November 2017 to August 2018).

(3) National Irrigation Master Plan 2002 (NIMP2002)

The study on the NIMP2002 started in October 2001 and lasted for 28 months until January 2004. The NIMP2002 prepared an irrigation master plan with a target year of 2017 and an action plan to work on the priority schemes with identified issues. The plan also included investigations on the range of bottlenecks hindering the implementation of the development activities and practical suggestions supported by some remedial measures, which were identified through investigations. The major objective of NIMP2002 was to realize "sustainable irrigation development by effectively mobilizing national resources" which would in turn contributes to the achievement of the goals of the "Agricultural Sector Development Strategy (ASDS)". The NIMP2002 was prepared based on two approaches: scheme-wise development plan (hard aspect) and issue-wise reform plan (soft aspect). With respect to the hard aspect, the plan proposed to develop 626 irrigation schemes with total irrigated area of 405,000 ha (counted on accumulation basis), while in terms of soft aspect, it proposed 37 reform plans to address various issues. With an effort of advancing the irrigation development according to the plan, GoT reported that the irrigated land area grew from 200,000 ha in 2004 to 460,000 ha in 2015, almost achieving the envisaged target.

(4) Background of the New Project

GoT requested JICA to update the NIMP2002 in view of the following developments:

- More than 15 years have passed since the formulation of the current NIMP2002, and the circumstances around irrigation development have changed greatly (greater competition in water use among sectors, urgency of actions to address the climate changes, the establishment of NIRC, necessity for updating data of irrigation schemes, etc.),
- Need of further efforts for poverty reduction, and
- Increasing demands for more sustainable irrigation development.

Having received the request, JICA implemented in December 2015 the "Detailed Planning Survey for Project" on the "Revision of National Irrigation Master Plan".

1.2.2 Expected Goal and Outputs of the Project

The expected goal of the Project is that the "irrigation development under the National Irrigation Commission (NIRC) is sustainably enhanced." The expected outputs are as follows:

Output 1: National Irrigation Master Plan is revised.
Output 2: Action Plan is established.

1.2.3 Target Area

The Project covers the mainland of Tanzania.

1.2.4 Counterpart and Relevant Organisations

Counterpart and relevant organisations of the Project are shown in Table 1.2.1 below.

Table 1.2.1 List of Counterpart and Relevant Organisations

Counterpart Organisation	NIRC
Relevant Ministries and Organisations (JCC Members)	MoWI Ministry of Agriculture*1 (MoA) Ministry of Finance and Planning (MFP) Ministry of Energy and Minerals (MEM) Ministry of Natural Resources and Tourism (MNRT) Ministry of Lands, Housing, and Human Settlements Development (MLHHSD) President's Office, Regional Administration, and Local Government (PO-RALG) Vice President's Office-Union Affairs and Environment (VPO-ENV)
Stakeholders (SCM Members)	Development Partners (DPs) Embassies Private Firms NGO, etc.

*Note: *1= Ministry of Agriculture, Livestock, and Fisheries (MALF) was split into the Ministry of Agriculture (MoA) and Ministry of Livestock and Fisheries (MoLF) in October 2017.*
JCC= Joint Coordination Committee, SCM= Stakeholders Consulting Meeting
Source: JICA Project Team

1.3 Objectives and Scope of the Project

The objectives of the Project are based on the Record of Discussions (R/D) agreed in June 2016 between the MoWI of the GoT and JICA, as follows:

- Revise the NIMP2002 in view of contributing to poverty reduction and addressing climate change,
- Enhance the capacity of NIRC, and
- Strengthen the sustainable irrigation development of Tanzania.

1.4 Major Considerations in Revising the NIMP2002

Prior to the Project, it was recognised that the current NIMP2002 would be updated based on the latest hydrological and meteorological data with particular attention to the following:

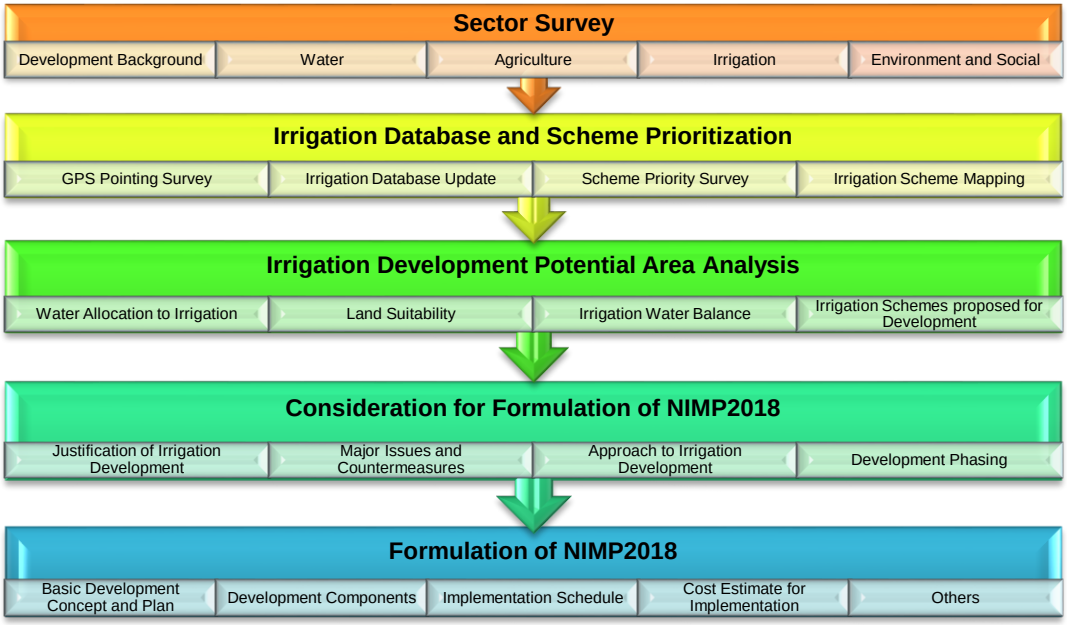
- Envision clearly the end-state of the irrigation development in the last year of the master plan,
- Examine carefully and come up with a scenario with which the end-state will be feasibly attained, and
- Elaborate how the achievement of the plan will contribute to the goals of higher policies and the national economy.

In light of these considerations, the Project will study the present state of the irrigation development and review the achievements and lessons learned. At the same time, it will measure irrigation potential and possible schemes based on the latest data. Then the Project will construct a "framework for NIMP2018" which enables the plan to achieve the development goals by the target year. Subsequently, an action plan will be prepared with clear "composition of development components" which is to be incorporated in the framework.

1.5 Work Plan of the Project

At first, the JICA Project Team reviewed the NIMP2002 to confirm the recent implementation status and also to learn the lessons and recommendations. Taking into account its review results as well as the terms of reference and the contract periods of the Project, the work plan was designed as shown in Figure

1.5.1.



Source: JICA Project Team

Figure 1.5.1 Work Plan of the Project

In addition to the formulation of the NIMP2018, the development programs for priority irrigation schemes to be implemented for the upcoming ten years will be proposed.

1.6 Review of NIMP2002

1.6.1 Proposed Development Plan

To contribute to the productivity and profitability of the agriculture sector, NIMP2002 selected 37 subject-wise improvement programs and 626 irrigation schemes to realize sustainable irrigation development targeting the year of 2017 as shown in Table 1.6.1.

Table 1.6.1 Development Target of NIMP up to 2017

Development Program and Project	No. of Programs and Projects	Accumulated Irrigation Development Area (ha)
(a) Scheme-wise Improvement Programs	37	-
(b) Irrigation Development Projects		
・ Improvement of Traditional Irrigation Schemes	462	274,600
・ Water Harvesting Irrigation Schemes	112	68,200
・ New Irrigation Schemes (smallholders)	42	62,600
Total (b)	626	405,400

Source: National Irrigation Master Plan 2002, JICA, November 2002

In addition, if irrigation development would be carried out under close cooperation with the agricultural sector, it was expected that there would be a high possibility of achieving national rice self-sufficiency in the amount of 1,239,000 ton by 2017.

1.6.2 Achievements of the Proposed Development Plan by 2016

(1) Irrigation-related Expenditure

In the NIMP2002, the government budget for irrigation development is projected for three cases, namely,

Base Case, High Case, and Low Case as a result of sensitive analysis, using the past actual expenditures and assuming the increase in gross domestic product (GDP) growth rate. The comparison table between the budget projections and actual expenditure are shown in Table 1.6.2 below.

Table 1.6.2 Comparison between Projected and Actual Expenditures (TZS Billion)

F.Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
High	17.8	19.0	20.3	21.7	23.1	24.7	26.4	28.3	30.2	32.3	34.6	37.0	39.6	42.3	45.3
Base	14.8	15.7	16.6	17.6	18.6	19.7	20.9	22.1	23.4	24.8	26.3	27.8	29.5	31.3	33.2
Low	14.7	15.5	16.3	17.1	18.0	18.9	19.9	20.9	22.0	23.1	24.2	25.5	26.8	28.2	29.6
Actual	NA	NA	NA	21.9	34.8	33.6	49.3	21.2	30.3	7.4	22.7	37.4	12.8	10.7	NA

Source: The Study on the National Irrigation Master Plan, Vol. 1 Main Report, November 2002, Nippon Koei (p.7-40) and NIRC for Actual data (2006-2016)

Due to the expenditures from Agricultural Sector Development Program 1 (ASDP1) basket fund between 2006 and 2011, the actual expenditures are higher than those in the projection. However, it tends to be decreasing since 2012 when ASDP1 was closed. The expenditures from 2012 onward are mainly Small-scale Irrigation Development Project (JICA) in 2013 and 2016, Feed the Future (USAID) in 2014.

(2) Accumulated Irrigation Development Area

The possible irrigation development area by 2017 is estimated on a cumulative basis for the three investment cases, taking into consideration the analysis results of inventory survey conducted in the NIMP2002. The comparison table between the projected irrigation development area and actual one is shown in Table 1.6.3 below.

Table 1.6.3 Accumulated Irrigation Areas (Thousand ha)

F.Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
High	218	229	239	250	265	276	281	294	312	325	337	352	372	387	405
Base	218	228	236	243	254	264	271	278	290	304	316	325	335	351	362
Low	218	222	234	240	248	261	268	274	287	296	306	321	328	337	350
Actual	NA	NA	264	274	289	311	331	346	355	364	450	461	461	NA	NA

Source: The Study on the National Irrigation Master Plan, Vol. 1 Main Report, November 2002, Nippon Koei (p.7-40) and NIRC for Actual data (2005-2015)

From Table 1.6.3, the actual irrigation development area by 2015 was much bigger than the area projected in the NIMP2002. Compared on the same basis with the NIMP2002, the irrigation development area only for smallholder schemes is 382,000 ha (refer to Table 5.5.5) in actual against 372,000 ha in the High Case by 2015. However, the irrigation development areas are unchanged since 2012. This is due to that ASDP1 was closed in 2012 and the projects implemented under the SSIDP and Feed the Future are improvement of existing irrigation schemes.

(3) National Paddy Production

In the NIMP2002, the possible production of paddy was estimated about 1.17 - 1.24 million tons for 2017. On the other hand, the actual paddy production has been sharply increasing from 2010 onwards as shown in Table 1.6.4. According to MALF[2], there are many reasons that contributed to the increase of paddy production. Among them are: the increase in the area cultivated under paddy, use of fertilizers

[2] Source: Agriculture Overview Report 2005 to 2010, http://www.kilimo.go.tz/index.php/en/resources/category/statistics

under inputs voucher system, enough rainfall distribution as well as increase in the use of irrigation.

Table 1.6.4 National Paddy Production (Thousand ton)

F.Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Actual	1,097	1,058	1,168	1,206	1,342	1,421	1,335	2,650	2,248	1,801	2,195	2,621	2,980	2,986	NA

Source: FAOSTAT, Tanzania (30th April 2018)

The national paddy production is estimated at 2.99 million tons in 2016, which is roughly three times that of the production in 2003-2004 or 2.6 times that of the projection by 2016.

(4) Status of Subject-wise Development Programs

In addition to the scheme-wise development program (hard component), the subject-wise improvement program (soft component) was proposed in the NIMP2002 to support the irrigation development in an effective manner, highlighting "Demand driven" and "Consistency in the whole undertakings" as basic principles. The achievement so far is shown in Table 1.6.5.

Table 1.6.5 Achievement of Subject-wise Improvement Program

Category	Action Has Been Taken				No Action
Number of Programs (%)	27 (73%)				10 (27%)
Score Range	80-100%	50-80%	20-50%	1-20%	
Number of Programs (%)	4 (15%)	14 (52%)	4 (15%)	5 (18%)	

Source: JICA Project Team

Out of 37 programs, 27 programs are now in progress, especially the Comprehensive Guidelines for Irrigation Scheme Development under District Agricultural Development Plan (commonly known as the CGL) is being disseminated to the large section of stakeholders. The remaining ten programs have taken no action, which are mostly specified as programs to be implemented in the medium term.

1.6.3 Lessons and Recommendations Abstracted from the ASDP1 Post-Evaluation Report

In Tanzania, the irrigation development was planned and implemented in a participatory manner for the past decade. Table 1.6.6 shows lessons and recommendations abstracted by the JICA Project Team from ASDP1 post-evaluation report.

Table 1.6.6 Lessons and Recommendations Abstracted from the ASDP1 Post-Evaluation Report

Item	Lessons and Recommendations
General aspect	・ Returns from the improvement of existing irrigation schemes were high and those of new schemes were low. It means that, if the decision to invest in irrigation schemes is based only on returns, improvement and rehabilitation of existing schemes should receive high priority. On the contrary, the national level policy of increasing the irrigated area to one million hectares requires investment in new schemes. ・ There is a need to strategize irrigation by reducing the acreage under paddy and replacing it with crops which require less water but this should be accompanied by marketing and post-harvest advisory services to help farmers produce such crops commercially. Additionally, appropriate crops with less water demand are required to address the water shortage reported in many schemes. It is important to expand cultivation area and to improve productivity through trainings on using seeds of good varieties and cultivation techniques such as water saving rice culture, O&M of irrigation system, etc.
Agronomic aspect	・ In most of the evaluated schemes, farmers used improved seeds and practiced good crop husbandry. ・ Salinity is building up in some irrigation schemes such as Mawala, Mbarangwe, Sakalilo, Kinyope, Ochuna, Ruvu, Ruaha Mbuyuni, Ngindo, Bugerega, Mvumi, and Mbeya Mbuyuni. A combination of crop rotation including paddy, drainage and salt flushing, and irrigation management should be employed to address the problem. ・ To ensure the achievement of successful and sustainable result, the available water sources may

Item	Lessons and Recommendations
	need to be integrated with the production of fruit trees and other high value crops with irrigation.
Irrigation infrastructure engineering aspect	・ Future ASDP investment should address the irrigation infrastructure engineering weaknesses and challenges identified in this study. Most importantly, new investment needs to be preceded by thorough feasibility studies to determine the most cost effective irrigation infrastructure, area to be developed for irrigation, and institutional infrastructure for organisation and management of the schemes. Additionally, the feasibility studies are required to give evidence that a given scheme is economically viable with an economic internal rate of return (EIRR) equal to or higher than 12% and ensure proper operation and maintenance (O&M) of irrigation facilities by respective IOs. ・ It is recommended that investment decisions are made after preparing a complete plan and feasibility study commensurate with the CGL for irrigation scheme development. Finally, the designs must be reviewed (for completeness and correctness) and approved by internal and/or external evaluators. ・ Part of the strategy is to design appropriate irrigation infrastructure to increase water use efficiency. This includes appropriate methods of reducing soil erosion and consequent siltation. This is a serious problem in the reservoir based schemes. Catchment area treatment is also required for other schemes to curb the declining irrigation water supply occurring during the dry season. ・ The next phase of ASDP may have to arrange a financial and technical assistance program aiming at enabling each rural household to own one or more sources of irrigation water. The new sources of irrigation water may include, but not limited to, spring, micro dams, subsurface dams, ponds, tanks and shallow wells integrated with groundwater recharge mechanism. ・ Unit cost of investment of new irrigation scheme and rehabilitation in Tanzania is lower than the equivalent cost in sub-Sahara Africa. This is attributed to incompletion of a number of irrigation schemes.
Economic and future development aspect	・ Focus group discussion reveals that such training and extension services were limited to production technologies and advisory services. This suggests the need to have a deliberate effort to enhance farmers marketing knowledge and skills. This should include enhancing farmers' horizontal and vertical linkages. ・ Spill-over effects of irrigation schemes also suggest that they have the potential to attract private businesses and services in their vicinity. Such private businesses can provide processing and other marketing services required to add value to irrigated crops. Investing in development of marketing infrastructure such as roads will further enhance participation of the private sector in the irrigated crop value chain. Such investment will help achieve ASDP objective of involving the private sector in irrigation development.
Institutional aspect	・ Enhancing collective action through building the capacity of irrigators to organise themselves for production, processing, and marketing will also help greatly to ensure sustainability of irrigation schemes. ・ With the increasing number of irrigators, climate change and increasing non-agricultural water uses, the role of the water basin in managing water use is becoming more important. This means the basin authorities need to be more active in coordinating different water users and in managing water use and development.

Source: Assessment of Achievement of the Agriculture Sector Development Program 1 (ASDP1).

1.7 Interview and Discussions with Major Stakeholders

The report has been compiled by the JICA Project Team based on numbers of interviews and consultations with stakeholders. The major meetings for the Project organised by the JICA Project Team are summarised in Table 1.7.1. Moreover, the minutes of Joint Coordination Committees (JCCs) are shown in Attachments-1.7.1, 1.7.2 and 1.7.3, respectively. As a reference, a list of meetings with number of stakeholders is also given in Attachment-1.7.4.

Table 1.7.1 Major Meetings Organised by the JICA Project Team

Major Meeting	Date	No. of Participants	Agenda
1st JCC	6th December 2016	48	Presentation and Discussion on Inception Report
1st SCM	7th December 2016	34	Presentation and Discussion on Inception Report
2nd JCC	21st September 2017	41	Presentation and Discussion on Interim Report

Major Meeting	Date	No. of Participants	Agenda
2nd SCM	27th September 2017	31	Presentation and Discussion on Interim Report
Meeting with Management Officers of MoA	7th March 2018	26	Discussion and Confirmation on Development Scenario of NIMP2018
Meeting with Management Officers in PO-RALG	13th March 2018	10	Discussion and Confirmation on Development Scenario of NIMP2018
Meeting with Management Officers in MoWI	14th March 2018	25	Discussion and Confirmation on Development Scenario of NIMP2018
Technical Transfer Workshop on NIMP2018	27th March 2018	45	Transfer of Technology on GIS and Irrigation Database
3rd JCC	4th April 2018	50	Presentation and Discussion on Draft Final Report
National Seminar on NIMP2018	5th April 2018	81	Presentation and Discussion on Draft Final Report
PSC Meeting	7th April 2018	57	Presentation and Discussion on Draft Final Report
3rd SCM	9th April 2018	32	Presentation and Discussion on Draft Final Report

Notes: JCC= Joint Coordinating Committee, SCM= Stakeholder Consulting Meeting, PSC= Parliamentary Standing Committee of Water and Agriculture Sectors
Source: JICA Project Team

Out of the above meetings, the detailed discussions about the contents on NIMP2018 were made in the meetings organised in March and April 2018. The notable issues and suggestions were made on i) water harvesting irrigation including small dams and ponds, ii) use of lake water (mainly Lake Victoria) for irrigation, iii) use of groundwater for irrigation, iv) land tenure, and v) review of protection areas and environmental flow requirement. These issues and suggestions will be examined from Chapter 8 onwards and be reflected in the development of NIMP2018.

Chapter 2 National Development Background

2.1 General

This chapter describes Tanzania's general conditions (natural, social, and economic) in order to grasp the overall situation in which the National Irrigation Master Plan 2018 (NIMP2018) is to be prepared and implemented. Some of the contents of this chapter are elaborated further in the subsequent chapters.

2.2 Country's Land and Social Situation

2.2.1 Land and Population

Tanzania is located in the eastern central part of African continent facing the Indian Ocean with more than 1,400 km coastline. It is a united republic composed of Tanganyika (Mainland) and Zanzibar. The basic data of the country are shown in Table 2.2.1

Table 2.2.1 Basic Data of Tanzania

Territory	Land Area (thousand km^2)	Population (million)	Density (persons/km^2)
Mainland	883.6	43.625	49
Mainland with water area	*945.0*	-	-
Zanzibar	2.5	1.304	530
Total	886.1	44.929	51

Source: Land area – NBS, 2016, Tanzania in Figures 2015, Population – NBS, Mar. 2013, Population and Housing Census 2012

The country is in the southern hemisphere stretching from latitude 1 degree to 11 degree south. The coastal areas are high in temperature and humid, while inland areas are, due to relatively high elevation, generally of low temperature and dry climate. According to the 2012 Population and Housing Census, the total population of the country as of 2012 is 44.9 million as shown in Table 2.2.2. Tanzanian population growth rate is 2.7% per annum which is higher than the average of African countries (2.55% annually in 2010-15[1]), expected to reach 57.1 million by 2020[2].

Table 2.2.2 Population of Tanzania

Population	2002 Census	2012 Census	Inter-censual Growth Rate	2015*
Tanzania	34,443,603	44,928,923	2.7	48,775,567
Tanzania Mainland	33,461,849	43,625,354	2.7	47,351,275

Note: 2015 is projection*
Source: NBS, 2016, Tanzania in Figures 2015 (Original Source: NBS, March 2013, Population and Housing Census 2012

The breakdown in proportion of the population in terms of sex and residential area is shown in Table 2.2.3.

[1] World Population Prospects: The 2015 Revision, Key Findings and Advance Tables, UN Department Economic and Social Affairs, Population Division
[2] According to the World Population Prospects: The 2015 Revision, Tanzania is considered as one of the nine fastest growing population countries, reaching 299 million by 2100.

Table 2.2.3 Breakdown of Tanzania Population

Population	Total (2012)	Male	Female	Rural	Urban
Tanzania	44,928,923	21,869,990	23,058,933	31,623,919	13,305,004
(%)	100.0	48.7	51.3	70.4	29.6
Tanzania (Mainland)	43,625,354	21,239,313	22,386,041	30,924,116	12,701,238
(%)	100.0	48.7	51.3	70.9	29.1
Zanzibar	1,303,569	630,677	672,892	699,803	603,766
(%)	100.0	48.4	51.6	53.7	46.3

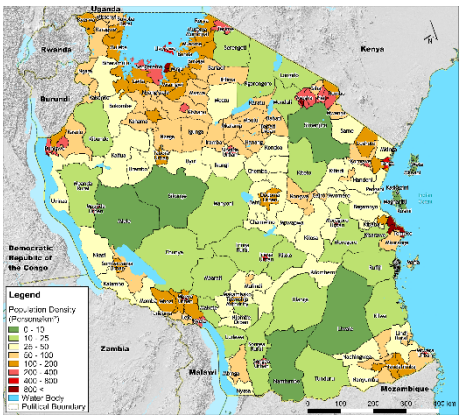
Source: NBS, March 2013, Population and Housing Census 2012)

Tanzania has been tracing the general trend of urbanisation. As shown in Table 2.2.4, as of 2012, approximately one-third of the population resides in urban areas. The pace of urbanisation is declining, but it is still more than 5%.

Table 2.2.4 Past Trend of Urbanisation of Tanzania (Mainland)

Year	Population	Urban Population	Percent Urban	Urban Growth Rate
1967	11,958,654	685,092	5.7	-
1978	17,364,498	2,257,921	13.3	13.3
1988	22,455,207	4,043,684	18.4	6.5
2002	33,461,849	7,554,838	22.6	6.9
2012	43,625,354	12,701,238	29.1	5.8

Source: NBS, 2015, Migration and Urbanisation Report 2015, (2012 Population and Housing Census Volume IV)



Source: NBS, 2013, Population and Housing Census 2012

Figure 2.2.1 Population Density Map

Urban expansion is taking place not only around Dar es Salaam but in those local centres such as Mwanza, Arusha, and Mbeya. As expanding more in the size and economic diversity, these urban areas attract more and more people, especially promising youth from surrounding areas. Given this trend of migration, it is imperative for the government to provide sufficient job opportunities at urban areas while improving efficiency of agricultural production.

Keeping pace with the population increase, the population density is increasing. The population density of the country as a whole is 51/km^2 (Mainland: 49/km^2, Zanzibar: 530/km^2). Regional density distribution is shown in Table 2.2.5. Dar es Salaam is the most populous region (5.2 million) followed by Mwanza and Mbeya (ranked by 2015 population). In general, the surrounding areas of Lake Victoria (Mwanza, Kagera, Mara, Geita, and Shiyanga) are relatively more populous than other parts of the country. On the other hand, Katavi and Lindi are the least populated areas. In terms of growth rate, Rukwa, Katavi, Manyara, and Kagera are the fastest growing (3.2%). Although Dar es Salaam marks the highest growth rate (5.6%), this is primarily due to urbanisation and inflow of population from rural areas.

Table 2.2.5 Regional Population, Density, and Growth Rate

Region	2002 Census	2012 Census	Population Density (2012 Census) (persons/km^2)	Inter-census Growth Rate	2015*
Tanzania	**34,443,603**	**44,928,923**	**51**	**2.7**	**48,775,567**
Tanzania Mainland	**33,461,849**	**43,625,354**	**49**	**2.7**	**47,351,275**
Dar es Salaam	2,487,288	4,364,541	2,644	5.6	5,166,570
Mwanza	2,058,866	2,772,509	240	3.0	3,031,422
Mbeya	2,063,328	2,707,410	45	2.7	2,937,310
Kagera	1,791,451	2,458,023	93	3.2	2,702,715
Tabora	1,710,465	2,291,623	30	2.9	2,501,796
Morogoro	1,753,362	2,218,492	32	2.4	2,380,750
Kigoma	1,674,047	2,127,930	58	2.4	2,286,727
Dodoma	1,692,025	2,083,588	50	2.1	2,217,856
Tanga	1,636,280	2,045,205	73	2.2	2,186,757
Geita	1,337,718	1,739,530	88	2.6	1,882,141
Mara	1,363,397	1,743,830	83	2.5	1,877,451
Arusha	1,288,088	1,694,310	46	2.7	1,839,531
Kilimanjaro	1,376,702	1,640,087	124	1.8	1,728,522
Simiyu	1,317,879	1,584,157	66	1.8	1,674,075
Shinyanga	1,249,226	1,534,808	94	2.1	1,632,593
Manyara	1,037,605	1,425,131	31	3.2	1,567,479
Singida	1,086,748	1,370,637	28	2.3	1,469,469
Ruvuma	1,113,715	1,376,891	22	2.1	1,467,362
Mtwara	1,124,481	1,270,854	71	1.2	1,318,374
Pwani	885,017	1,098,668	34	2.2	1,172,306
Rukwa	729,060	1,004,539	46	3.2	1,105,931
Iringa	840,404	941,238	26	1.1	973,784
Lindi	787,624	864,652	13	0.9	889,197
Njombe	648,464	702,097	33	0.8	719,036
Katavi	408,609	564,604	12	3.2	622,121

Note: 2015 data is projection, Songwe Region is a part of Mbeya Region at this time.*
Source: NBS, 2013, Population and Housing Census 2012

2.2.2 Poverty Status

The poverty status of the country is summarized in Table 2.2.6. Since the early 2000s, Tanzania has placed continuous efforts to eradicate poverty. Because of this, the situation has gradually but steadily been improving. For example, the rural poverty with respect to the Basic Need Poverty has declined from 38.7% in 2000/01 to 33.3% in 2011/12. During the same time, Dar es Salaam has improved from 17.6% to 4.1%, while other urban areas did similarly, from 25.8% to 21.7%. The comparison of the improvements in Dar es Salaam and other areas, it could be said that poverty reduction has still been a phenomenon limited to major urban areas, leaving most of the country untapped. Tanzania's recent economic expansion has not effectively lifted rural population out of poverty.

Table 2.2.6 Poverty Trend of Tanzania

Year	Region	% of Population Below Food Poverty Line	% of Population Below Basic Needs Poverty Line	% of Female Headed Households
1991/92	Dar es Salaam	13.6	28.1	14.1
	Other Urban	15.0	28.7	23.9
	Rural	23.1	40.8	16.7
	Total	**21.6**	**38.6**	**17.6**

Year	Region	% of Population Below Food Poverty Line	% of Population Below Basic Needs Poverty Line	% of Female Headed Households
2000/01	Dar es Salaam	7.5	17.6	20.9
	Other Urban	13.2	25.8	27.9
	Rural	20.4	38.7	22.1
	Total	**18.7**	**35.7**	**22.9**
2007	Dar es Salaam	3.2	14.1	24.4
	Other Urban	8.9	22.7	30.1
	Rural	13.5	39.4	23.0
	Total	**11.8**	**34.4**	**24.5**
2011/12	Dar es Salaam	1.0	4.1	22.5
	Other Urban	8.7	21.7	27.6
	Rural	11.3	33.3	24.3
	Total	**9.7**	**28.2**	**24.7**

Source: NBS, Tanzania in Figures 2012, 2015 (orig. Household Budget Surveys, 1991/92, 2000/01, 2007 and 2011/12)

2.2.3 Nutrition and Other Welfare Status

Although poverty status of the country is still slow in improvement, other social indicators show general advancement. Table 2.2.7 shows few indicative indexes illustrating the progress of the country's general advancement.

Table 2.2.7 Trend of Child Mortality and Malnutrition

Mortality Indicator (deaths per 1,000)	1999	2004/05	2010	2015/16
Infant mortality	99	68	51	43
Child mortality	53	47	32	25
Under-5 mortality	147	112	81	67
Childhood Malnutrition Indicator (%)	**1999 (TDHS)**	**2004/05 (TDHS)**	**2010 (TDHS)**	**2014 (NNS SMART)**
Stunting (%)	48.3	44.4	42.5	34.7
Wasting (%)	5.6	3.5	4.9	3.8
Underweight (%)	25.3	16.7	16.2	13.4

Note: Stunting: Height-for-Age Z-score is less than 2.0, Wasting: Weigh-for-Height Z-score is less than 2.0, Underweight: Weigh-for-Age Z-score is less than 2.0, TDHS: Tanzania Demographic and Health Survey, NNS SMART: National Nutrition Survey, Standardized Monitoring and Assessment of Relief and Transitions

Source (Mortality): Ministry of Health, NBS, Tanzania Demographic and Health Survey and Malaria Indicator Survey 2015-16
(Malnutrition): Tanzania Food and Nutrition Centre, Tanzania National Nutrition Survey 2014, page 74

As seen in Table 2.2.7, all of the children mortality rates have declined by more than half for the last 15 years. Also, there are noticeable improvements in the children nutritional status.

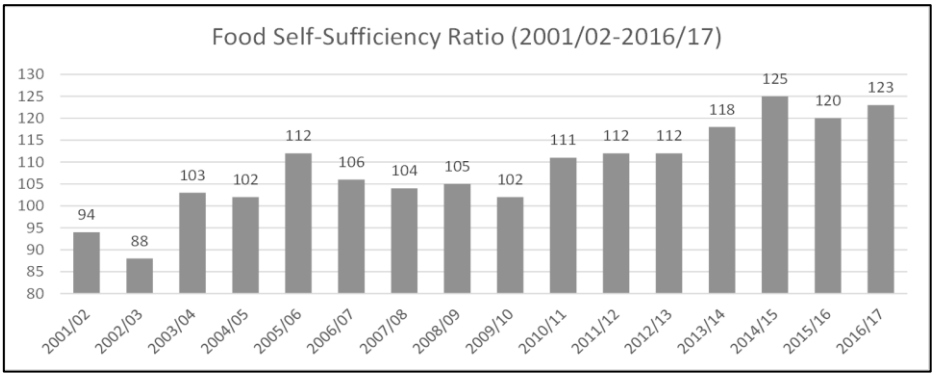
2.2.4 Food Security Situation

The trend of food security situation measured by the Food Self-Sufficiency Ratio (SSR) is shown in Figure 2.2.2 for the last 16 years. As observed in the diagram, the national food situation had improved notably since 2010/11 achieving steadily more than 110% ratio. Therefore, it can be said that the country as a whole has achieved food security with sufficient margin. Although there have been spots of food shortage every year. Note that the SSR is calculated according to the grain conversion of the relevant crop production (tonne)[3].

However, due to continuing dependence on rainfall for food production, there are still areas in the country where food security is threatened by poor harvest. Regional variation of food security situation is shown in

[3] The conversion factors are for example, maize = 1.0, Rice = 0.65, Banana = 0.35, etc. The calculation also considers the subtraction of no-food use of crops.

Table 2.2.8. It should be noted that the data of Table 2.2.8 are from MALF while the Figure 2.2.2 are constructed by assembling data of various national policies.



Source: 1) "MKUKUTA ANNUAL IMPLEMENTATION REPORT 2009/10", Ministry of Finance and Economic Affairs, November 2010
2) "MKUKUTA ANNUAL IMPLEMENTATION REPORT 2013/14", Ministry of Finance and Economic Affairs, November 2014
3) "COMPREHENSIVE REVIEW REPORT FOR TANZANIA FIVE YEAR DEVELOPMENT PLAN 2011/2012-2015/16", Ministry of Finance and Planning, January, 2016
4) http://www.thecitizen.co.tz/News/1840340-3358402-k5r9noz/index.html
5) http://www.kilimo.go.tz/index.php/en/resources/view/hali-ya-chakula-nchini-kuelekea-mwaka-2017

Figure 2.2.2 Trend of Tanzania Food SSR

Table 2.2.8 Regional Variation in Food Security

	Region	2008/09	2009/10*	2010/11	2011/12	2012/13	2013/14*	Average
1	Arusha	92	60	NA	89	91	97	86
2	Dar es Salaam	12	11	NA	5	2	2	6
3	Dodoma	112	78	NA	98	101	100	98
4	Geita	NA	NA	NA	NA	NA	155	
5	Iringa	149	167	NA	130	166	176	158
6	Kagera	125	127	NA	122	147	155	135
7	Katavi	NA	NA	NA	NA	NA	186	
8	Kigoma	118	131	NA	125	138	182	139
9	Kilimanjaro	90	84	NA	116	93	103	97
10	Lindi	121	104	NA	109	104	129	113
11	Manyara	116	85	NA	113	99	98	102
12	Mara	99	92	NA	99	117	118	105
13	Mbeya	131	135	NA	153	152	158	146
14	Morogoro	108	103	NA	116	108	130	113
15	Mtwara	139	126	NA	132	146	139	136
16	Mwanza	95	98	NA	99	101	115	102
17	Njombe	NA	NA	NA	NA	NA	176	
18	Pwani	97	97	NA	101	110	116	104
19	Rukwa	132	167	NA	153	167	186	161
20	Ruvuma	131	136	NA	149	173	197	157
21	Shinyanga	95	95	NA	98	92	98	96
22	Simiyu	NA	NA	NA	NA	NA	98	
23	Singida	99	98	NA	108	118	112	107
24	Songwe	NA	NA	NA	NA	NA		
25	Tabora	99	104	NA	110	94	97	101
26	Tanga	106	100	NA	112	113	111	108
	Tanzania all	**105**	**103**	**111**	**112**	**112**	**118**	**110**
No. of Vulnerable LGAs		21	57		NA	63	61	49

*Note: * indicates data of the "Preliminary Forecast". NA: Data is not available*
Source: Ministry of Agriculture Livestock and Fisheries, AGSTAT reports, 2009, 2010, 2011, 2013

Apart from Dar es Salaam, which is the largest consumption area, regions such as Arusha, Dodoma, Kilimanjaro, and Shinyanga, are relatively prone to food insecurity. Given the nationwide food sufficiency of these years, the challenge is not production but storage and distribution.

2.3 Overview of National Economy

2.3.1 Performance of National Economy

The Tanzania economy as a whole has been growing relatively stable and at a high rate for the last eight years (2008–2015). The real average annual growth rate (at 2007 constant price) was 6.3% as shown in Table 2.3.1.

Table 2.3.1 GDP Annual Growth Rates at 2007 Prices, Tanzania Mainland, 2008 – 2015 (%)

Economic Activity	2008	2009	2010	2011	2012	2013	2014r	2015p	Avg. [8 yrs: 2008-15]
GDP (whole economy) (2007 const. price)	5.6	4.8	6.6	7.6	5.5	6.7	6.9	6.7	6.3
Agriculture, Forestry, and Fishing	7.5	5.1	2.7	3.5	3.2	3.2	3.4	2.3	3.9
Crops	*7.8*	*5.5*	*3.7*	*4.8*	*4.2*	*3.5*	*4.0*	*2.2*	*4.5*
Livestock	*8.1*	*5.3*	*1.4*	*1.6*	*1.8*	*2.0*	*2.2*	*2.4*	*3.1*
Forestry	*3.8*	*5.1*	*3.4*	*3.3*	*3.5*	*4.7*	*5.1*	*2.6*	*3.9*
Fishing	*7.2*	*0.5*	*0.9*	*2.6*	*2.9*	*5.5*	*2.0*	*2.5*	*3.0*
Industry and Construction	6.5	3.3	9.1	12.0	4.0	9.5	10.3	11.3	8.3
Services	4.2	5.8	7.8	8.4	7.2	7.1	7.2	6.9	6.8
GDP at market prices	5.6	5.4	6.4	7.9	5.1	7.3	7.0	7.0	6.5

Note: r: revised, p: provisional
Source: NBS, MoFP, November 2016, National Account of Tanzania Mainland 2007 - 2015,

The values of GDP are shown in Table 2.3.2. As of 2015 (provisional), the Tanzania economy is TZS 44.1 trillion at the current prices.

Table 2.3.2 GDP at 2007 Prices, Tanzania Mainland, 2008 – 2015 (TZS in Million)

Economic Activity	2008	2009	2010	2011	2012	2013	2014r	2015p
GDP (whole economy) (2007 constant price)	24,948,888	27,628,327	29,441,005	31,673,636	33,420,626	35,673,045	38,137,426	40,708,958
Agriculture, Forestry, and Fishing	7,181,357	8,113,750	8,332,436	8,621,829	8,901,917	9,186,731	9,497,468	9,719,965
Crops	*3,603,539*	*4,098,750*	*4,248,443*	*4,454,219*	*4,640,787*	*4,801,783*	*4,993,855*	*5,106,027*
Livestock	*2,513,284*	*2,859,665*	*2,900,642*	*2,948,017*	*3,001,944*	*3,062,481*	*3,129,647*	*3,204,928*
Forestry	*639,762*	*697,692*	*721,555*	*745,684*	*771,590*	*808,231*	*849,445*	*871,448*
Fishing	*424,772*	*457,643*	*461,796*	*473,910*	*487,597*	*514,235*	*524,521*	*537,562*
Industry and Construction	5,406,038	5,949,363	6,489,910	7,271,804	7,566,057	8,287,309	9,144,464	10,174,156
Services	12,692,496	13,989,391	15,076,525	16,341,278	17,520,835	18,767,585	20,119,051	21,511,358
GDP (market prices)	26,770,432	29,781,719	31,675,504	34,179,297	35,936,459	38,546,546	41,231,365	44,100,809

Note: r: revised, p: provisional
Source: NBS and MoFP, November 2016, National Account of Tanzania Mainland 2007 – 2015

Major drivers of this economic growth are not agriculture but industry and construction, and services sectors with eight-year average real growth rates of 8.3% and 6.8%, respectively. Within the industry and construction sector, active subsectors are manufacturing (7.0%) and construction (11.0%), while in the service sector are: information and communication (15.9%), finance and insurance (12.3%) and professional, scientific and technical (11.0%).

In contrast, agricultural, forestry, and fishing sector has attained only 3.9% of average growth rate. Given

the average population growth rate being approximately 2.7% (PHC 2012), the net growth of the sector is just over 1.2%. Along with this relatively slow growth, the share of the agricultural sector in the total gross domestic product (GDP) has been declining as shown in Table 2.3.3.

Table 2.3.3 Sector Shares of GDP at 2007 Prices, Tanzania Mainland, 2008 – 2015 (%)

Economic Activity	2008	2009	2010	2011	2012	2013	2014r	2015p
GDP (whole economy) (2007 constant price)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Agriculture, Forestry, and Fishing	26.8	27.2	26.3	25.2	24.8	23.8	23.0	22.0
Crops	13.5	13.8	13.4	13.0	12.9	12.5	12.1	11.6
Livestock	9.4	9.6	9.2	8.6	8.4	7.9	7.6	7.3
Forestry	2.4	2.3	2.3	2.2	2.1	2.1	2.1	2.0
Fishing	1.6	1.5	1.5	1.4	1.4	1.3	1.3	1.2
Industry and Construction	20.2	20.0	20.5	21.3	21.1	21.5	22.2	23.1
Services	47.4	47.0	47.6	47.8	48.8	48.7	48.8	48.8
Balance	5.6	5.8	5.6	5.7	5.3	6.0	6.0	6.1

Note: r: revised, p: provisional
Source: computed by JICA Team based on NBS and MoFP, November 2016, National Account of Tanzania Mainland 2007 – 2015

The trend of the per capita GDP is shown in Table 2.3.4. While steadily increasing, its overall level is still around USD 1,000 indicating great potential of economic expansion.

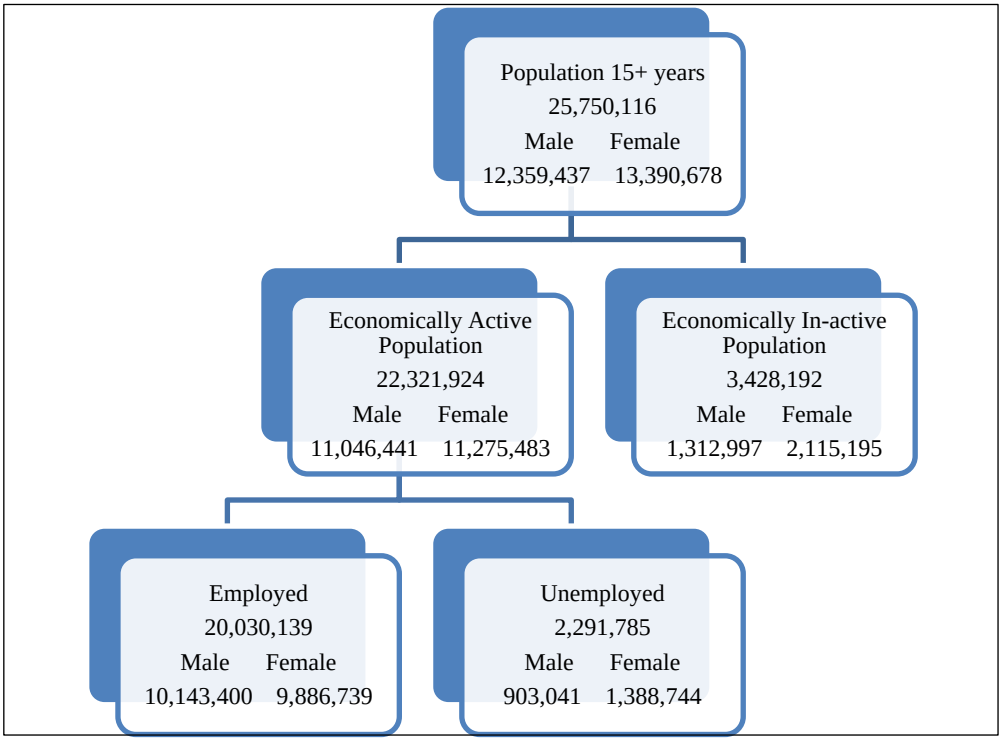
Table 2.3.4 Trend of Per Capita GDP, Tanzania Mainland, 2008 – 2015

Per Capita GDP	2008	2009	2010	2011	2012	2013	2014r	2015p
Per Capita GDP at current market prices (TZS)	699,127	927,330	1,045,848	1,222,224	1,408,223	1,582,797	1,724,416	1,918,928
Exchange rate (TZS/ USD)	1,196	1,320	1,396	1,557	1,572	1,598	1,653	1,991
Per Capita GDP in USD	584	702	749	785	896	991	1043	964

Note: r: revised, p: provisional
Source: computed by the JICA Team based on NBS and MoFP, November 2016, National Account of Tanzania Mainland 2007 – 2015

2.3.2 Labour Market

The employed population of the country is approximately 21 million (Male: 11 million, Female: 10 million) as shown below, which is 82.2% of the population of the concerned age group. In contrast, unemployment population is approximately 1.1 million which is 4.5%. (There is a portion of 13.3% of economically in-active population (like students)).



Source: NBS, November 2015, Integrated Labour Force Survey (LFS), analytical report

Figure 2.3.1 Total Population and Employed/ Unemployed Population

Changes in the unemployment rate are shown in Table 2.3.5, comparing the rates between 2006 and 2014. The table also shows the contrast between urban and rural areas.

Table 2.3.5 Changes in Unemployment Rate and Contrast between Urban and Rural Areas (%)

Category	Dar es Salaam		Other Urban		Total Urban		Rural		Total	
	2006	2014	2006	2014	2006	2014	2006	2014	2006	2014
A: Looking for work (strict international definition)	16.8	10.3	3.6	2.1	8.9	4.6	0.8	0.6	3.0	2.1
B: Available but not looking for work	4.4	9.9	2.9	3.6	3.5	5.5	0.9	1.8	1.7	3.1
A+B: Relaxed international definition	21.2	20.2	6.5	5.7	12.4	10.1	1.7	2.4	4.7	5.2
C: With marginal attachment to employment	10.3	1.3	10.0	4.2	10.2	3.3	5.8	6.1	7.0	5.1
A+B+C: National definition	31.5	21.5	16.5	9.9	22.6	13.4	7.5	8.4	11.7	10.3

Note: International standard definition is the one of A. Tanzania uses different definition with additions of B and C.
Source: NBS、Nov. 2015, Integrated Labour Force Survey (LFS), analytical report

As shown in the table, the unemployment rate has declined from 2006 to 2014. Considering the growth or the total population, it clearly suggests that jobs have been created with a higher rate. The table also shows the seriousness of unemployment in the urban areas. Further characteristics of unemployment are shown in Table 2.3.6.

Table 2.3.6 Unemployment Population by Age Groups, Sex, and Areas

Age/ Sex		Age Group				
		15 - 24	25 - 35	36 - 64	65 +	Total
Dar es Salaam	Male	75,394	37,557	25,004	2,897	140,851
	Female	142,063	162,411	82,501	1,593	388,568
	Total	**217,456**	**199,968**	**107,505**	**4,490**	**529,420**
Other Urban	Male	85,762	44,857	52,351	13,373	196,342
	Female	169,270	117,394	70,055	13,074	369,792
	Total	**255,032**	**162,251**	**122,406**	**26,446**	**566,134**

Age/ Sex		Age Group				
		15 - 24	**25 - 35**	**36 - 64**	**65 +**	**Total**
Rural	Male	175,453	124,087	223,946	42,361	565,847
	Female	184,483	144,453	249,036	52,412	630,384
	Total	**359,936**	**268,540**	**472,982**	**94,773**	**1,196,231**
Total	Male	336,609	206,501	301,300	58,631	903,041
	Female	495,815	424,258	401,593	67,079	1,388,744
	Total	**832,424**	**630,759**	**702,893**	**125,710**	**2,291,785**

Source: NBS, Nov. 2015, Integrated Labour Force Survey (LFS), analytical report

As general characteristics, it is observable that unemployment is severe in urban areas, young generations, and female population. Given the fact that Tanzania is still moving to more intensive urbanisation, the government needs to work hard to create more jobs in urban areas and to further invigorate economic activities in rural areas.

2.3.3 Export and Import of the Country

Tanzania's overall trade has been expanding rapidly although the yearly rates of expansion vary rather significantly. The average growth rates for the last seven years are 21.4% in export while 20.4% in import. The excess import has been the continuous state of the country's national economy. The excess import together with the balance of the service account (like earnings from tourism) and external support like the official development assistance (ODA) comprises the current account which is being offset by the capital account like private direct investments.

Table 2.3.7 Tanzania Export and Import, 2008 – 2015 (TZS in Billion)

	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**Avg (7yrs)**
Exports (FoB)	3,195	3,672	5,604	7,331	8,653	8,644	11,367	11,586	-
Export Growth Rate (%)	-	*14.9*	*52.6*	*30.8*	*18.0*	*-0.1*	*31.5*	*1.9*	*21.4*
Imports (CIF)	8,839	8,447	11,087	17,217	18,276	18,884	20,977	29,353	-
Import Growth Rate (%)	-	*-4.4*	*31.3*	*55.3*	*6.2*	*3.3*	*11.1*	*39.9*	*20.4*
Balance of Trade	-5,644	-4,775	-5,483	-9,886	-9,623	-10,239	-9,610	-11,586*	

*Note: * This is the value reported in the data source. But correct value is "-17,767".*
Source: NBS, Tanzania in Figures 2012, 2015 (orig. Bank of Tanzania)

Major export commodities are mineral and natural resources such as gold and diamond which have the share of 31.0% on average in the total export value during 2008 through 2015. The similar share of the agricultural commodities is 16.2% for the same period. Major commodities in the agricultural export are coffee (3.1%), tobacco (4.6%), cotton (2.5%), cashew nuts (3.4%), and tea (1.2%). The major commodities and their shares are summarized in Table 2.3.8.

Table 2.3.8 Value and Share of Export Commodities, 2008 – 2015 (TZS in Billion)

Commodity		**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**Avg (8 yrs)**
Exports Total (FoB) (TZS billion)		3,195	3,672	5,604	7,331	8,653	8,644	11,367	11,586	
Diamond and Gold	Value	832	1,082	1,351	3,481	3,452	2,832	2,786	2,783	
	Share (%)	26.0	29.5	24.1	47.5	39.9	32.8	24.5	24.0	31.0
Major Agricultural Commodities	Value	605	857	751	1,092	1,167	988	1,843	1,441	
	Share (%)	19.2	23.0	13.4	15.1	13.9	12.1	17.4	15.2	16.2
Coffee	Value	124	150	162	226	293	259	204	310	
	Share (%)	3.9	4.1	2.9	3.1	3.4	3.0	1.8	2.7	3.1

Commodity		2008	2009	2010	2011	2012	2013	2014	2015	Avg (8 yrs)
Cotton	Value	96	147	133	104	165	138	558	80	
	Share (%)	3.0	4.0	2.4	1.4	1.9	1.6	4.9	0.7	2.5
Cashew nuts	Value	82	94	173	190	222	301	648	497	
	Share (%)	2.6	2.6	3.1	2.6	2.6	3.5	5.7	4.3	3.4
Tobacco	Value	210	328	179	438	348	160	319	428	
	Share (%)	6.6	8.9	3.2	6.0	4.0	1.8	2.8	3.7	4.6
Tea	Value	50	88	68	74	87	88	73	91	
	Share (%)	1.6	2.4	1.2	1.0	1.0	1.0	0.6	0.8	1.2

Source: NBS, Tanzania in Figures 2012, 2015 (orig. National Bureau of Statistics)

Although the exports of agricultural commodities are affected by conditions of the international markets, Tanzania's exports are in general expanding while the shares in the total export are in the declining trend.

Among the import, major commodities are oil (Petroleum), machinery, and transport equipment, which jointly amount to almost 50% of the import. The transport equipment is mostly the import of vehicles, passenger cars, or trucks.

Table 2.3.9 Value and Share of Major Import Commodities, 2008 – 2015 (TZS in Billion)

Commodity		2008	2009	2010	2011	2012	2013	2014	2015	Avg (8 yrs)
Food and Beverages	Value	702	724	1,069	1,059	1,749	1,505	1,773	1,498	
	Share (%)	7.3	8.6	8.7	6.1	8.2	7.6	8.5	5.1	7.5
Oil (Petroleum)	Value	2,764	1,850	2,691	4,860	4,571	5,170	5,890	14,627	
	Share (%)	28.9	21.9	21.9	27.9	21.6	26.0	28.1	49.8	28.2
Building and Construction Material	Value	949	805	960	1,325	1,398	1,953	1,942	1,655	
	Share (%)	9.9	9.5	7.8	7.6	6.6	9.8	9.3	5.6	8.3
Machinery	Value	1,107	1,179	1,241	2,068	1,827	1,355	2,164	3,819	
	Share (%)	11.6	14.0	10.1	11.9	8.6	6.8	10.3	13.0	10.8
Transport Equipment	Value	1,127	1,085	1,440	1,795	2,162	2,090	1,933	1,988	
	Share (%)	11.8	12.8	11.7	10.3	10.2	10.5	9.2	6.8	10.4
Others	Value	2,921	2,804	4,753	6,292	8,675	12,645	7,276	5,520	
	Share (%)	30.5	33.2	38.6	36.1	40.9	63.5	34.7	18.8	37.0
Total	Value	9,569	8,447	12,315	17,418	21,201	19,905	20,977	29,352	
	Share (%)	100	100	100	100	100	100	100	100	

Source: NBS, Tanzania in Figures 2012, 2015 (orig. National Bureau of Statistics)

2.3.4 Trend of Agricultural Sector

Agricultural sector is the most important sector in Tanzania's economy due to its dominance in employment (66.0% of Tanzania Mainland Household engages in agriculture[4]), its direct relation to poverty alleviation, and potential for domestic market. Unfortunately, as described in Section 2.3.1, the sector has lagged behind the overall growth of the national economy, despite rapid expansion of few commodities such as oil seeds, horticulture, and dairy products.

First, the proportions of national population engaging in agricultural activities are observed below.

[4] NBS, Population and Household Census 2012, Table 13.1. (Tanzania Mainland Total 66.0%, Rural 85.1%, Urban 14.9%)

Table 2.3.10 Population Engaging in Agricultural Activities

Area/ Sex	Population	Agriculture (Crop) (%)	Livestock Keeping (%)	Fisheries (%)	Other Activities (%)
Tanzania	18,295,288	62.1	2.4	1.0	34.5
Rural	13,288,808	75.7	2.9	1.0	20.4
Urban	5,006,480	26.0	0.9	1.0	72.1
Male	9,407,163	58.0	2.8	1.7	37.5
Female	8,717,862	64.1	1.8	0.3	33.8
Tanzania (Mainland)	17,916,156	62.8	2.4	0.9	33.9

Source: NBS, 2013, Population and Housing Census 2012

As shown in the table, agricultural population (crop, livestock, and fisheries) shares about 65% of the whole working population. Especially in the rural area, the rate goes up to 80%. It is also noted that more female population is engaging in agricultural activities, in particular, in crop production.

Major crops of the sector are maize, sorghum, millet, paddy, wheat, cassava, beans, potato, and banana. Production trend of these crops is shown in Table 2.3.11. Chief staple crops such as maize and rice show steady trend, if gradual, expansion in production.

Table 2.3.11 Production Trend of Major Food Crops, 2005 – 2015 (Thousand Tonnes)

Crop	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Maize	3,131	3,423	3,302	3,555	3,324	4,733	4,341	5,104	5,174	6,734	5,903
Paddy	957	1,148	1,209	1,390	1,460	1,614	1,461	1,170	1,307	1,681	1,937
Wheat	44	110	83	92	94	62	113	109	92	167	72
Millet/ Sorghum	721	942	1,165	1,064	204	1,034	1,119	1,052	1,041	1,246	1,007
Cassava	2,851	2,053	1,733	1,797	1,759	4,548	1,549	1,821	1,943	1,664	1,962
Beans/Legumes	650	1,050	1,156	1,125	1,184	1,254	1,632	1,827	1,641	1,697	1,808
Bananas	2,007	1,169	1,027	982	991	3,156	1,048	842	1,307	1,064	1,195
Sweet Potatoes	1,220	1,704	1,721	1,755	1,667	1,700	1,710	1,418	1,259	1,167	1,090

Source: NBS, Tanzania in Figures 2012, 2015, Statistical Abstract 2011 (June 2012) Table G.2 and G.6 (Original Source: Ministry of Agriculture, Livestock and Fisheries)

Regarding cash crops, those conventional commodities still occupy major position. These commodities are influenced by international market conditions, and in general, Tanzania has not fared well in the past with the market. The Production Trend of Major Cash Crops, 2005 – 2015 is shown in Table 2.3.12.

Table 2.3.12 Production Trend of Major Cash Crops, 2005 – 2015 (Tonnes)

Crop	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Cashew nuts	90,385	88,213	92,573	99,107	74,169	121,070	160,000	160,000	127,947	123,449	197,933
Coffee	34,334	45,534	33,708	58,052	40,000	60,575	56,247	33,219	71,200	47,301	41,674
Cotton	378,000	130,565	199,954	200,662	267,004	163,518	225,938	225,938	357,130	246,767	203,312
Pyrethrum	2,500	2,046	1,000	1,500	3,320	5,000	5,700	5,700	6,100	7,090	6,050
Sisal	27,794	30,847	33,039	33,000	26,363	24,091	33,406	25,690	34,875	37,571	39,204
Sugar	-	-	279,494	276,605	279,850	263,461	260,055	262,880	296,697	294,421	304,007
Tea	30,000	31,348	34,763	34,770	33160	31,646	33,000	32,810	33,700	33,000	35,750
Tobacco	56,500	50,617	50,784	55,356	60,900	130,000	126,624	126,624	86,359	100,000	87,737

Source: NBS, Tanzania in Figures 2012, 2015, Statistical Abstract 2011 (June 2012) Table G.1
(Original Source: Ministry of Agriculture, Livestock and Fisheries)

Apart from these conventional crops, Tanzania has seen rapid expansion in new types of cash crops such as sunflower, groundnuts, and horticultural crops. The first two products are processed to edible oil while the last one is for direct consumption, all of which are response to growing urban consumption with rising income. The details of the expansion of these crops are described in Chapter 4.

On the other hand, livestock products are also expanding. Especially, milk and egg are growing with good pace of expansion. In general, these animal-related commodities are responsive to income increase. It is believed that the production is rising in response to the expansion of middle class in the urban area. Production Trend of Major Livestock Products, 2005 – 2015 is shown in Table 2.3.13

Table 2.3.13 Production Trend of Major Livestock Products, 2005 – 2015

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Milk Production (Thousand ltr)											
Indigenous Cattle	920,000	941,815	945,524	980,000	1,012,436	997,261	1,135,422	1,255,938	1,297,775	1,339,613	1,381,451
Hybrid Cattle	466,400	470,971	475,681	520,000	591,690	652,596	608,800	597,161	623,865	650,570	677,275
Total	1,386,400	1,412,786	1,422,205	1,500,000	1,604,126	1,649,857	1,744,222	1,853,099	1,921,640	1,990,183	2,058,726
Meat Production (Tonnes)											
Beef	204,520	210,370	180,629	218,976	255,178	243,943	262,606	289,835	299,581	309,086	319,112
Goat/ Sheep	78,093	78,579	80,936	81,173	82,884	86,634	103,709	111,106	115,652	120,199	124,745
Pork	27,000	29,925	31,721	33,307	36,000	38,180	43,647	47,246	50,814	74,174	54,360
Chicken	68,896	69,420	77,280	77,250	78,168	80,916	93,534	84,524	87,408	95,292	99,540
Total	378,509	388,294	370,566	410,706	452,230	449,673	503,496	532,711	553,455	598,751	597,757
Egg Production (Number)											
Egg	1,800,000	2,145,000	2,230,900		2,806,350	2,917,875	3,339,566	3,494,584	3,725,200	3,899,569	4,153,800

Source: NBS, Tanzania in Figures 2012, 2015, Statistical Abstract 2011 (June 2012)
(Original Source: Ministry of Agriculture, Livestock and Fisheries)

2.3.5 Tanzania in the East African Regional Economy

Tanzania is the second major country in the East African Community (EAC) which is composed of Burundi, Kenya, Rwanda, Tanzania, Uganda, and South Sudan. The general comparison among the countries is shown in Table 2.3.14.

Table 2.3.14 Comparison of Economic Profile of Tanzania with its Surrounding Countries

No	ITEM	UNIT	Tanzania	Kenya	Uganda	Rwanda	Burundi	S. Sudan
1	Area of the country[1]	km^2	947,300	580,370	241,550	26,340	27,830	643,330
2	Total population[2]	No. (mil.)	53.47	46.05	39.03	11.61	11.18	12.34
3	Population density	No./km^2	56.4	79.3	161.6	440.8	401.7	19.15
4	GDP (current price)[3]	USD (mil.)	47,431	70,529	25,528	8,376	3,007	9,015
5	GDP per capita (current price)[4]	USD	840	1,377	676	697	276	731
6	Export total value (fob) [5]	USD (mil.)	4,924	5,906	2,245	659	111	-
7	Import total value (cif)[5]	USD (mil.)	10,285	16,093	5,780	2,570	755	-
8	Trade (Exp+Imp) (value) proportion to GDP[5]	%	24.1	23.9	24.0	22.2	18.9	-
9	Export with EAC (value)[6]	USD (mil.)	779.4	1,430.8	642.2	352.4	25.5	-
10	Import with EAC (value)[6]	USD (mil.)	709.9	416.9	684.6	465.1	126.1	-

Note: Year of measurement
1. Area of the country: Tanzania (2013), Kenya (2013), Uganda (2013), Rwanda (2013), Burundi (2013), S. Sudan (2013)
2. Total population: Tanzania (2015), Kenya (2015), Uganda (2015), Rwanda (2015), Burundi (2015), S. Sudan (2015)
3. GDP (current price): Tanzania (2016), Kenya (2016), Uganda (2016), Rwanda (2016), Burundi (2016), S. Sudan (2015)
4. GDP per Capita (current price): Tanzania (2015), Kenya (2015), Uganda (2015), Rwanda (2015), Burundi (2015), S. Sudan (2015)
5. Export and Import (value): Tanzania (2015), Kenya (2015), Uganda (2015), Rwanda (2015), Burundi (2015)
6. Intra-EAC Export and Import (value): Tanzania (2014), Kenya (2014), Uganda (2014), Rwanda (2014), Burundi (2014),
Source: Area and Population data: FAO AQUASAT, http://www.fao.org/nr/water/aquastat/data/query/index.html (30/10/2016)
GDP (current price): World Bank, 2016 World Development Indicators http://data.worldbank.org/data-catalog/world-development-indicators
Trade data: WTO Database: http://stat.wto.org/CountryProfile/WSDBCountryPFHome.aspx, South Sudan has not been a member of WTO.
EAC trade data and items: EAC, 2014, Trade Report

In terms of population size, Tanzania is the largest among the six countries, implying good potential for market expansion. However, in the economic size, it is second to Kenya with per capita GDP being only 60% of Kenya. As for trade, Tanzania is again second to Kenya in both overall trade and within EAC trade. However, it seems that Tanzania remains behind Kenya within EAC trade because Kenya's export to the member countries shows dominant size. These data seem to suggest that given the size of population and land area, Tanzania has great potential in developing its economy and contributes to the regional community.

If one expands the comparison to a wider area including other neighbouring countries like D.R. Congo, Zambia, Malawi, and Mozambique, Tanzania's position is similar. It has a large population only after D.R. Congo and third in terms of per capita GDP after Kenya and Zambia. Trade volume (in USD value) is again third after Kenya and Zambia. Overall, Tanzania stands at a leading position among the regional countries with opportunities waiting for further exploitation.

Comparison in agricultural/ irrigation aspects

It is attempted in Table 2.3.15 below (FAO AQUASTAT) to show similar comparison of Tanzania with EAC countries in terms of agriculture and irrigation aspects. Among the basic information, it is observed that due probably to the wider territorial area, both Tanzania and Kenya have less percentage of agricultural and cultivated land than the other three countries. On the other hand, as for water resources, Tanzania is better endowed with available water volume due to rainfall and large territory, giving the highest renewable water per person.

Table 2.3.15 Comparison of Agricultural Profile of Tanzania with Surrounding Countries (FAO AQUASTAT)

No.	ITEM	UNIT	Tanzania	Kenya	Uganda	Rwanda	Burundi	S. Sudan
1	**BASIC INFORMATION**							
1.1	Area of the country[1]	thousand ha	94,730	58,037	24,155	2,634	2,783	64,333
1.2	Agricultural land[1]	thousand ha	39,650	27,630	14,415	1,842	2,033	-
	% against the total area of the country[1]	%	42	48	60	70	73	-
1.3	Cultivated area[1]	thousand ha	15,650	6,330	9,100	1,432	1,550	2,700
	% against the total area of the country[1]	%	17	11	38	54	56	4
1.4	Total population[2]	thousand inhabit	53,470	46,050	39,032	11,610	11,179	12,340
	% of rural population[2]	%	69	74	83	69	88	81
1.5	GDP per capita (current price)[2]	USD	840	1,377	676	697	276	730
	% of Agriculture, value added to GDP[2]	%	31	33	25	33	43	-
2	**WATER RESOURCES**							
2.1	Average precipitation (long term)	mm/yr	1,071	630	1,180	1,212	1,274	900
	in volume (long term)	MCM/yr	1,015,000	365,600	285,000	31,920	35,460	579,900
2.2	Internal renewable water resources (long term)	MCM/yr	84,000	20,700	39,000	9,500	10,060	2,107
2.3	Total renewable water resources (long term)	MCM/yr	96,270	30,700	60,100	13,300	12,536	49,500
	per inhabitant (long term)[3]	M3/yr	1,800	667	1,540	1,146	1,122	4,011
2.4	Total dam capacity[2]	MCM	104,200	24,790	80,082	-	-	-
2.5	Total water withdrawal[4]	MCM	5,184	3,218	637	150	288	658
	% of Agriculture[4]	%	89	59	41	68	77	240
	% of Municipalities (Domestic use)[5]	%	10	37	51	24	17	193
	% of Industry[5]	%	1	4	8	8	6	225
	('% of Irrigation)[4]	%	84	50	-	68	69	-
3	**IRRIGATION AND DRAINAGE**							

No.	ITEM	UNIT	Tanzania	Kenya	Uganda	Rwanda	Burundi	S. Sudan
3.1	Irrigation Potential	ha	2,132,221	353,050	90,000	165,000	215,000	1,500,000
	% against cultivated area[6]	%	13.6	5.6	1.0	11.5	13.9	54.3
3.2	Total area equipped for irrigation[7]	ha	363,514	150,570	11,137	9,625	21,430	38,100
	- Full control irrigation equipped area[8]	ha	245,514	144,100	8,716	4,625	6,960	32,100
	- Equipped lowlands (wet land, flood plains, etc.)[9]	ha	117,000	0	2,412	5,000	14,470	-
	- Spate irrigation[10]	ha	1,000	6,470	-	-	-	6,000
	% against irrigation potential[10]	%	17.0	42.6	12.4	5.8	10.0	2.5
	% against cultivated area[10]	%	2.3	2.4	0.1	0.7	1.6	1.4
3.3	Total harvested area in full control irrigation[11]	ha	332,392	140,200	15,150	4,000	6,960	29,071
	- Rice[11]	ha	71,370	25,000	12,000	2,000	4,210	-
	- Maize[11]	ha	124,000	6,000	400	-	-	-
	- Vegetables[12]	ha	41,721	45,200	300	2,000	800	1,771
	- Sugarcane[12]	ha	13,333	8,000	1,820	-	1,450	1,311
	- Cotton[11]	ha	14,700	6,000	-	-	-	2,591
	- Flower[11]	ha	-	5,000	230	-	-	-
	- Coffee[11]	ha	2,763	20,000	-	-	500	-
	-Tea[11]	ha	2,570	8,000	-	-	-	-
	- Fruits[11]	ha	1,375	17,000	200	-	-	-
3.4	Irrigated cropping intensity for full control area[11]	%	135	103	175	200	156	157

Note: Year of measurement, 1. Tanzania (2013), Kenya (2013), Uganda (2013), Rwanda (2013), Burundi (2013), S. Sudan (2013)
2. Tanzania (2015), Kenya (2015), Uganda (2015), Rwanda (2015), Burundi (2015), S. Sudan (2015)
3. Tanzania (2015), Kenya (2014), Uganda (2014), Rwanda (2004), Burundi (2014), S. Sudan (2014)
4. Tanzania (2002), Kenya (2010), Uganda (2008), Rwanda (2000), Burundi (2000), S. Sudan (2011)
5. Tanzania (2002), Kenya (2010), Uganda (2008), Rwanda (2000), Burundi (2005), S. Sudan (2011)
6. Tanzania (2013), Kenya (2013), Uganda (2013), Rwanda (2013), Burundi (2013), S. Sudan (2011)
7. Tanzania (2013), Kenya (2010), Uganda (2012), Rwanda (2007), Burundi (2000), S. Sudan (2011)
8. Tanzania (2013), Kenya (2010), Uganda (2012), Rwanda (1996), Burundi (2000), S. Sudan (2011)
9. Tanzania (2013), Kenya (2010), Uganda (2012), Rwanda (2000), Burundi (2000), S. Sudan (2011)
10. Tanzania (2013), Kenya (2010), Uganda (2012), Rwanda (2000), Burundi (2000), S. Sudan (2011)
11. Tanzania (2013), Kenya (2012), Uganda (2012), Rwanda (2007), Burundi (2000), S. Sudan (2011)
12. Tanzania (2013), Kenya (2012), Uganda (2012), Rwanda (2007), Burundi (2003), S. Sudan (2011)

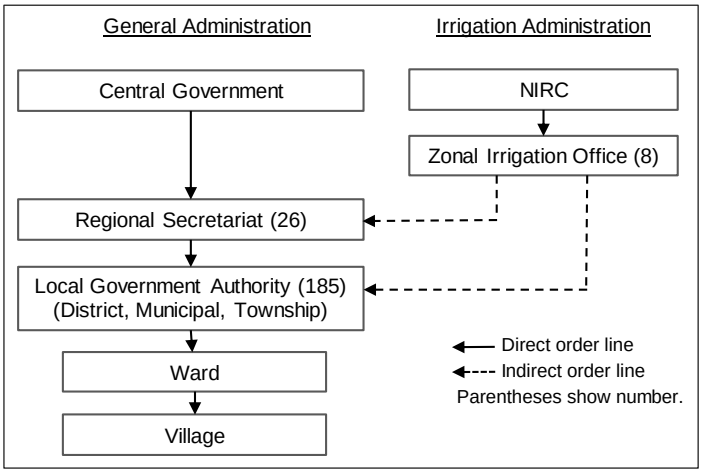
Source: FAO AQUASTAT, http://www.fao.org/nr/water/aquastat/data/query/index.html (30/10/2016)

With regard to irrigation, although Tanzania is relatively advanced in irrigation development, all EAC countries are far below their potential. Only Kenya has so far achieved 42% development against the potentially irrigable land. On the other hand, despite limited irrigation development, probably due to its diverse agro-ecological potential, Tanzania shows the greatest variety of crop production in the irrigated land.

2.4 Government Status

2.4.1 Administrative Structure

Since the end of the last century, the Government of Tanzania (GoT) has been promoting the decentralized structure of the public administration. Following the adoption of the Local Government Reform Programme (LGRP) in 1998, the Local Government Authorities (LGAs) have been tasked to plan, budget, and implement various development activities in order to address challenges at



Source: JICA Project Team

Figure 2.4.1 Administration Structure in Tanzania

the grassroots level. On the other hand, the ministries and agencies at the national level are mandated to provide guidance to LGAs with policies and strategies. There is a Regional Secretariat (RS) which connects guidance of the central ministries to LGAs as a liaison. As shown in Figure 2.4.1, although National-Regional-Local structure is a standard, the irrigation subsector maintains the conventional non-standard line of command. Namely, there is the National Irrigation Commission that directly communicates with the Zonal Irrigation Office which in turn communicates/ instructs/ helps the LGAs.

Although the administrative structure has been arranged according to the vision of decentralization, the financial side has not yet been up to that level, leaving LGAs much dependent on grants provided by the national government.

2.4.2 Public Finance

GoT's overall budget (expenditure) was TZS 14.603 trillion in 2014/15 (provisional) against the total revenue (both national and local) of TZS 10.957 trillion. The difference (TZS 3.646 trillion) was financed by grants and financing (loans). The internal shares of budget components are shown in Table 2.4.1 for 2014/15, the latest financial year where records are available.

Table 2.4.1 Summary of 2014/15 Budget Composition

Budget Components		Amount (TZS in Million)	Share (%)	Remarks
Total Revenue		10,957,765	100.0	
			75.0	Against the expenditure
	Revenue (Central)	10,597,681	96.7	
	Revenue (Local)	360,084	3.3	
Total Expenditure		14,603,714	100.0	
	Recurrent	10,893,486	74.6	
	Development	3,710,228	25.4	
	Development (Local fund)	2,264,506	15.5	
			61.0	Against the development
	Development (Foreign fund)	1,445,722	9.9	
			39.0	Against the development
Grants		1,024,132	7.0	Against the expenditure
Financing (Loans)		2,806,518	19.2	Against the expenditure
	Foreign Financing	2,006,742	71.5	Against total financing
			13.7	Against the expenditure
	Local Financing	799,776	28.5	Against total financing
			5.5	Against the expenditure

Source: Bank of Tanzania, Annual Report 2014/15 (Original source: Ministry of Finance, Bank of Tanzania and National

As can be observed in Table 2.4.1, the total revenue is just 75% of the total expenditure while the remaining amount is fulfilled by grants and loans. As to the proportion of recurrent budget (salaries and duty operation costs of officers) against the total expenditure is 74.6%, with the rest 25.4% going to development projects like construction and studies. The weight of foreign supports in the total budget is observed by the sum of grants and financing (Foreign), which comes to 26.2% of the total expenditure. The details of the past government budget compositions are shown in Table 2.4.3.

On the other hand, the proportion of the government budget (revenue) in the national economy has been changing as shown in Table 2.4.2.

Table 2.4.2 Historical Trend of Government Budget (Revenue) Against GDP (TZS in Billion)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	Avg
GDP at Current Prices	26,770	32,765	37,727	43,836	52,763	61,434	70,953	79,718	90,864	
GDP Growth Rate (%)	-	22.4	15.1	16.2	20.4	16.4	15.5	12.4	14.0	16.5
GoT Revenue*	3,654	4,293	4,645	5,736	7,221	8,443	10,253	10,958	13,907	
Revenue Growth Rate (%)	-	17.5	8.2	23.5	25.9	16.9	21.4	6.9	26.9	18.4
% Revenue against GDP	13.6	13.1	12.3	13.1	13.7	13.7	14.5	13.7	15.3	13.7

*Note: * GoT Revenue is the value of a fiscal year where first half of the year falls into the year of the table.*
Example: the GoT Revenue of 2007 in the table is the revenue of the fiscal year 2007/08.
Source: GDP at Current Price -- National Accounts of Tanzania Mainland 2007 - 2015 (NBS and MoF, Nov. 2016)
GoT Revenue -- Bank of Tanzania Annual Report 2014/15 and 2015/16

The overall trend of the budget is summarized below.

- Government revenue is expanding roughly at the same pace as the economy's expansion.
- On average, the proportion of the revenue to the entire economy is 13.7%, which is lower than the Sub-Saharan Africa median value (17.1%)[5].

Recognizing the possibility of expanding the revenue, the current government is making efforts to increase the tax revenue in which the government can reduce the dependency on external resources for development activities.

[5] Computed by the JICA Project Team based on the IMF Regional Economic Outlook, Sub-Saharan Africa, April 2016

Table 2.4.3 Government Finance (Actual), 2005/06 – 2014/15 (TZS in Millions)

	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14p	2014/15p	10 year Average
Total revenue (including LGAs)	***2,124,843.70***	***2,739,022.40***	***3,653,605.20***	***4,293,074.30***	***4,645,213.30***	***5,736,266.10***	***7,221,408.60***	***8,442,611.20***	***10,252,981.00***	***10,957,765.30***	
Total revenue - central government	*2,124,843.70*	*2,739,022.40*	*3,653,605.20*	*4,293,074.30*	*4,645,213.30*	*5,577,986.10*	*7,025,884.10*	*8,221,776.30*	*9,937,753.10*	*10,597,681.00*	
(%) Total revenue - central government	100.0	100.0	100.0	100.0	100.0	97.2	97.3	97.4	96.9	96.7	98.2
LGA Own Sources						*158,280.00*	*195,524.50*	*220,835.00*	*315,227.90*	*360,084.30*	
(%) LGA Own Sources	0.0	0.0	0.0	0.0	0.0	2.8	2.7	2.6	3.1	3.3	1.8
Other[1]					*16,327.00*			*72,300.00*			
(%) Other	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.9	0.0	0.0	0.2
Total Expenditure[2]	***3,873,254.80***	***4,474,680.90***	***5,327,779.30***	***6,734,078.00***	***8,173,749.30***	***9,439,407.20***	***10,764,528.40***	***12,714,236.40***	***14,011,133.00***	***14,603,714.40***	
Recurrent expenditure	*2,661,862.50*	*3,137,469.50*	*3,398,023.90*	*4,681,459.30*	*5,562,443.10*	*6,690,370.00*	*6,989,806.60*	*9,043,323.00*	*10,085,090.80*	*10,893,486.10*	
(%) Recurrent expenditure	**68.7**	**70.12**	**63.78**	**69.52**	**68.05**	**70.88**	**64.93**	**71.13**	**71.98**	**74.59**	**69.4**
Development Expenditure and net lending	*1,211,392.20*	*1,337,211.40*	*1,929,757.40*	*2,052,618.70*	*2,611,306.20*	*2,749,037.20*	*3,774,721.70*	*3,670,913.50*	*3,926,042.20*	*3,710,228.20*	
(%) Development Expenditure and net lending	**31.3**	**29.9**	**36.2**	**30.5**	**31.9**	**29.1**	**35.1**	**28.9**	**28.0**	**25.4**	**30.6**
Local	*296,100.00*	*503,291.20*	*567,421.00*	*906,023.20*	*1,004,530.50*	*984,555.00*	*1,872,311.70*	*2,314,717.90*	*2,121,211.50*	*2,264,506.00*	
(% to Total Exp.) Local	7.6	11.2	10.7	13.5	12.3	10.4	17.4	18.2	15.1	15.5	14.1
(% to Dev Exp.) Local	**24.4**	**37.6**	**29.4**	**44.1**	**38.5**	**35.8**	**49.6**	**63.1**	**54.0**	**61.0**	**46.9**
Foreign	*915,292.20*	*833,920.20*	*1,362,336.30*	*1,146,595.50*	*1,606,775.70*	*1,764,482.20*	*1,902,410.00*	*1,356,195.60*	*1,804,830.70*	*1,445,722.20*	
(% to Total Exp.) Foreign	23.6	18.6	25.6	17.0	19.7	18.7	17.7	10.7	12.9	9.9	16.5
(% to Dev Exp.) Foreign	**75.6**	**62.4**	**70.6**	**55.9**	**61.5**	**64.2**	**50.4**	**36.9**	**46.0**	**39.0**	**53.1**
Overall Balance before Grants	***-1,748,411.00***	***-1,735,658.50***	***-1,699,784.00***	***-2,441,003.70***	***-3,512,209.00***	***-3,703,141.10***	***-3,543,119.70***	***-4,271,625.20***	***-3,758,151.90***	***-3,645,949.00***	
Grants	***1,000,160.20***	***952,225.50***	***1,144,811.60***	***1,166,371.20***	***1,405,287.70***	***1,627,424.70***	***1,855,096.60***	***1,378,718.20***	***1,587,648.60***	***1,024,132.70***	
(% to Total Exp.) Grants	**25.8**	**21.3**	**21.5**	**17.3**	**17.2**	**17.2**	**17.2**	**10.8**	**11.3**	**7.0**	**15.0**
Overall Balance (cheques cleared)	***-924,412.50***	***-955,797.00***	***-902,809.20***	***-1,215,042.20***	***-1,939,623.60***	***-2,393,214.90***	***-2,070,124.10***	***-2,804,319.30***	***-2,497,879.20***	***-2,806,518.20***	
Financing:	***924,412.50***	***955,797.00***	***902,809.20***	***1,215,042.20***	***1,939,623.60***	***2,393,214.90***	***2,070,124.10***	***2,804,319.30***	***2,497,879.20***	***2,806,518.20***	
(% to Total Exp.) Financing	23.9	21.4	16.9	18.0	23.7	25.4	19.2	22.1	17.8	19.2	20.3
Foreign Financing (net)	***561,219.00***	***717,789.30***	***1,250,859.30***	***956,367.40***	***1,379,656.40***	***1,148,884.50***	***1,735,260.40***	***1,734,998.00***	***2,271,136.60***	***2,006,741.80***	
(% to Total Exp.) Foreign Financing (net)	**14.5**	**16.0**	**23.5**	**14.2**	**16.9**	**12.2**	**16.1**	**13.6**	**16.2**	**13.7**	**15.8**
Domestic (net)[4]	***363,193.50***	***238,007.70***	***-351,197.70***	***258,674.80***	***559,967.10***	***1,244,330.40***	***334,863.70***	***1,069,321.30***	***226,742.60***	***799,776.30***	
(% to Total Exp.) Domestic (net)	9.38	5.32	-6.59	3.84	6.85	13.18	3.11	8.41	1.62	5.48	4.5

Notes: *1 EPA refund (2009/10); Radar refund (2012/13)*
2 Exclude amortization and expenditure float, includes road fund and retention expenditure
3 Domestic interest payments and amortization include cash and non cash
4 Positive value means financing and a negative value means repayment
p = Provisional

Source: Bank of Tanzania Annual Report 2014/15 (Original source: Ministry of Finance, Bank of Tanzania and National Bureau of Statistics)

2.4.3 Budget and Expenditure of Agricultural Sector

Table 2.4.4 shows the budgets of the agricultural sector-related ministries[6]. Note that these are ministries' total budget including both recurrent and development. Given the mandates of the central ministries, these are mostly recurrent budget. Still it is notable that they are much smaller in comparison with other major sectors such as education or health with their proportions to the total expenditure being approximately 17%[7] and 8%[8], respectively.

Table 2.4.4 Agricultural Sector Ministries' Budget and Total Government Budget (TZS in Billion)

	2009/10	2010/11	2011/12	2012/13	2013/14p	2014/15p	2015/16
Total Expenditure	8,174	9,439	10,765	12,714	14,011	14,604	17,760
Agricultural related ministry budget	386	370	330	331	383	400	401
% of Agriculture Budget	4.7	3.9	3.1	2.6	2.7	2.7	2.3

Note: There are substantial budget allocated to LGAs through DADP and DIDF funds. These are not included here.
Source: GoT Revenue -- Bank of Tanzania Annual Report 2014/15 and 2015/16
Agricultural Sector Ministries Budget: Calculation based on data of Ministry of Finance Budget Book (Data of respective year: 2011/12, 2012/13, 2013/14, 2014/15)

Agricultural sector budgets are also allocated to LGAs. They are primarily under the budget of ASDP funds, namely, funds for DADP. There have been some possibilities that LGA (agriculture) obtains funds from other fund sources such as LGDG[9]. However, that possibility was rather limited until 2015/16 due to the existence of ASDP1. Following Table 2.4.5 summarizes the purposes of DADP funds.

Table 2.4.5 Types of ASDP/DADP Funds at LGA Level

Abbrev.	Full Name	Purpose
DADG	District Agricultural Development Grant	General infrastructure projects. Can be road, irrigation, warehouse, dip tank, etc.
ACBG	Agricultural Capacity Building Grant	LGA's capacity building activities. Can be training, equipment procurement
AEBG	Agricultural Extension Block Grant	Farmer capacity building, extension services. Can be FFS, AI, seeds, farmers' training.
DIDF	District Irrigation Development Fund	Specifically irrigation development, but at the LGA level.

Source: Produced by JICA Project Team

However, as seen in Table 2.4.6, it seems that LGAs were receiving fairly steady funds during the period of ASDP1 (2006/07 – 2012/13) (the Programme was then extended to 2015/16), although the amount may not have been enough if one looks at the per LGA values. On average, an LGA received TZS 214 million by DADG, while TZS 51 million by DIDF. However, the figure of DIDF should be much higher for those LGAs which received the fund because that fund was not for all LGAs. It was provided in response to proposals by LGAs and subject to screening done by NIRC in terms of their viability and profitability.

[6] Here, agricultural sector related ministries are as follows:
[1)] Ministry of Agriculture, Food Security and Cooperatives,
[2)] Ministry of Livestock and Fishery Development,
[3)] Ministry of Water (Irrigation Division) (until 2010/11), and
[4)] Ministry of Industry and Trade. In addition, since 2014/15, National Irrigation Commission is added.
[7] UNICEF Education budget brief (FY 2011/12–FY 2015/16)
[8] UNICEF Health budget brief (FY 2011/12–FY 2015/16)
[9] LGDG: Local Government Development Grant

Table 2.4.6 DADP Funds Disbursement (TZS in Million)

S/N			1	2	3	4	5	6	7	8	Annual Average	Remark
Year			2006 /07	2007 /08	2008 /09	2009 /10	2010 /11	2011 /12	2012 /13	2013 /14		
No. of LGA			122	132	132	132		132	132	160		
・ Funds to LGAs	・ ASDP/ DADP Funds	Basic DADG		4,704	4,998			4,998	4,998	0		・
		Top up DADG	8,968	20,414	21,754	33,906		33,568	30,424	0	24,105	Average Annual DADG
		Total DADG/ LGA	74	190	203	257		292	268	0	214	Average Annual DADG/ LGA
		Basic ACBG			7,288			3,493	3,843	5,560		
		Top up ACBG	3,293	15,484	10,697	16,644		0	0	0	9,472	Average Annual CBG
		Total ACBG/ LGA	27	117	136	126		26	29	35	71	Average Annual CBG/ LGA
		AEBG	1,586	9,012	9,401	9,205		0	0	10,907	5,730	Average Annual AEBG
		AEBG/ LGA	13	68	71	70		0	0	68	41	Average Annual AEBG/ LGA
		DIDF	164	7,386	4,635	23,700		11,190	0	0	6,725	Average Annual DIDF
		DIDF/ LGA	1	56	35	180		85	0	0	51	Average Annual DIDF/ LGA
	DASIP Funds	Investment (Top-up)	0	0	0	0		20,324	0	0		
		Capacity (Top-up)	0	0	0	0		2,013	0	0		
・ LGA Fund Total			14,011	57,000	58,771	83,456		64,396	39,266	16,467	47,624	Average Annual DADP Fund
・ LGA Fund Total (w/o DASIP)			14,011	57,000	58,771	83,456		42,059	39,266	16,467	44,433	
・ Average Fund/ LGA			116	434	448	635		490	300	103	361	Average Annual DADP Fund/ LGA
・ Average Fund/ LGA (w/o DASIP)			116	434	448	635		321	300	103		
・ Funds to Region	・ Local							102	102			
	・ Foreign							840	713			
・ All Total			13,847	57,000	58,771	83,456		65,338	40,081	16,467	47,852	Average Annual DADP Fund

Note: Those values shaded grey are total of the category. That is, no classification of Basic and Top-up was available.
Source: MAFC DPP Budget Office. As to the DIDF funds, those 2011/12, 2012/13 and 2013/14 data are given by NIRC.

2.4.4 Budgets for Irrigation Sector

The general trend of the irrigation-related funds since 2006/07 is shown in Table 2.4.7. In irrigation development, there is NIDF for large-scale projects in addition to DIDF, which is for projects at LGA level. Similar to the DADP funds above, DIDF and NIDF surged during the ASDP period, but then decreased as it was closed. The hike in 2014/15 and 2015/16 in DIDF is due to JICA's Small-Scale Irrigation Development Project (SSIDP). On average, government annual resource to irrigation development is TZS 12.8 billion which is approximately USD 8.3 million. Details of NIRC budgets are described in Section 5.5.1.

Table 2.4.7 Irrigation-related Expenditure

S/N	Fiscal Year	NIDF (TZS in Mil.)	DIDF (TZS in Mil.)	Total (NIDF+DIDF, TZS in Mil.)	Incremental Area (ha)	Expenditure/ Incremental Area (TZS in Mil. /ha)	Remark
1	2006/07	5,127	163	5,290	9,557	0.55	ASDP1 Period
2	2007/08	4,044	7,386	11,430	15,300	0.75	
3	2008/09	5,125	4,635	9,760	21,500	0.45	
4	2009/10	5,675	22,198	27,873	20,745	1.34	
5	2010/11	4,111	2,460	6,571	14,200	0.46	
6	2011/12	1,591	11,190	12,781	8,912	1.43	
7	2012/13	7,672	0	7,672	8,912	0.86	
8	2013/14	8,490	0	8,490	86,878	0.10	
9	2014/15	10,659	18,212	28,871	10,934	2.64	
10	2015/16	5,131	14,470	19,601			
11	2016/17	3341	0	2,986			
TOTAL		**60,968**	**80,713**	**141,326**	**196,938**	**---**	
Annual Average		5,542	7,338	12,848	21,882	0.72	
Annual Average (USD in Mil.)		3.60	4.76	8.34	---	466 USD/ha.	

*Note: *1 Exchange rate=TZS. 1,541/USD (2006-2016 average)*
**2 The average of Expenditure/Incremental Area (0.72 USD million) is calculated by TZS 141,326 million/196,938 ha.*
Source: NIRC

In addition to the above NIDF/DIDF funds, there are other funds available for irrigation development. They are so-called "off-budget" funds provided typically by development partners (DPs) stand-alone projects. These funds are often difficult to track the details like annual outflows and appropriation among multiple components of the project. For the concerned period, major source of funds of such nature are shown in Table 2.4.8.

Table 2.4.8 Major Funds for Irrigation Development Other than NIDF/DIDF

S/N	Fund name	Total Budget	Project Period	Budget/ Year
1	Food Assistance Counterpart Fund (FACF)[1]	7,598 (TZS in Mil.)	Irregular	691 (TZS in Mil.)
2	World Bank: Expanding Rice Productivity Project	22.9 (USD in Mil.)	2015 Mar 2020 Apr	4.58 (USD in Mil.)
3	USAID Feed the Future (NAFACA component)	30.0 (USD in Mil.)	2011-2015	6.00 (USD in Mil.)
4	NIRC recorded other sources[2]	29,531 (TZS in Mil.)	Irregular	2,684 (TZS in Mil.)

Note: 1. The total and the average fund of FACF are derived from the data of NIRC of 2006/07 through 2016/17.
2. The total and the average fund of the other sources are derived from the data of NIRC of 2006/07 through 2016/17.
USAID: United States Agency for International Development
Source: NIRC data, World Bank: http://projects.worldbank.org/P144497?lang=en, USAID: Lee Rosne, 2012 May 22, (PPT material), Balancing Quick Wins with Sustainability: Feed the Future's NAFAKA Project in Tanzania

While the level of total expenditure fluctuated depending upon the level of available funds in the Basket Fund, averaged amount of annual fund is USD 8.34 million. On the other hand, there have been a few other non-basket (off-budget) projects. Major examples are USAID Feed the Future Project (NAFAKA component, USD 30 million for five years, i.e. USD 6 million/year), and World Bank Expanding Rice Productivity Project (USD 22.9 million for five years, USD 4.58 million/ year)[10]. Moreover, there was the annual disbursement of DADG fund to all LGAs by the Basket Fund between 2006/07 and 2012/13. DADG was provided primarily for building local infrastructure including irrigation schemes. The annual average was TZS 31,953 million. Because this fund was for any type of local agricultural infrastructure,

[10] These projects covered both physical and institutional components, the former being construction of facilities and latter being training for O&M, production technologies, and organisation management. Because details are not available for expenditure of respective components, the values reported here are simple annual amount derived from total amount divided by the project duration.

it may have not been used for irrigation. Assuming about 10% of the annual total was used for irrigation[11], the available fund is TZS 3,195 million (approx. USD 2.34 million[12]). These expenditures are summarized in Table 2.4.9.

Table 2.4.9 Past Annual Funds Available for Irrigation Development

S/N	Fund Name	Budget/ Year (USD in Mil.)
1	NIDF	3.58
2	DIDF	4.76
3	FACF	0.45
4	WB: Expanding Rice Productivity Project	4.58
5	USAID Feed the Future (NAFACA component)	6.00
6	NIRC recorded other sources[2]	1.74
7	DADG	2.34
	Total	23.45

Note: The conversion of T. Shilling to US dollar was done based on the average exchange rate of the two currencies for the concerned period. The basic yearly exchange rates are obtained from World Bank Development Indicators.
Source: JICA Project Team

There were other project funders such as AFDB, IFAD, BMGF, and EU. However, their targets are often on subjects other than irrigation, like value chain development, extension and research, and promotion of commercial farming, etc. Therefore, their financial contributions are excluded here. In sum, examining the past ten years of irrigation development, average annual public (government and DPs) expenditure is estimated approximately USD 23 million per year.

2.5 Overview of Government Development Policy

2.5.1 National Development Policy

Tanzania's development policies in the last 15 years are all built upon the "Tanzania Development Vision 2025" (Vision 2025) which was proclaimed in 1999 with aspiration that the country would progress from a least developed country to a middle-income country by 2025. The vision was declared despite that it was time of adjustment to excess debts of the country to the international community.

In response to the adjustment process, the development policies of early 2000s were social sector-oriented. Then, gradually, the government veered the policy towards more growth-oriented direction as the country's confidence grows in pace with the country's economic expansion. Major development policies of the last 15 years are summarized in Table 2.5.1 in chronological order.

[11] There was the DADP progress report prepared and submitted by all LGAs quarterly to the central government. Examining the three annual reports, 2008/09, 2009/10 and 2010/11, it was found that the shares of expenditure to irrigation activities in total expenditure were 6.1%, 5.7% and 30.5% respectively. Considering yearly specific conditions such as focus on procurement of vehicles and office equipment in the beginning of ASDP period (2008/09) and government's explicit instruction to LGAs to purchase power tillers (2009/10), and taking relatively safe side, it might be reasonable to assume that 10% of DADG has been diverted to irrigation development.
[12] TZS 1,362.6/ USD which is the average exchange rate 2006-2012 was applied here.

Table 2.5.1 Major Development Policies of Tanzania

Target Period	Name of Policy	Characteristics
2000/01 – 02/03 (3 years)	Poverty Reduction Strategic Paper 1 (PRSP 1)	・ Focus on poverty alleviation. ・ Focus on social sector (education, health, agriculture (research and extension), rural roads, etc.) ・ Macro economy and structural reform
2005/06 – 09/10 (5 years)	Poverty Reduction Strategic Paper 2 (PRSP 2), or National Strategy for Growth and Reduction of Poverty (NSGRP)	・ Cluster approach ・ Cluster I: Economic growth and poverty reduction ・ Cluster II: Quality of life and well-being ・ Cluster III: Governance ・ Equity and broad based development with more focus on economic growth
2010/11 – 14/15 (5 years)	National Strategy for Growth and Reduction of Poverty II (NSGRP II) (or MKUKUTA II)	・ More focus on economic growth ・ Maintaining the cluster approach (with same coverage) ・ More promotion of private sector involvement
2011/12 – 25/26 (15 years)	Long Term Perspective Plan (LTPP)	・ Review of the implementation of Vision 2025 ・ Bases for the three five-year development plans ・ Specific focus on economic growth
2011/12 – 15/16 (5 years)	Five Year Development Plan I (FYDP I) - *Unleashing the Growth Potential*	・ Strong focus on economic growth ・ Intervention priorities rather than sector ones (Flagship projects) ・ Focus on manufacturing sector ・ High promotion of private sector participation
2016/17 – 20/21 (5 years)	Five Year Development Plan II (FYDP II) - *Nurturing an Industrial Economy*	・ Focus on economic growth ・ Flagship projects with large investments ・ Strategic consideration of geographic position (Corridor approach and area focus) ・ Improving business and investment environment

Source: Prepared by JICA Project Team

As summarized above, the country's development orientation has been shifting gradually more towards economic growth while maintaining social sector improvements. However, since the early 2010s, Tanzania has geared clearly to growth drive by introducing the sequential five-year development plans. Now, the country is pressing hard to expand its industrialization by promoting manufacturing, major capital intensive investments, and area specific (corridor) approaches based on the country's locational advantage.

In addition to the general development policies, the government launched in 2013/14 the Big Results Now (BRN) initiative which was an economy-wide but short-duration, very intensive and narrowly focused development program. Identifying six sectors (electricity and gas, transport, agriculture, water, education, and resource mobilization) with highly concentrated sets of interventions, the initiative attempted to accomplish visible changes in a manner of crashing work. Although it did not accomplish the original goals within the planned three years (by 2015/16) due to insufficient resource mobilization, the methodology of intensive engagement and critical monitoring seem to give a fresh impetus to the government operation.

2.5.2 Agricultural Development Policy

Throughout the transition of national development policies, the agricultural sector has always been counted as one of the major sectors for national development. In the poverty reduction policies during the 2000s, which emphasised social aspects in development, the development of agricultural sector was

considered critical as it would have a direct impact on poverty reduction as major parts of poverty resided in rural areas. Agriculture was also viewed essential in mitigating both income and food poverty. As the national policy turned more toward growth oriented, the agricultural sector continued to be regarded as important with a few added roles for economic advancement. The new roles are agricultural processing, export promotion of specific commodities, and overall domestic market expansion with an aim of broad-based economic progress.

While the importance of agricultural sector has remained in every national development policy, the aspects to which development interventions are directed have shifted as the national focuses have evolved. During the 2000s, the focuses of development were on conventional areas of productivity, profitability, technical modernisation, etc. As time passes, concepts of marketing, value chain, value addition, private investments, financial supports, and environmental concerns are flowing into the overall framework. Major agricultural development policies, strategies, and programs are listed in Table 2.5.2 with short summary of characteristics.

Table 2.5.2 Agricultural Sector Major Development Policies, Strategies, and Programs

Target Period	Name of Policy	Characteristics
2001 Oct. – (No specific duration)	Agricultural Sector Development Strategy 1 (ASDS1)	・ Response to PRSP 1. ・ Reform in the ministries' interventions to the sector ・ 3 innovative focuses 1) Focus on productivity and profitability with favourable environment for investments 2) Promotion of private/public partnership 3) Introduction of District Agricultural Development Plan (DADP)
2006/07 – 12/13 (7 years)	Agricultural Sector Development Program 1 (ASDP1)	・ Operationalization of ASDS ・ Adoption of the basket fund approach ・ Adoption of DADP (bottom-up approach in planning and implementing development interventions) ・
2013 Oct. – (No specific duration)	National Agriculture Policy	・ Prepared in response to various changes taking place in the surrounding of the sector (Kilimo Kwanza, CAADP, TAFSIP, international trade, etc.) ・ Comprehensive
2015/16 – 24/25 (10 years)	Agricultural Sector Development Strategy 2 (ASDS2)	・ Review of ASDS1, after the completion of ASDP1. ・ 6% growth rate with higher investments ・ Better productivity and commercialization for better income ・ Private sector involvement ・ Improvement in regional trade (EAC, SADC, etc.)
2016/17 – 25/26 (10 years)	Agricultural Sector Development Program 2 (ASDP2)	・ Focus on commercialization of agriculture ・ Promotion of value chain and value addition ・ Prioritized intervention (commodity and area focus) ・ Private sector mobilization (business promotion)

Source: Prepared by the JICA Project Team

The latest relevant policy/ program of the agricultural sector is ASDP2, which is a direct evolution from previous ASDP1. Comparing with the latter, the former is more focused and prioritized in its engagement. It is explicit in target commodities and areas for interventions. Also, ASDP2 gives greater emphasis on value addition and value chain development than any of the previous policies and programs.

2.5.3 Irrigation Development Policy

Parallel to the agricultural development, irrigation development has also been recognized as a crucial

component for development. As early as 2002, the government had already prepared the NIMP2002 which became a guiding document for all later irrigation development. On the other hand, it is only recent that the irrigation-specific policies were prepared despite that the importance was repeatedly mentioned in all of the major policy/ program documents.

The irrigation policy was prepared in 2010 followed by other key documents (National Irrigation Act 2013, National Irrigation Development Strategy 2013). Moreover, the National Irrigation Commission was established as a semi-independent organisation under the Ministry of Agriculture Food Security and Cooperatives (MAFC) in 2013. Major policy documents and their characteristics are summarized in Table 2.5.3.

Table 2.5.3 Irrigation Development Policy and Other Documents

Target Period	Name of Policy	Characteristics
February 2010 – Present	National Irrigation Policy	・ Formulated to "provide a baseline for a focused development of irrigation sector". ・ A general guidance for interventions. ・ Guidance is structured with respect to the types of irrigation scheme (traditional, improved, smallholders', or commercial, etc.) and key issues in relation to irrigation such as research, appropriate technology, production, capacity, etc. ・ For each subject, issue, objective, and policy statements are given.
2013 – Present	National Irrigation Act	・ This is a law specifically enacted to facilitate irrigation development of the country. ・ It has provision of establishing the National Irrigation Commission. ・ It provides definitions of many terms pertinent to irrigation. ・ It facilitates improvement of irrigation facility construction and operation by legally demanding particularities of actions to be taken.
November 2013	National Irrigation Development Strategy (Draft)	・ Document is still a draft. ・ Tentatively, it proposes the coverage of 15 years of 2013 through 2028. ・ Although not very specific, it describes how to proceed in major aspects of irrigation development such as: ・ Investment ・ Training ・ Management ・ Institution ・ Research and technologies ・ Financial mechanism ・ Production

Source: Prepared by the JICA Project Team

Recognizing the significance of irrigation development, many policies described specific targets to be achieved in a set year. Following Table 2.5.4 shows the list of such declaration. Unfortunately, however, due to various obstacles such as financial shortage and inadequate manpower, these goals are not yet achieved to date.

Table 2.5.4 List of Irrigation Development Target in the Past

Date of Document	Name of Policy	Target
July 2010	National Strategy for Growth and Reduction of Poverty II (NSGRP II) (or MKUKUTA II)	1,000,000 ha by 2015 [From 370,000 ha (2009)]
June 2011	Five-Year Development Plan I (FYDP I) - *Unleashing the Growth Potential*	1,000,000 ha by 2015/16
2015	CCM Manifesto	1,000,000 ha by 2020
June 2016	Five-Year Development Plan II (FYDP II) - *Nurturing an Industrial Economy*	700,000 ha by 2020 1,000,000 ha by 2025

Source: Prepared by the JICA Project Team

The latest ASDP2 document does not specify target areas of irrigation development.

2.6 Overview of Development Partners Policy and Activities

2.6.1 Development Partners' General Policies in Supporting Tanzania and their Characteristics

Because of its political stability and openness to outside, Tanzania has been favoured by numerous DPs both multilateral organisations like the World Bank (WB) and African Development Bank (AfDB) and bilateral aid agencies like USAID and Irish Aid. In the agricultural sector, major supporters are the following:

- WB
- AfDB
- Food and Agriculture Organization (FAO)
- World Food Program (WFP)
- Bill and Melinda Gates Foundation (BMGF)
- International Fund for Agricultural Development (IFAD)
- USAID
- Japan International Cooperation Agency (JICA)
- Irish Aid

The agencies typically carry out their support, financial or technical, in accordance with their multi-year strategic plans. Perusing the plans, there are some commonalities and general trends in how they engage in the Tanzania agricultural development.

It is the DPs common understanding that despite the fact that the country has enjoyed an impressive growth with more than 6% on average in the last decade or so, such growth has not been translated to enough poverty reduction and economic transformation. Given this observation, many DPs recognize the importance of improving the livelihood of rural population which is mostly smallholder farmers.

At the same time, many DPs align their supports with government key development policies which are TDV 2025 and NSGRP II (and FYDP I) until 2015, and FYDP II since 2016. Following the basic orientation of the recent policies, major DPs are re-focusing to infrastructure sectors such as road and transport, and energy (WB and AFDB), while maintaining the supports to institutional reforms in governance and accountability.

Regarding agricultural sector, attention is increasingly given to commercialization of farming. Often observed expressions are "value chain development", "value addition", and "market access". Paring with these words are "involvement of private sector" and "enhancement of private investments" in agricultural sector. A background or overarching issue of this is the "improvement of business environment". This trend is also a reflection of the general trajectory of the government development policy. Many DPs still maintain the aspects of productivity improvement, but greater elements of commercialization and marketing are being included in DPs aid policies in recent years.

Apart from above trends, there are a few separate lines of focus in DPs. These are concerns about women, youth and children (USAID and Irish Aid), nutrition (USAID, FAO and BMGF), and climate resilience (many DPs). Major points of DPs' aid policies are summarized in Table 2.6.1

Table 2.6.1 Characteristics of DPs' Policies

DP	Policy Doc. Referred	Major Concerns and Goals
WB	Country Assistance Strategy 2012 - 2015	(1) To promote inclusive and sustainable private sector-led growth (2) To build infrastructure and deliver services (3) To strengthen human capital and safety net (4) To improve accountability and governance
AFDB	Country Strategic Paper 2016-2020	(1) Infrastructure development (2) Governance and accountability
IFAD	Country Strategic Opportunities Programme 2016-2021	Strategic Objectives (SO) SO 1: To improve institutional performance SO 2: More inclusive and resilient value chains of priority commodities SO 3: Climate resilient and productivity-increasing technologies SO 4: Land governance enabling more inclusive investments
FAO	Country Programming Framework Jan. 2014 – June 2016	A. Promoting agriculture as a profitable business Outcome A1: Agricultural productivity increases in selected commodities Outcome A2: Smallholders and trader farmers and traders engaged in marketing and commercialization of agricultural produce B. Sustainable management of natural resources Outcome B1: Effective and sustainable natural resources management C. Agricultural development planning and sector investment support Outcome C1: Agricultural statistics Outcome C2: ASDP planning support
USAID	Country Development Cooperative Strategy Oct. 2014 – Oct. 2019	Development Objective (DO) 1: Women and youth empowerment Intermediate Result (IR) 1.1: Gender equality is improved. IR 1.2: Health status is improved. IR 1.3: Lifelong learning skills. DO 2: Inclusive and broad-based economic growth IR 2.1: Binding constraints to private sector investment is decreased. IR 2.2: Agricultural productivity and profitability are increased. IR 2.3: Stewardship of natural resources is improved.
Irish AID	Country Strategic Paper 2011 – 2015	Overall goal: To reduce poverty and vulnerability and to support inclusive growth Specific objectives: 1) To improve livelihood for smallholders and pastoralists 2) To improve food security and nutrition, particularly for women and children 3) To enhance the quality and equity of local health services
Japan/ JICA	Tanzania Country Assistance Policy (September 2017)	Overall Goal: To support the formation and enhancement of a positive feedback loop between inclusive and stable economic growth and poverty reduction along the Tanzania's national strategy which aims at attaining the middle-income status in the world, (1) Formation of sectors driving the economic growth Agriculture: Support to rice production, irrigation development and food value chain within the framework of ASDP II. Industry: Support to business undertaking including the improvement of business environment and KAIZEN under FYDP II. (2) Infrastructure development Transport sector, power and energy sector, and sustainable urban development (3) Governance and public services Local administration management, water, health services, and public financial management
BMGF	"What we do", Strategy overview	Goal: To reduce hunger and poverty for millions of farming families in sub-Saharan Africa and South Asia by increasing agricultural productivity in a sustainable way. Strategy: ・ Listening to farmers and addressing their specific needs ・ Increasing farm productivity (comprehensive approach) ・ Fostering sustainable agricultural practices ・ Achieving greater impact with partners Strategic areas: ・ Research and development ・ Agricultural policies ・ Livestock ・ Market access and market systems ・ Strategic partnerships and advocacy

Source: Prepared by the JICA Project Team

2.6.2 DPs' Major Activities and Financial Engagement in Agricultural Sector

The major activities and financial supports of the major agricultural DPs are summarized in Table 2.6.2

Table 2.6.2 DPs' Major Activities and Financial Supports

DP	No	Title	Period		Budget		Remarks
					Currency	(Mil.)	
AFDB	1	Marketing Infrastructure Value Addition and Rural Finance Support Program (MIVARF)	2012	2016	UA	40.0	Co-finance with IFAD (AFDB portion is UA 40.0 Mil.)
	2	District Agricultural Sector Investment Project (DASIP)	2006	2013	UA	36.0	
	3	ASDP1	2007	2010	UA	40.0	
EU	1	SAGCOT support	2014	2017	EUR	36.5	
GIZ	1	Competitive African Rice Initiative (CARI)	2014	2017	USD	5.6	
IFAD	1	Marketing Infrastructure Value Addition and Rural Finance Support Program (MIVARF)	2012	2018	USD	90.5	Co-finance with AFDB
	2	Rural Micro, Small and Medium Enterprise Support Program (MUVI)	2007	2016	USD	19.5	
	3	ASDP1	2006	2014	USD	93.4	
Irish Aid	1	ASDP1	2007	2012	EUR	24.6	Estimates from Country Strategy Paper
JICA	1	ASDP1	2006	2012	USD	20.0	
	2	Small-scale irrigation development project	2014	2016	USD	34.0	
USAID	1	Feed the Future (Tanzania)	2011	2015	USD	350.0	USD 70 Mil./year
WB	1	ASDP1	2006	2016	USD	90.0	
	2	ASDP1 (Addition (1)) (to Accelerated Food Security)	2009		USD	30.0	
	3	ASDP1 (Addition (2))	2010		USD	35.0	
	4	ASDP1 (Addition (3))	2012		USD	30.0	
	5	Accelerated Food Production	2009	2014	USD	160.0	
	6	Accelerated Food Production (Addition (1))	2012		USD	25.0	
	7	SAGCOT support	2016	2021	USD	70.0	
	8	Expanding Rice Production	2015	2020	USD	22.9	

Source: Prepared by the JICA Project Team

Apart from the activities in Table 2.6.2, there are numerous relatively small projects carried out by different DPs. Many of them are technical cooperation projects conducted by FAO, AGRA, and JICA. Another type of project is location-, crop-, or subject-specific projects such as EU's sugar, or cassava or horticulture project. Another is the support to agricultural finance, which includes Canada's contribution to the Financial Sector Deepening Trust (FSDT), or Netherland and Sweden's support to a matching fund for agricultural entrepreneurship (Tanzania Agribusiness Window)[13].

Overall DPs are supporting the sector along the government development policies, although it is vice-versa as DPs are actively engaging with the government in policy formulation. In terms of funding modality, however, there is a notable shift among DPs from pooled-fund approach to independent stand-alone project approach. Hence, although the government makes it clear that the pooled/ basket fund approach is their preferred modality for ASDP2, it is likely that many DPs support the program through their own individual projects.

[13] Agribusiness Window was first proposed in 2007 at the World Economic Forum (Africa). Then with the supports of Netherland and Sweden, the system began to operate since 2008. The window is one of several matching funds available for those entrepreneur and venture business. Other target areas than agriculture are rural electrification, climate change, and rural finance.

2.7 Private Sector Activities

Tanzania has seen steady and impressive economic growth for the last several years with an average growth rate achieving 6.5%. This growth was spurred by vigorous private sector activities. As shown in Table 2.7.1, they have been taking place mostly in the subsectors of construction, information and communication, financial and insurance, and professional activities. Unfortunately, agricultural sector is not part of this dynamic expansion.

Table 2.7.1 GDP Growth Rate by Subsectors (2008-2015)

Economic Activity	2008	2009	2010	2011	2012	2013	2014r	2015p	Avg. [8 yrs: 2008-15]
GDP at market prices	5.6	5.4	6.4	7.9	5.1	7.3	7.0	7.0	6.5
Agriculture, Forestry and Fishing	7.5	5.1	2.7	3.5	3.2	3.2	3.4	2.3	3.9
・ Crops	7.8	5.5	3.7	4.8	4.2	3.5	4.0	2.2	4.5
・ Livestock	8.1	5.3	1.4	1.6	1.8	2.0	2.2	2.4	3.1
・ Forestry	3.8	5.1	3.4	3.3	3.5	4.7	5.1	2.6	3.9
・ Fishing	7.2	0.5	0.9	2.6	2.9	5.5	2.0	2.5	3.0
Industry and Construction	6.5	3.3	9.1	12.0	4.0	9.5	10.3	11.3	8.3
・ Mining and quarrying	-9.8	18.7	7.3	6.3	6.7	3.9	9.4	9.1	6.5
・ Manufacturing	11.4	4.7	8.9	6.9	4.1	6.5	6.8	6.5	7.0
・ Electricity supply	8.1	4.3	13.4	-4.3	3.3	13.0	9.3	5.8	6.6
・ Water supply; sewerage, waste management	2.3	4.6	2.2	-1.2	2.8	2.7	3.7	0.1	2.2
・ Construction	9.7	-3.8	10.3	22.9	3.2	14.6	14.1	16.8	11.0
Services	4.2	5.8	7.8	8.4	7.2	7.1	7.2	6.9	6.8
・ Wholesale and retail trade; repairs	6.5	2.7	10.0	11.3	3.8	4.5	10.0	7.8	7.1
・ Transport and storage	1.8	6.9	10.7	4.4	4.2	12.2	12.5	7.9	7.6
・ Accommodation and food services	3.3	1.0	3.7	4.1	6.7	2.8	2.2	2.3	3.3
・ Information and communication	11.9	26.6	24.4	8.6	22.2	13.3	8.0	12.1	15.9
・ Financial and insurance activities	18.8	18.4	12.6	14.8	5.1	6.2	10.8	11.8	12.3
・ Real estate	1.7	1.8	1.8	1.9	2.0	2.1	2.2	2.2	2.0
・ Professional, scientific and technical activities	30.6	15.8	29.9	4.8	-5.8	5.4	0.5	6.8	11.0
・ Administrative and support service activities	-1.8	0.4	8.6	5.1	23.8	12.2	6.0	4.7	7.4
・ Public administration and defence	-6.3	-0.7	-5.0	15.9	9.1	7.8	3.9	4.6	3.7
・ Education	9.5	9.2	6.4	5.6	7.4	4.3	4.8	6.3	6.7
・ Human health and social work activities	5.5	7.4	3.3	5.3	11.4	8.8	8.1	4.7	6.8
・ Arts, entertainment and recreation	6.4	3.0	7.3	7.7	11.0	5.7	5.7	6.2	6.6
・ Other service activities	5.8	5.9	6.0	6.2	6.4	6.5	6.7	6.9	6.3
・ Activities of households as employers	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
・ FISIM, unallocated	6.8	20.0	7.9	22.6	1.2	0.1	9.7	11.7	10.0

Notes: r: revised, p: provisional
Source: NBS, MoFP, November 2016, National Account of Tanzania Mainland 2007 - 2015

On the other hand, the government has been active in promoting the public-private partnership (PPP) to induce private entities into the traditionally often publicly implemented sectors. The PPP policy was enacted in 2009, followed by the introduction of the Act in 2010 and the Regulation in 2011, and setting-up of PPP Finance Unit in the Ministry of Finance and Coordination Unit in TIC. This series of establishments of new policy instruments corresponds to the preparation and implementation of the second growth-oriented national development policy: National Strategy for Growth and Reduction of Poverty II (NSGRP II) (or MKUKUTA II) as well as the declaration of Kilimo Kwanza. Although the

PPP drive has expected some increase in foreign direct investment (FDI), there has been limited expansion in FDI since 2008 as shown in Table 2.7.2. Major FDI activities have been in mining and quarrying, manufacturing, and financial subsectors. The inflow showed overall expansion but with considerable fluctuation over the period.

Table 2.7.2 Trend of FDI (Flow and Stock) (USD in Million)

Activity	Flows						Stock					
	2008	2009	2010	2011	2012	2013	2008	2009	2010	2011	2012	2013
Mining and quarrying	669.8	385.1	909.9	406.5	889.3	520.4	3,714.1	4,099.2	5,009.1	5,415.5	6,304.8	6,825.2
Manufacturing	277.6	214.5	157.1	217.3	563.7	386.6	870.7	1,085.2	1,242.3	1,459.5	2,023.3	2,409.9
Financial and insurance	81.7	95.9	95.5	121.1	148.1	752.2	416.3	512.2	607.6	728.7	876.8	1,629.0
Electricity and gas	1.0	2.1	290.5	209.4	618.3	37.3	24.7	26.8	317.3	526.7	1,145.0	1,182.3
Accommodation	129.7	35.9	21.1	165.6	5.4	47.0	388.7	424.6	445.7	611.3	616.8	663.8
Wholesale and retail trade	21.1	-16.9	36.9	114.5	-35.2	123.5	372.0	355.1	392.0	506.5	471.3	594.8
Information and communication	127.6	185.1	83.5	-98.3	-420.1	195.9	532.4	717.4	801.0	702.7	282.6	478.5
Agriculture	21.2	29.0	22.9	31.4	11.2	10.3	202.3	231.3	254.2	285.6	296.8	307.1
Professional activities	-0.7	0.5	213.0	6.1	20.1	-0.1	1.1	1.6	214.6	220.6	240.7	240.6
Construction	-3.7	14.9	-23.5	30.7	-28.1	13.8	119.5	134.4	110.9	141.5	113.4	127.2
Real estate activities	26.5	1.5	1.5	12.0	23.4	-0.6	79.7	81.2	82.8	94.7	118.1	117.5
Transportation and storage	2.7	3.9	4.0	10.4	-1.0	19.5	28.8	32.7	36.7	47.1	46.1	65.6
Other service activities	1.4	1.4	-0.8	1.1	3.9	22.9	3.8	5.2	4.4	5.5	9.4	32.3
Education	0.4	0.3	1.6	1.8	0.5	2.2	2.0	2.3	3.9	5.7	6.2	8.4
Grand Total	1,383.3	953.1	1,813.3	1,229.4	1,799.6	2,130.9	6,945.6	7,898.7	9,711.9	10,941.3	12,740.9	14,871.8

Source: Bank of Tanzania, NBS, 2013 and 2014, Tanzania Investment Report

Apart from general investments by private sector, in the PPP drive, the government envisioned more specific joint venture with private companies. Their focus is placed on infrastructure (road, rail, port, airport, and power) and agricultural sectors. This government intention was explicitly materialized in the BRN initiative which aims at rapid completion of clearly targeted projects in the six priority sectors. However, as described in Section 2.5.1, the attempt produced only limited results. As such, while the national economy is steadily expanding, the government still needs to carry out various reforms to attract private sector into its national development.

2.8 Basic Infrastructure

2.8.1 Transport

(1) Road Networks

The Tanzania National Roads Agency (TANROADS) - an executive agency under the Ministry of Works, Transport, and Communications - came into operation in July 2000 and is the agency responsible for the maintenance and development of the trunk and regional road network in Tanzania Mainland. The total classified road network in Tanzania Mainland was estimated to be 86,472 km based on the Road Act 2007, which has expanded to 108,946 by 2015. The Ministry of Works through TANROADS is managing the national road network of about 35,000 km, comprising 12,786 km of trunk road and 22,214 km of regional road. The remaining network of 73,946 km of urban, district, and feeder roads is under the responsibility of the President's Office Regional Administration and Local Government (PO-RALG). Table 2.8.1 shows the road network status of Tanzania Mainland from 2010 to 2015.

Table 2.8.1 Road Network in Kilometres by Status, Tanzania Mainland (km), 2010 – 2015

Item	2010	2011	2012	2013	2014	2015
1. National Roads						
1.1 Trunk Roads (paved)	5,377	5,377	6,219	6,292	6,565	7,342
1.2 Trunk Roads (unpaved)	6,822	6,822	5,987	5,912	6,221	5,444
1.3 Regional Trunk Roads (paved)	780	780	1,067	1,082	1,240	1,321
1.4 Regional Roads (unpaved)	20,490	20,490	20,990	21,047	20,974	20,893
Subtotal (1)	33,469	33,469	34,263	34,333	35,000	35,000
2. Local Roads						
2.1 Local Roads (paved)	842	746	1,031	966	988	1,326
2.2 Local Roads (paved)	56,798	52,603	53,348	52,241	51,676	72,620
Subtotal (2)	57,640	53,349	54,379	53,207	52,664	73,946
Total	91,109	86,818	88,642	87,540	87,664	108,946

Source: TANROADS/PO RALG, 2015 Tanzania in Figures, NBS, June 2016

(2) Railways

There are two railway operators in Tanzania, namely, the Tanzania Railways Corporation (TRC) and the Tanzania-Zambia Railway Authority (TAZARA).

TRC operates 2,600 km of 1,000 mm narrow gauge track including the central line between Kigoma and Dar es Salaam which carries international freight and passengers in transit from Burundi, the DR Congo, and Rwanda to Dar es Salaam, and the Mwanza Branch Line carries freight and passengers between Uganda and Dar es Salaam. TRC also operates the Tanga Line from Tanga to Arusha with a link line to Rubu for connection to Dar es Salaam.

TAZARA operates 1,860 km of 1,067 mm narrow gauge track (matching Zambian/Southern African networks) between Dar es Salaam and New Kapiri Mposhi in Zambia, of which 969 km is in Tanzania and 891 km in Zambia. TAZARA currently handles exports/imports of both Tanzania and Zambia, as well as Malawi, DR Congo, the great lakes region, South Africa and Zimbabwe.

There may be a big room for both railway operators to improve the management and customers' services. For instance, TAZARA Line has a designed capacity of five million tons of freight per annum but remains the same as low performance. Table 2.8.2 shows the freight and passengers transported by

railway in Tanzania Mainland

Table 2.8.2 Freight and Passengers Transported by Railway, Tanzania Mainland, 2010-2015

Item	2010	2011	2012	2013	2014	2015
1. Tanzania Railways (TRC)						
1.1 Freight (thousand tons)	265	138	154	185	190	211
1.2 Passengers (thousand)	284	227	339	373	295	405
2. Tanzania Zambia Railways (TAZARA)						
2.1 Freight (thousand tons)	540	248	259	245	208	130
2.2 Passengers (thousand)	758	414	678	654	536	436

Source: Ministry of Works, Transport and Communication, 2015 Tanzania in Figures, NBS, June 2016

Construction of a 207 km of 1,435 mm standard gauge line linking Dar es Salaam with Morogoro will start in May 2017 and is expected to open in October 2019 as the first phase of a long-term proposed 2,561 km standard gauge regional network to be extended to Rwanda and Burundi.

The governments of Zambia and Tanzania are reportedly seeking Chinese loans to finance rehabilitation of the 1,860 km TAZARA railway.

(3) Port

The coastline of Tanzania Mainland is approximately 800 km long, extending from the Kenyan border in the north to the Mozambican border in the south. The major seaports (Dar es Salaam, Tanga, and Mtwara) handle not only Tanzania's cargo, but also transit goods to land-locked countries of Burundi, Democratic Republic of Congo, Malawi, Rwanda, Uganda, and Zambia. The seaport of Dar es Salaam handles about 15 times as much trade as the rest of the Tanzanian seaports. In addition to the seaports, there are lake ports such as Mwanza, Bukoba, and Musoma in Lake Victoria, Kigoma and Kasanga in Lake Tanganyika, and Itungi and Mbamba Bay in Lake Nyasa. It can be seen in Table 2.8.3 that the volume of cargo handled at the above three ports is steadily increasing at the annual rate of about 11% for the last five years.

Table 2.8.3 Cargoes and Passengers Transported by Marine, Tanzania Mainland, 2010-2015

Item	2010	2011	2012	2013	2014	2015
1. Dar es Salaam Port						
1.1 Ships Calls	-	1,510	1,427	1,463	1,600	1,520
1.2 Cargo (thousand DWT)	8,815	9,920	10,867	13,515	14,476	14,558
1.3 Passengers (thousand)	-	1,009	1,343	1,292	1,441	1,620
2. Tanga Port						
2.1 Ships Calls	-	146	212	142	136	83
2.2 Cargo (thousand DWT)	377	500	644	384	750	693
2.3 Passengers (thousand)	-	23	13	2	0	0
3. Mtwara Port						
3.1 Ships Calls	-	60	111	558	599	198
3.2 Cargo (thousand DWT)	170	214	235	188	358	259
3.3 Passengers (thousand)	N/A	N/A	N/A	N/A	N/A	N/A

Note: DWT = Dead Weight Tonnes
Source: Ministry of Works, Transport and Communication, 2015 Tanzania in Figures, NBS, June 2016

It is notable to add that the development of Bagamoyo Special Economic Zone (SEZ) includes a new construction of Mbegani Seaport.

(4) Airports

There are currently 26 airports including four international airports in the mainland of Tanzania. The four international airports are Dar es Salaam (Julius Nyerere), Kilimanjaro, Mwanza, and Mbeya (Songwe). Only international airports have runways over 3,000 m long, which have a capacity to handle 128 tons Boeing 757-200 and 135 tons Boeing 757-300. Most of other small airports are capable of handling light passenger-cargo aircrafts. Table 2.8.4 shows air transport, domestic, and international passengers (in thousand) in Tanzania

Table 2.8.4 Air Transport, Domestic and International Passengers (in thousand), Tanzania

Item	2010	2011	2012	2013	2014	2015
1. International Passengers						
1.1 Julius Nyerere I.A.	870	1,004	1,100	1,137	1,192	1,251
1.2 Kilimanjaro I.A.	283	317	330	368	362	333
1.3 Abeid Amani Karume I.A.	216	275	309	367	409	409
1.4 Mwanza I.A.	16	21	20	18	9	6
Subtotal (1)	1,385	1,617	1,759	1,890	1,972	1,999
2. Domestic Passengers						
2.1 Julius Nyerere I.A.	610	734	868	1,077	1155	1141
2.2 Kilimanjaro I.A.	141	253	236	318	307	318
2.3 Abeid Amani Karume I.A.	325	381	390	440	438	388
2.4 Mwanza I.A.	201	290	365	420	402	427
Subtotal (2)	1,277	1,658	1,859	2,255	2,302	2,274
3. Other Airport Passengers	355	357	439	483	604	579
Total (1)+(2)+(3)	1,632	2,015	2,298	2,738	4,878	4,852

Note: Songwe International Airport was opened and operational in December 2012.
Source: Ministry of Works, Transport and Communication, 2015 Tanzania in Figures, NBS, June 2016

The number of passengers is constantly increasing with the annual growth rate of about 8% for international and 10% for domestic for the last five years.

2.8.2 Power Supply

Tanzania Electric Supply Company Limited (TANESCO) is a parastatal organisation under the Ministry of Energy and Minerals. The company generates, transmits, distributes, and sells electricity to Tanzania Mainland and sells bulk power to the Zanzibar Electricity Corporation (ZECO). TANESCO owns most of the electricity generating, transmitting, and distributing facilities in Tanzania Mainland as shown in Table 2.8.5

Table 2.8.5 Installed Capacity, Electricity Generated and Sales, Tanzania, 2010 – 2015

Item	Unit	2010	2011	2012	2013	2014	2015
1. Installed Capacity							
1.1 Grid System Installed Capacity	MW	1,003.5	1,270.7	1,438.2	1,501.2	1,521.9	1,516.2
2. Maximum Demand							
2.1 Grid System Maximum Demand	MW	832.6	829.0	851.4	898.7	934.6	988.3
2.2 Grid System	GWh	5,183.1	5,050.4	5,339.6	5,758.3	6,029.0	6,188.0
2.3 Off-grid System	GWh	76.1	83.6	149.9	178.5	191.8	201.0
3. Generation							
3.1 Import from Neighbouring Countries	GWh	57.5	61.6	60.9	60.2	61.0	70.5
4. Sales							
4.1 Small Customers	GWh	389.7	328.8	320.8	280.6	217.4	148.8
4.2 Middle Customers	GWh	1,330.4	1,270.8	1,508.0	1,749.1	1,890.6	2,082.7
4.3 Big Customers	GWh	2,152.2	2,151.6	2,301.0	2,570.4	2,595.3	2,721.1
4.4 Zanzibar	GWh	175.4	277.3	298.6	218.7	348.5	344.6

Source: Source: Tanzania Electricity Supply Company (TANESCO), 2015 Tanzania in Figures, NBS, June 2016

According to the Power System Master Plan Updated 2016, a total installed generation capacity is planned to expand to 5,011 MW (excluding renewable and import) by 2020 which is 3.3 times bigger than the existing installed capacity.

2.8.3 Water Supply

In Tanzania, provision of water supply and sanitation services is done through Water Supply and Sanitation Authorities (WSSAs) which are regulated by the Energy and Water Utilities Regulatory Authority (EWURA); and Community Owned Water Supply Organisations (COWSOs), which are regulated by the Ministry of Water and Irrigation (MoWI). A new Water Supply and Sanitation Act, Cap 272 came into operation in August 2009, and provides clear division of responsibilities between MoWI, WSSAs, and EWURA. EWURA currently regulates 130 WSSAs, which provide water supply and sanitation services in regional and district headquarters, small towns, and national projects water authorities. Meanwhile, COWSOs are responsible for rural water supply.

The World Health Organisation (WHO)/ United Nations Educational, Scientific and Cultural Organisation (UNESCO) Joint Monitoring Program (JMP) for water supply and sanitation updated the estimates on the use of water supply and sanitation facilities in Tanzania in 2015 as shown in Table 2.8.6

Table 2.8.6 Estimates on the Use of Water Supply and Sanitation Facilities, 1990-2015

URBAN WATER					
Estimated coverage 2015 update					
Year	Total improved	Piped onto premises	Other improved	Other unimproved	Surface water
1990	92%	31%	61%	5%	3%
1995	89%	30%	59%	8%	3%
2000	86%	29%	57%	11%	3%
2005	83%	29%	54%	14%	3%
2010	80%	28%	52%	17%	3%
2015	77%	28%	49%	20%	3%

URBAN SANITATION				
Estimated coverage 2015 update				
Year	Improved	Shared	Other unimproved	Open defecation
1990	6%	6%	86%	2%
1995	11%	11%	76%	2%
2000	16%	16%	66%	2%
2005	21%	21%	56%	2%
2010	26%	26%	46%	2%
2015	31%	31%	36%	2%

RURAL WATER					
Estimated coverage 2015 update					
Year	Total improved	Piped onto premises	Other improved	Other unimproved	Surface water
1990	45%	0%	45%	30%	25%
1995	45%	1%	44%	31%	24%
2000	45%	2%	43%	32%	23%
2005	45%	3%	42%	33%	22%
2010	45%	4%	41%	34%	21%
2015	46%	6%	40%	34%	20%

RURAL SANITATION				
Estimated coverage 2015 update				
Year	Improved	Shared	Other unimproved	Open defecation
1990	7%	3%	80%	10%
1995	7%	3%	78%	12%
2000	7%	3%	77%	13%
2005	8%	4%	74%	14%
2010	8%	4%	73%	15%
2015	8%	4%	71%	17%

TOTAL WATER					
Estimated coverage 2015 update					
Year	Total improved	Piped onto premises	Other improved	Other unimproved	Surface water
1990	54%	6%	48%	25%	21%
1995	54%	7%	47%	26%	20%
2000	54%	8%	46%	27%	19%
2005	55%	10%	45%	28%	17%
2010	55%	11%	44%	29%	16%
2015	56%	13%	43%	30%	14%

TOTAL SANITATION				
Estimated coverage 2015 update				
Year	Improved	Shared	Other unimproved	Open defecation
1990	7%	4%	80%	9%
1995	8%	5%	77%	10%
2000	9%	6%	75%	10%
2005	11%	8%	70%	11%
2010	13%	10%	65%	12%
2015	16%	12%	60%	12%

Notes: (Water Supply) Surface water= river, dam, lake, pond, etc., Other unimproved= unprotected dug well, unprotected spring, cart with small tank/drum, etc. Other improved= public taps or standpipes, tube wells or boreholes, protected dug wells and spring, etc. Pipe onto premises= piped household water connection located inside the user's dwelling, plot or yard, Total improved= Piped onto premises + Other improved
(Sanitation) Open defection= human faeces are disposed of in fields, forest, open body of water, etc., Other unimproved= Unimproved facilities include pit latrines without a slab or platform, etc., Shared= Sanitation facilities of an otherwise acceptable type shared between two or more households, Improved= Flush/pour flush to: - piped sewer system, - septic tank, - pit latrine; Ventilated improved; Pit (VIP) latrine; Pit latrine with slab, Composting toilet

Source: United Republic of Tanzania: Estimates on the Use of Water Sources and Sanitation Facilities (1990 - 2015), WHO/UNESCO Joint Monitoring Program (JMP) for Water Supply and Sanitation, Updated June 2015

As for the performance of COWSOs, data is limited. Water utilities performance of WSSAs is evaluated on a sample basis as shown in Table 2.8.7.

Table 2.8.7 Selective Key Performance Indicators of WSSAs, Tanzania, 2013/14 - 2015/16

Item	2013/14	2014/15	2015/16
1. National and Region (25 out of 33 WSSAs)			
1.1 Total water connection (No.)	494,573	528,960	577,391
1.2 Population directory served with water (%)	54%	57%	57%
1.3 Non-revenue water (%)	44%	44%	42%
1.4 Population connected to sewerage network (%)	8%	7%	6%
2. District (69 out of 73 WSSAs)			
2.1 Total water connection (No.)	82,600	89,064	94,631
2.2 Population directory served with water (%)	40%	40%	41%
2.3 Non-revenue water (%)	40%	38%	42%
2.4 Population connected to sewerage network (%)	N/A	N/A	N/A
3. Township (15 out of 24 WSSAs)			
3.1 Total water connection (No.)	12,707	15,291	18,008
3.2 Population directory served with water (%)	41%	45%	37%
3.3 Non-revenue water (%)	41%	35%	36%
3.4 Population connected to sewerage network (%)	N/A	N/A	N/A

Note: Kahama WSSA is a district water supply and sanitation authority but has been included here because it is operating as a Regional WSSA.

Source: 1) Water Utility Performance Review Report for the FY2015/16, Regional and National Project Water Utilities, Energy and Water Utilities Regulatory Authority (EWURA), December 2016
2) The same for Districts and Township Water Utilities, Energy and Water Utilities Regulatory Authority (EWURA), December 2016

Judging from the above selective key performance indicators, there is no significant improvement except the number of total water connection.

2.8.4 Communications

Tanzania has two fixed-line operators (Tanzania Telecommunication Company Limited (TTCL) and Zantel) and seven operational mobile networks. With four major operators - Vodacom, Airtel (formerly Zain), Tigo, and Zantel - mobile penetration has expanded to 80%. Along with the expansion of mobile networks, internet services penetration has reached to 40% with the higher growth rate than that of mobile penetration in the last five years as shown in Table 2.8.8

Table 2.8.8 Estimated Number of Subscription on Telephones and Internet Users in Tanzania

Item	2011	2012	2013	2014	2015	2016
1. Telecom Services						
1.1 Fixed Lines	161,063	176,367	164,999	151,274	142,819	129,597
1.2 Mobile	25,666,455	27,450,789	27,442,823	31,862,656	39,665,600	40,044,186
Subtotal (1)	25,827,518	27,627,156	27,607,822	32,013,930	39,808,419	40,173,783
Penetration	59%	61%	61%	71%	79%	80%
2. Internet Services						
2.1 Fixed Wireless	968,088	777,461	1,056,940	1,913,082	662,882	1,218,693
2.2 Mobile Wireless	3,665,680	6,031,323	7,493,823	11,320,031	16,280,943	18,014,358
2.3 Fixed Wired	677,450	712,095	761,508	984,198	319,698	629,474
Subtotal (2)	5,311,218	7,520,878	9,312,272	14,217,311	17,263,523	19,862,525
Penetration	12%	17%	21%	29%	34%	40%

Source: Tanzania Communication Regulatory Authority, Quarterly Communications Statistics Report, December 2016

It is notable that mobile money services such as M-Pesa, Tigo Pesa, and Airtel Money are rapidly expanding over the country because of i) bridging the vast distances among people, enabling much lower

thresholds for profitable service provision, enhancing convenience of service, reducing delivery times, and making payments for services such as electricity and make international money transfers.

2.8.5 Economic Development Corridors

Tanzania has broadly four economic development corridors: TAZARA Corridor, Central Corridor, Tanga Corridor, and Mtwara Corridor. Table 2.8.9 summarizes the regional coverage and major transport infrastructures by each economic development corridor.

Table 2.8.9 Regional Coverage and Major Transport Infrastructures by Economic Development Corridor

Development Corridor	Region Covered	Major Roads	Railway	Port and Airport
TAZARA (SAGCOT)	Dar es Salaam, Pwani, Morogoro, Iringa, Njombe, Ruvuma, Mbeya, Katavi and Rukwa	Dar es Salaam - Morogoro – Iringa – Mbeya – Tunduma	・ TAZARA Line	・ Dar es Salaam Port ・ Julius Nyerere I.A. ・ Songwe I.A.
Central	Dodoma, Singida, Tabora, Kigoma, Shinyanga, Simiyu, and Mwanza	Dar es Salaam –Morogoro – Dodoma – Tabora – Kigoma – Mwanza	・ TRC Central Line ・ TRC Mwanza Line ・ TRC Mpanda Line	・ Kigoma Lake Port ・ Mwanza Lake Port ・ Mwanza I.A.
Tanga	Tanga, Kilimanjaro, Arush, Manyara, Mara and Kagera	Dar es Salaam – Chalinze – Tanga – Moshi – Arusha – Singida – Nzega - Mwanza	・ TRC Tanga Line ・ TRC Link Line	・ Tanga Port ・ Kilimanjaro I.A.
Mtwara	Lindi and Mtwara	Dae es Salaam – Lindi – Mtwara	・ None	・ Mtwara Port

Source: JICA Project Team

TAZARA development corridor, also known as Southern Agriculture Growth Corridor of Tanzania (SAGCOT), has been initiated by the government to promote commercial agriculture in accordance with SAGCOT plan targeting the year of 2030. In such an approach as SAGCOT, it is expected for other corridors to accelerate the regional economy including the agricultural sector.

Chapter 3 Present Conditions of Water Sector

3.1 General

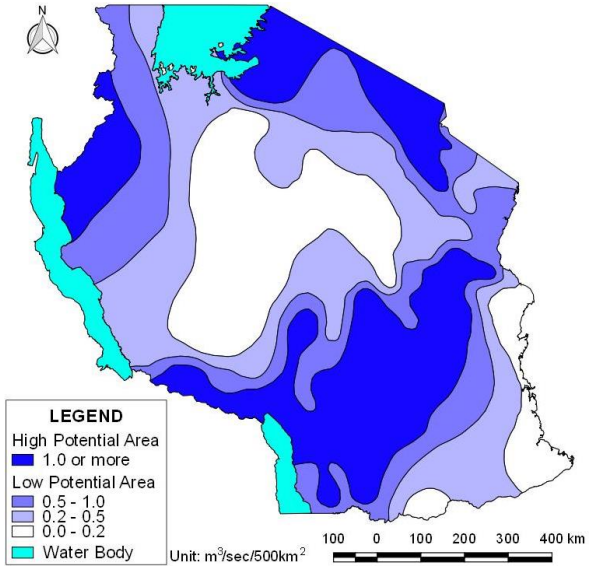
(1) Necessity of Water Resources Study in National Irrigation Master Plan 2018

Water resources is thought to be one of the possible bottlenecks in irrigation development in the National Irrigation Master Plan 2018 (NIMP2018). In order to appropriately evaluate irrigation potential, it is essential to understand water resources availability spatially and seasonally.

Since the Integrated Water Resources Management and Development Plans (IWRMDP) have been formulated by the Ministry of Water and Irrigation (MoWI) as described later, the NIMP2018 project will fully utilize those information in making water resources assessment required for the NIMP2018.

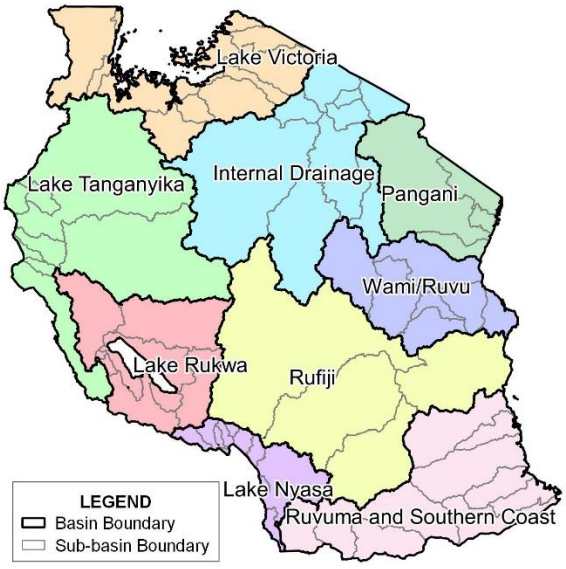
(2) Outline of the Water Resources Assessment in National Irrigation Master Plan 2002

The National Irrigation Master Plan 2002 (NIMP2002) study assessed the water resources potential mainly from the factors including macroscopic water balance, specific runoff, flow regime, and groundwater. The water resources potential was then assessed from the three points of view, namely: 1) quantitative potential of water in natural condition, 2) allowable water quantity under the artificial control, and 3) seasonal steadiness of water availability. The water resources potential estimated in the NIMP2002 is presented in Figure 3.1.1.



Source: Prepared by the JICA Project Team based on NIMP2002

Figure 3.1.1 Water Resources Potential Estimated in NIMP2002



Source: JICA Project Team based on Information by MoWI

Figure 3.1.2 Basin and Sub-basin Boundaries

(3) Basin and Sub-basin Boundary

The mainland of Tanzania is divided into nine basins and further divided into 71 sub-basins as presented in Figure 3.1.2. Basic information on the nine basins are summarised in Table 3.1.1. Since water resources management and development are undertaken on the basis of river basins, the study on water resources in the NIMP2018 also made a basin-wise or sub-basin-wise. The catchment areas of respective

sub-basins to be used in this study are based on the information provided by MoWI.

Table 3.1.1 Basic Information of Nine Basins

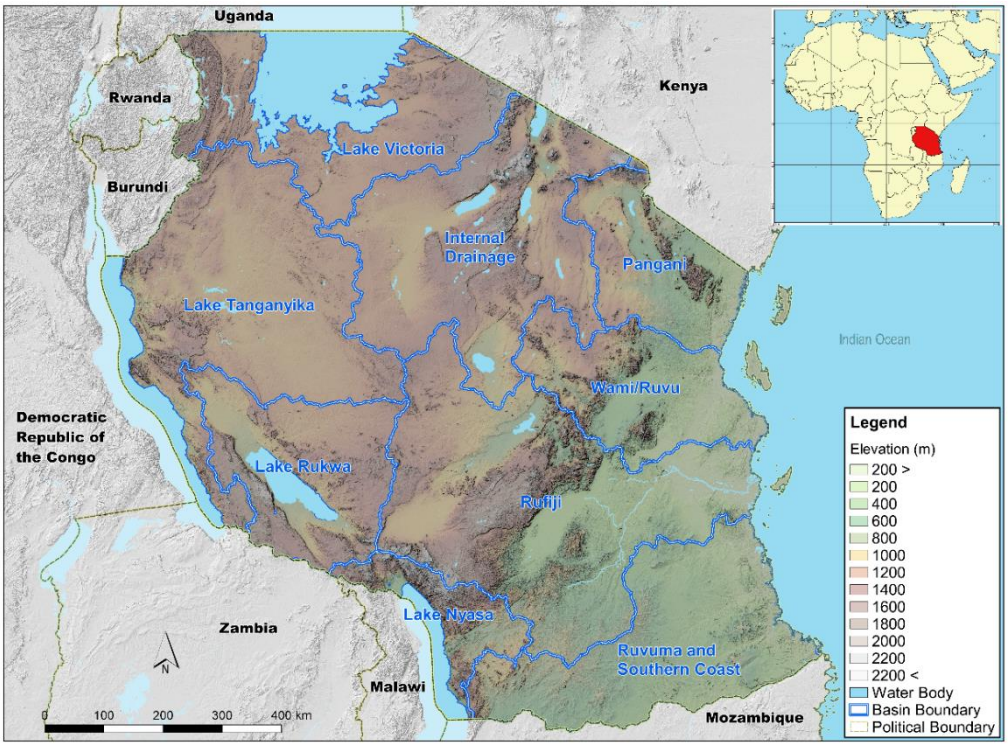
No.	Basin Name	Basin Code*1	Catchment Area (km²)*2	Nos. of Sub-basin	Drainage System
I	Pangani	PG	59,102	4	Indian Ocean
II	Wami / Ruvu	WR	66,295	7	Indian Ocean
III	Rufiji	RF	183,791	4	Indian Ocean
IV	Ruvuma and Southern Coast*3	RV	105,582	10	Indian Ocean
V	Lake Nyasa	LN	27,594	10	Indian Ocean
VI	Lake Rukwa	LR	74,965	7	Endorheic basin
VII	Lake Tanganyika	LT	149,500	7	Atlantic Ocean
VIII	Lake Victoria	LV	85,630	13	Mediterranean Sea
IX	Internal Drainage	ID	143,100	9	Endorheic basin
---	Total	---	895,559	71	---

*Notes: *1. Basin code used in this report is provided by the NIMP2018 study and it is not an official code.*
**2. Catchment areas are based on the respective IWRMDPs and LVBC reports described in Subsection 3.4.1. It is noted that the total of catchment areas is different from the mainland area.*
**3. The Ruvuma and Southern Coast basin is simply called as "Ruvuma basin" hereafter referred in this report.*
Source: Prepared by the JICA Project Team based on information provided by MoWI

3.2 Natural Conditions

3.2.1 Geographical Features

Tanzania is located just south of the equator, lying mostly between latitudes 1° and 12°S, and longitudes 29° and 41°E. Its mainland has an area[1] of 883,600 km². Tanzania has complex topographical features extending from a narrow coastal belt of the western Indian Ocean with sandy beaches to an extensive plateau with altitude ranging from 1,000 to 2,000 m above mean sea level. Tanzania has several fresh water bodies, including Lake Victoria, the largest in Africa; Lake Tanganyika, the longest and deepest in Africa; and Lake Nyasa. Figure 3.2.1 below presents topographic map depicting the above features.



Source: JICA Project Team based on the SRTM data

Figure 3.2.1 Topographic Map with Basin Boundaries

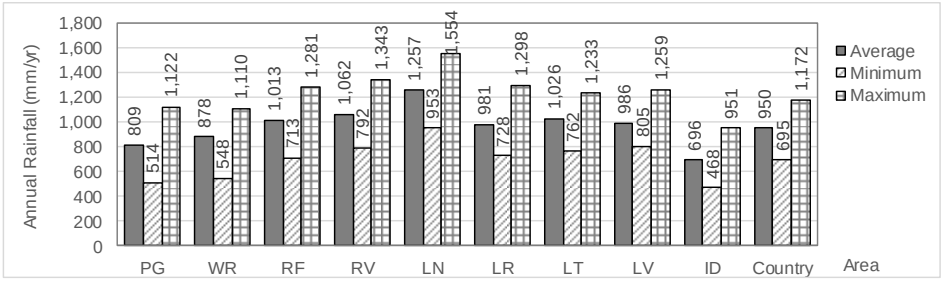
[1] Tanzania in Figures 2015 (National Bureau of Statistics, January 2016)

3.2.2 Hydrometeorological Features

(1) Rainfall

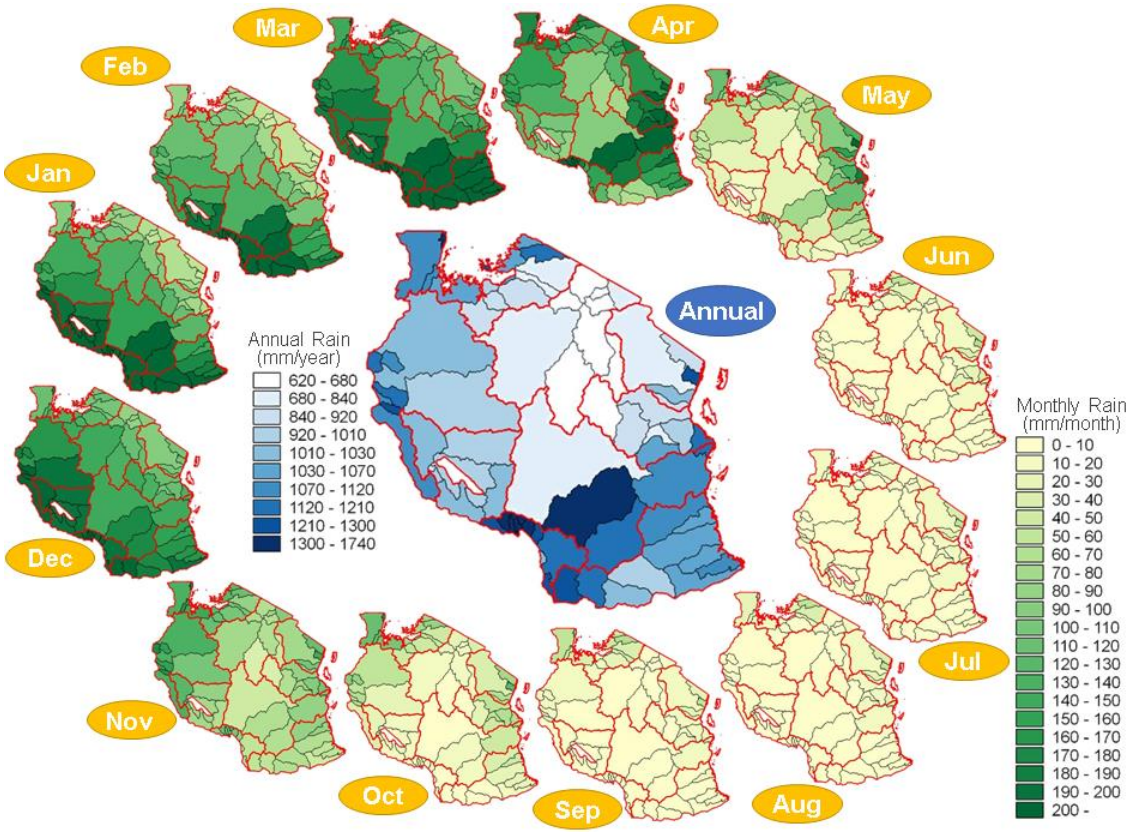
According to the Tanzania Meteorological Agency (TMA)[2], the climate of Tanzania is characterised by two main rain seasons, namely: the long rains (*Masika*) that fall from mid-March to end-May and the short rains (*Vuli*) that begin in mid-October and continues to early December.

Figure 3.2.2 presents the annual mean rainfall for 30 years from 1981 to 2010 by basin, while Figure 3.2.3 presents the annual and monthly mean rainfall for the same period by sub-basin. The highest rainfall is observed in the month of March with a national average of 172 mm/month. In addition to the seasonal distribution, both Figure 3.2.2 and Figure 3.2.3 show spatial unevenness. Some of the sub-basins receive relatively high rainfall of more than 1,500 mm/yr, although national average is 950 mm/yr.



Source: Prepared by the JICA Project Team based on CHIRPS data provided by CHG[3]

Figure 3.2.2 Annual Rainfall Data by Basin (1981-2010)



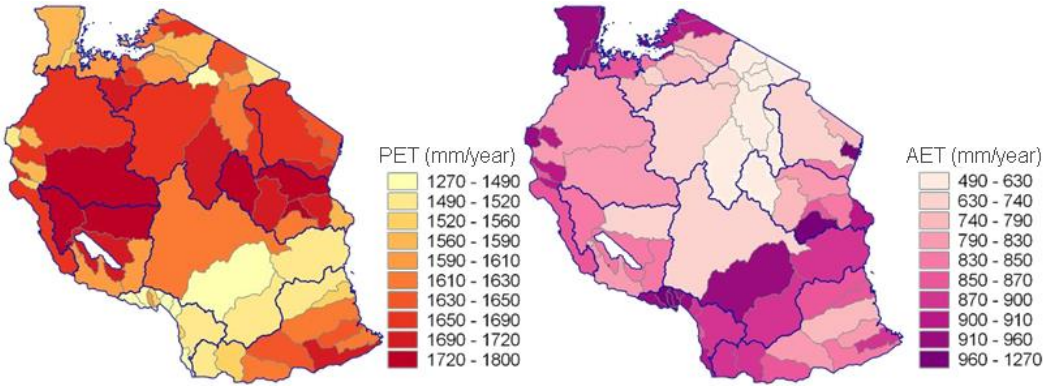
Source: Prepared by the JICA Project Team based on CHIRPS data provided by CHG

Figure 3.2.3 Annual and Monthly Rainfall by Sub-basin (1981-2010)

[2] Climate Change Projection for Tanzania, ISBN 978-9987-9981-0-5. pp.2 (Tanzania Meteorological Agency)
[3] Climate Hazards Group InfraRed Precipitation with Station Data (CHIRPS), Climate Hazards Group (CHG)

(2) Evapotranspiration

Figure 3.2.4 presents the potential evapotranspiration (PET) and actual evapotranspiration (AET). The national averages of PET and AET are 1,633 mm/yr and 771 mm/yr, respectively. Relatively high PET is observed in the Wami/Ruvu, Lake Rukwa, and Lake Tanganyika basins, where air temperature is higher. On the other hand, higher AET is observed in the Rufiji, Lake Nyasa, and Lake Victoria basins, where rainfall is higher.

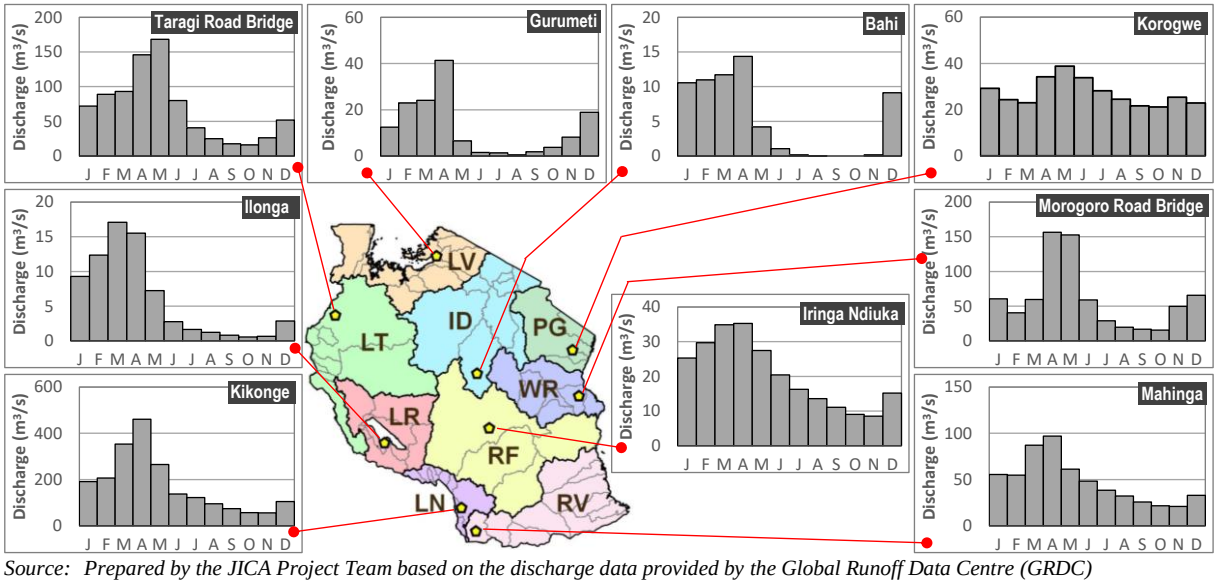


Source: Prepared by the JICA Project Team based on PET and AET data provided by CGIAR-CSI[4]

Figure 3.2.4 Annual PET and AET by Sub-basin (1950-2000)

(3) Hydrology

Figure 3.2.5 presents the mean monthly river discharge at some selected monitoring stations representing the respective nine basins. Basic information of the stations is presented in Appendix A. Although the data are a bit old and actual hydrological phenomena usually differ depending on the locations even in the same basin, the hydrographs below reasonably represent hydrological features.



Source: Prepared by the JICA Project Team based on the discharge data provided by the Global Runoff Data Centre (GRDC)

Figure 3.2.5 Mean Monthly Discharge at Selected Stations

[4] Consultative Group on International Agricultural Research (CGIAR) Consortium for Spatial Information (CSI)

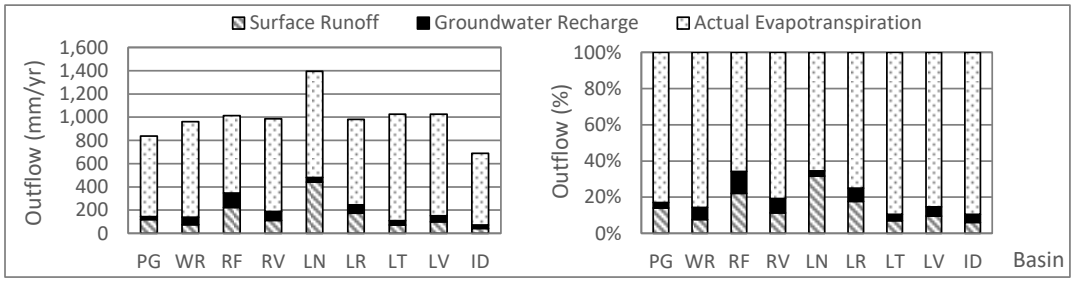
3.2.3 Macroscopic Water Balance in the Country

Prior to assessment of water resources potential, it is essential to understand a general feature of water balance in the entire Tanzania. In considering a hydrological cycle, inflow is defined as rainfall, while outflow is divided into surface runoff, groundwater recharge and actual evapotranspiration. The result is summarised in Table 3.2.1 and Figure 3.2.6.

Table 3.2.1 Macroscopic Water Balance by Basin

No.	Basin	Catchment Area (km^2)	Inflow (mm/yr)	Outflow (mm/yr)		
			Rainfall*1	Surface Runoff*2	Groundwater Recharge*3	Actual Evapo-transpiration*4
I	Pangani	59,102	838	118	25	695
II	Wami / Ruvu	66,295	961	73	64	823
III	Rufiji	183,791	1,013	223	123	667
IV	Ruvuma	105,582	987	111	79	797
V	Lake Nyasa	27,594	1,394	442	39	913
VI	Lake Rukwa	74,965	981	173	71	737
VII	Lake Tanganyika	149,500	1,026	71	37	918
VIII	Lake Victoria	85,630	1,027	99	52	877
IX	Internal Drainage	143,100	689	42	31	616
Total (km^2) / Ave. (mm/yr)		895,559	955	128	64	763

*Notes: *1. Rainfall is provided by the IWRMDP reports and LVBC report (or CHIRPS (CHG) data for Nos. III, VI and VII).*
**2. Surface runoff is 2015 data presented in the IWRMDP reports and LVBC report. Details are described in Subsection 3.7.1(1).*
**3. Groundwater recharge is provided by the IWRMDP reports and LVBC report. Details are described in Subsection 3.7.1(2).*
**4. AET is estimated by deducting surface runoff and groundwater recharge from rainfall.*
Source: JICA Project Team based on the abovementioned data



Note: The left-side figure is shown in mm/yr and the right-side figure is shown in percentage (%).
Source: JICA Project Team based on the data mentioned in Table 3.2.1 above

Figure 3.2.6 Macroscopic Water Balance by Basin

3.3 Relevant Policies and Strategy

(1) Tanzania Development Vision 2025

The Tanzania Development Vision 2025 aims at achieving a high quality livelihood for its people, attaining good governance through the rule of law, and developing a strong and competitive economy. Water is positioned as one of the most important agents to enable the country to achieve its objectives of both social and economic development, such as eradicating poverty, attaining water and food security, and sustaining biodiversity and sensitive ecosystems.

(2) National Water Policy

The first National Water Policy (NAWAPO) was developed in 1991. In response to many changes in circumstances surrounding the water sector, thereafter, the government revised the policy in 2002 with the main objective of developing a comprehensive framework for sustainable development and

management of the nation's water resources. NAWAPO 2002 states key considerations on priority on water use and the utilization of transboundary water resources.

(3) National Water Sector Development Strategy 2006-2015

The National Water Sector Development Strategy 2006-2015 (NWSDS) sets out how the NAWAPO 2002 will be implemented to achieve its targets. NWSDS has been developed to support re-alignment of the water-related aspects of other key sectoral policies with NAWAPO, and to provide a focus on specific roles of the various actors through clearly defining roles and responsibilities and hence, the removal of duplications and omissions.

(4) Water Sector Development Programme 2006-2025

The Water Sector Development Programme 2006-2025 (WSDP) follows a sector wide approach to planning (SWAP) with an overall objective of strengthening sector institutions for integrated water resources management and improve access to water supply and sanitation services.

Because of the long-term nature of the program, its implementation is done in phases of five years each. Currently, Phase II is being implemented for the period 2014/15-2018/19. As part of the WSDP Phase II, IWRMDPs for the respective nine basins are to be formulated.

(5) Water Resources Management Act, 2009

In order to provide the enabling legislative framework for implementing NAWAPO and NWSDS, the Water Resources Management Act No. 11 of 2009 (WRMA) was enacted in 2009. The WRMA provides new legislative framework in order to realise the integrated water resources management and development with the initiative of administratively and financially autonomous Basin Water Boards (BWB) and participation of water users.

3.4 Existing Plans and Studies

3.4.1 IWRMDP

(1) Basic Information on IWRMDP Formulation

As part of the WSDP for the period 2006-2025, MoWI has been formulating IWRMDP for the respective nine basins with a planning horizon of 2035.

The IWRMDPs were formulated with due consideration to the projected irrigation water demand for 2035 by inquiring necessary information from each zonal irrigation office (ZIO), according to the MoWI.

(2) Status of IWRMDP Formulation

As summarised in Table 3.4.1, water resources assessment and/or formulation of IWRMDP for three basins have not yet been completed. In case of the Lake Victoria basin, even assessment study has not commenced yet. However, the Lake Victoria Basin Commission (LVBC) conducted a study for Lake Victoria Basin Water Resources Management Plan - Phase 1 in 2014 (hereinafter called the LVBC study). The study assessed available water resources and projected future water demand by sub-basin for the entire catchment area covering the Lake Victoria basin of Tanzania. NIMP2018 utilizes the result of LVBC study instead of IWRMDP for the Lake Victoria basin.

Table 3.4.1 Status of IWRMDP Formulation in Nine Basins

No.		I	II	III	IV	V	VI	VII	VIII	IX
Basin Name (Basin Code)		Pangani (PG)	Wami/ Ruvu (WR)	Rufiji (RF)	Ruvuma (RV)	Lake Nyasa (LN)	Lake Rukwa (LR)	Lake Tan-ganyika (LT)	Lake Victoria (LV)	Internal Drainage (ID)
Status (Fund Source*)	WR Assessment	Complete (WB)	Complete (JICA)	Complete (WB)	Complete (WB)	Complete (WB)	Complete (WB)	Complete (WB)	Not yet (GoT)	Complete (WB)
	Formulation of IWRMDP	Not yet (TBD)	On-going (WB)	Complete (WB)	Complete (WB)	Complete (WB)	Complete (WB)	Complete (WB)	Not yet (GoT)	Complete (WB)

Notes: WR: Water Resources, WB: World Bank, JICA: Japan International Cooperation Agency, GoT: Government of Tanzania, TBD: To be determined
Source: JICA Project Team based on interview with MoWI

(3) Water Balance Method by Basin

The IWRMDPs for the nine basins have been/ will be prepared by different consultant firms after much discussion with the respective basin water offices (BWOs). Although the term of references (TORs) for their consulting services are similar among the basins, the respective firms adopted different methodologies. There has been no document that compares or summarises the differences in their methods. It is necessary to look over the study results horizontally in the NIMP2018 considering its target area of entire Tanzania mainland, while due consideration of regional characteristics is also important in water resources planning. The basic conditions in terms of input for water balance calculation are summarised in Table 3.4.2.

Table 3.4.2 Basic Conditions of Water Balance Calculation

(No.) Basin Code	Water Balance Calculation Basis	Supply Side						Demand Side (Sectors considered in balance calculation)								
		Surface Runoff					Ground-water									
		Estimation*1			Reliability of Water Utilization	Period of Used Hydro Data	Consi-dered in Water Balance	Domestic & Institute	Industry & Mining	Irrigation	Livestock	Wildlife	Tourism	Fisheries & Aquaculture	Hydropower	Environment Flow
		2015	2025	2035												
(I) PG	Monthly long-term*2	O	O	O	Mean runoff	1952-2011	Yes	✓	✓	✓	✓	✓	✓	---	---	✓
(II) WR	Monthly (selected year)	O	X	X	1/10 drought year runoff	1951-1980	Yes	✓	✓	✓	✓	---	---	✓	---	✓
(III) RF	Monthly long-term	O	Gr	Gr	Mean runoff	1950-2011	Yes	✓	✓	✓	✓	---	---	---	✓*3	✓
(IV) RV	Monthly long-term*2	O	O	O	Mean runoff / 80% dependable	1959-1994	Yes	✓	---	✓	✓	✓	---	---	---	✓
(V) LN	Monthly (mean value)	O	O	O	Mean runoff	1950-2012	Yes	✓	✓	✓	✓	---	---	---	✓*3	✓
(VI) LR	Monthly long-term	O	Gr	Gr	Mean runoff	1956-2013	No	✓	✓	✓	✓	---	---	---	---	✓
(VII) LT	Annual	O	O	O	Mean runoff	1974-2002	Yes	✓	✓	✓	✓	✓	✓	---	✓	✓
(VIII) LV	Annual	O	X	X	Mean runoff	1967-2013	No	✓	✓	✓	✓	---	---	✓	---	---
(IX) ID	Monthly long-term	O	O	O	Mean runoff	1953-1999	Yes	✓	✓	✓	✓	✓	✓	✓	✓*3	✓

*Notes: *1. The symbols "O" / "X" / "Gr" denote "estimated" / "not estimated" / "presented in a form of hydrograph", respectively.*
**2. Although the reports do not clearly mention, it is presumably long-term basis computation.*
**3. Although hydropower water demand is estimated, it is treated as non-consumptive water in water balance calculation.*
Source: Summarised by the JICA Project Team based on the LVBC study and IWRMDPs reports

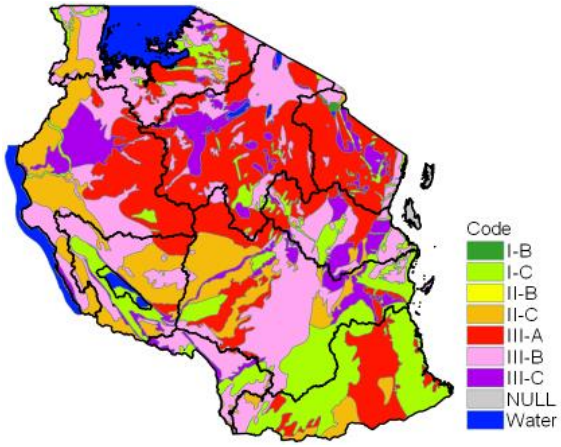
3.4.2 Other Studies Related to Water Resources

(1) Groundwater

Aside from the groundwater assessment made by the respective IWRMDP studies, some information on country-wise groundwater assessments were obtained from the previous studies as follows:

(a) Groundwater Productivity Map, Sub-saharan Africa Hydrological Assessment

Figure 3.4.1 shows the distribution of productive aquifer in the mainland of Tanzania. Most of the northern parts are low to fairly productive formations. On the other hand, highly and moderately productive aquifers are distributed mainly in the southern part of the country.



Code	Aquifer Productivity	Amount
I-B	Highly productive aquifer	10-50 l/s
I-C	Moderately productive aquifer	0.1-15 l/s
II-B	Moderately productive aquifer	5-20 l/s
II-C	Locally productive aquifer	0.1-10 l/s
III-A	Low to fairly productive aquifer	> 1 l/s and < 4 l/s
III-B	Low yielding formations	0-1 l/s
III-C	Unproductive aquifer	0 l/s
Null	No data	---
Water	Water body	---

Source: Sub-saharan Africa Hydrological Assessment (SADCC Countries), World Bank, and UNDP
Note: The original map provided in a Tiff format was digitized and coloured by the JICA Project Team.

Figure 3.4.1 Groundwater Productivity Map

(b) Assessment of Groundwater Availability and its Current and Potential Use and Impacts

The IWMI (2010)[5] assesses groundwater availability, potential use and impacts in Tanzania by reviewing existing reports and data. According to the report, groundwater has not been extensively used for irrigation largely due to the lack of detailed information.

(2) Environmental Flow Requirement

(a) Draft Guideline on Environmental Flow Assessment

The MoWI is currently preparing a draft guideline on environmental flow assessment (EFA). The draft guideline introduces a general review of methodologies in four major groups: i) hydrology-based methodologies; ii) hydraulic rating methodologies; iii) habitat simulation methodologies; and iv) holistic methodologies.

(b) Practical Example of EFA

The Comprehensive EFAs are only available in the Ruvu River basin[6] and the Kilombero River basin[7] so far done by collaborative body with technical and financial assistance from the United States Agency for International Development (USAID). Both assessments were made after the completion of

[5] IWMI (International Water Management Institute), 2010, Assessment of Groundwater Availability and Its Current and Potential Use and Impacts in Tanzania
[6] Environmental Flow Recommendations for the Ruvu River Basin, Tanzania (USAID, 2014)
[7] Environmental Flows in the Rufiji River basin Assessed from the Perspective of Planned Development in the Kilombero and Lower Rufiji Sub-basins (USAID, 2016)

IWRMDPs for Wami/Ruvu and Rufiji basins, respectively. In general, a detailed EFA study covers only a particular river basin. For this reason, the said assessments do not cover the entire basin areas of Wami/Ruvu and Rufiji.

(3) Climate Change

TMA reports[8] climate change projections for Tanzania. The conclusions are summarised as follows:

- The country is projected to experience consistent and sustained warming from 2025 to 2100, with the warming being more pronounced over the south-western highland and over the western parts, where a warming of up to 3.8 °C is projected by 2100.
- Although less confidence can be placed in model output for rainfall changes, most of the models suggest an increase in mean annual rainfall of up to 11% in 2100, particularly over the north-eastern highland.
- Seasonal rainfalls for every three months are projected to decrease or increase depending on areas and seasons.

3.5 Water Resources Structures

(1) Existing Dams

A list of both man-made and natural existing reservoirs was collected from MoWI. The list contains 694 dams and the total capacity excluding hydropower plant (HPP) dams is 425.9 MCM as summarised in Table 3.5.1. Since the list was prepared for the purpose of dam safety study, small-scale dams and water pans are not included in the list.

Table 3.5.1 Number and Reservoir Capacity of Existing Dams

Basin*1	Nos. of Dams				Reservoir Capacity (MCM)
	All Dams in the List	Dams with Positional Information*2	Dams with Capacity Data		
				Excluding HPP*3	Excluding HPP
Pangani	131	120	118	117	49.1
Wami Ruvu	157	136	134	134	40.9
Rufiji	67	67	67	65	79.8
Ruvuma	62	59	58	58	19.1
Lake Tanganyika	35	34	34	34	50.3
Lake Victoria	139	129	127	127	78.5
Internal Drainage	103	87	84	84	108.2
Total	694	632	622	619	425.9

*Note: *1. Although the Lake Nyasa and Lake Rukwa basins have storage dams, an inventory survey has not been conducted in the basins.*
**2. The dams with questionable coordinates data that indicate different position from the basin or district mentioned in the list were excluded in the second column and later because the coordinates data are not able to correctly identify sub-basin.*
**3. There are only three reservoir type hydropower plants (HPP), namely: Nyumba ya Mungu Dam (600 MCM) in Pangani Basin, Mtera Dam (3,200 MCM) and Kidatu Dam (125 MCM) in Rufiji Basin. All of them are single purpose dams for hydropower.*
Source: 1. List of existing dams (As of November 2016, MoWI)
2. Power System Master Plan 2016 Update (Dec. 2016, Ministry of Energy and Minerals)

(2) Planned Dams

The IWRMDP studies for the respective basins proposed 69 dams in total except for hydropower single purpose dams. These proposals include new construction and heightening of existing dykes. Among

[8] Climate Change Projection for Tanzania, ISBN 978-9987-9981-0-5. pp.37 (Tanzania Meteorological Agency)

these, the MoWI has completed the construction designs of three major dams, namely: Kidunda, Farkwa, and Ndembera (Lugoda) dams.

On the other hand, Tanzania Electric Supply Company Limited (TANESCO)[9] has 23 projects for large- and medium-scale HPP according to the Power System Master Plan 2016 Update. Out of these, the Kikonge HPP is the only multi-purpose dam for hydropower and irrigation purposes. The project is in collaboration between the National Irrigation Commission (NIRC) and TANESCO.

The total reservoir capacity of the above planned 70 dams is 8,723 MCM, although the allocation for each sector is not mentioned in the reports. The list of planned dams is presented in Attachment-3.5.1.

3.6 Water Resources Management at the Basin Level

The JICA Project Team conducted field visit in the course of study for the principal purpose of data collection from the BWOs. Since the purpose of visit is the collection of data that are hardly obtainable through the existing reports, the visit areas were limited to four basins, namely: the Pangani, Wami/Ruvu, Rufiji, and Lake Victoria basins. The major findings obtained through interviews with BWOs and the field surveys are listed below.

(1) Hydrological Monitoring

- It was found in the Pangani, Rufiji, and Lake Victoria basins that some malfunctioning devices are left unrepaired.
- Pangani BWO has current meters and Q-liner, which is a type of Acoustic Doppler Current Profiler (ADCP), and conducts discharge measurement regularly. However, rating curves have not been updated since the initial development in 1994.

(2) Data Management in BWO

- Each BWO uses either HYDATA[10] or DSS[11] as database for hydrological data. The data are stored in different database and format depending on the BWO.
- Groundwater data, such as list of boreholes, are not well prepared and updated by BWOs. Besides, each BWO uses a different format and has so many missing data.

(3) Water Use Management

- Neither BWO nor water users monitor the actual amounts of water abstraction. In addition, BWO is not able to verify water abstraction applied by water users due to lack of data, such as available amount of water at an intake point, actual water abstraction, etc.
- Although water use permit needs to be granted on a seasonal basis, the Pangani and Lake Victoria BWOs grant the permits throughout the year.
- BWOs recognize many non-approved water users in their basin. Consequently, appropriate water fee is not collected from those users.

[9] TANESCO is a parastatal organisation under the Ministry of Energy and Minerals.
[10] HYDATA is a database and analysis system for processing the hydrometeorological data, including river water levels and flows, reservoir, lake and tank levels and storages, rainfall, and so forth.
[11] Decision Support System (DSS) is a comprehensive information, modeling, and decision support software for basin management.

3.7 Water Resources Assessment

3.7.1 Estimation of Water Resources

(1) Surface Water Resources

(a) Approach for Utilizing the Previous Study Results

Many of the IWRMDP and LVBC study reports do not present numerical data of the estimated monthly surface runoff. Some reports present only annual basis data, but others present monthly basis data in a form of hydrograph, which is hardly referable in the NIMP2018 study. Thus, there was a need to re-generate monthly surface runoff data by using available information clearly mentioned in the reports as well as supplementally applying public hydrological data. The details of method of re-generating mean monthly surface runoff are explained in Appendix A.

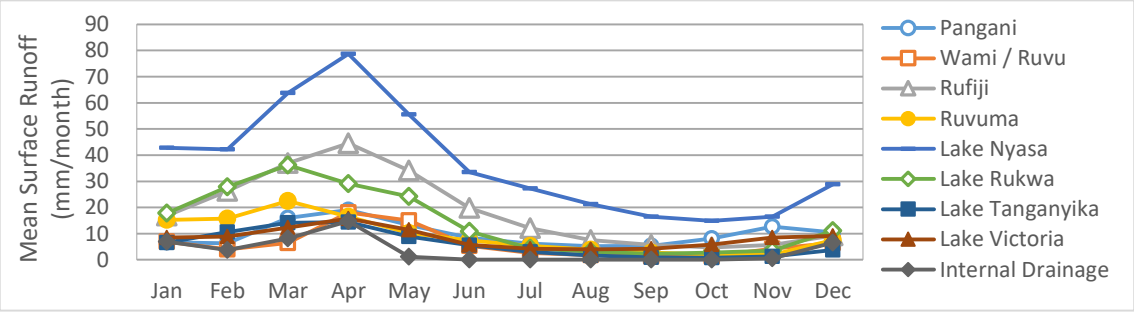
(b) Result of Re-generating Mean Monthly Surface Runoff

Table 3.7.1 and Figure 3.7.1 present the summary of mean monthly surface runoff by basin for 2015.

Table 3.7.1 Mean Monthly Surface Runoff by Basin for 2015

Basin	Area (km^2)	Surface Runoff (mm/month for each month and mm/yr for total)													Rain (mm/yr)	RC*1
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total		
Pangani	59,102	6.7	6.3	16.0	19.0	13.3	8.3	6.2	5.3	5.4	8.2	12.7	10.4	117.8	809	0.15
Wami / Ruvu	66,295	6.9	4.0	6.5	18.1	15.0	5.3	2.6	1.7	1.3	1.2	4.3	6.5	73.4	878	0.08
Rufiji	183,791	16.8	26.3	36.9	44.5	34.1	19.8	12.1	7.6	5.8	4.7	5.6	9.2	223.3	1,013	0.22
Ruvuma	105,582	15.2	15.7	22.5	16.5	10.2	7.4	5.3	3.9	2.7	2.0	1.9	7.6	110.8	1,062	0.10
Lake Nyasa	27,594	42.7	42.2	63.7	78.7	55.5	33.5	27.2	21.3	16.5	14.9	16.4	28.9	441.7	1,257	0.35
Lake Rukwa	74,965	17.8	27.9	36.2	29.1	24.2	10.8	4.3	3.1	2.3	2.7	3.5	11.1	173.2	981	0.18
Lake Tanganyika	149,500	6.5	10.6	14.2	14.3	8.9	5.5	3.0	1.6	0.9	0.7	1.2	3.7	71.2	1,026	0.07
Lake Victoria	85,630	8.5	8.9	12.3	15.8	11.4	5.7	4.2	4.0	4.3	5.8	8.6	9.1	98.6	986	0.10
Internal Drainage	143,100	6.9	3.8	8.1	14.8	1.2	0.0	0.0	0.0	0.0	0.0	0.5	6.6	41.8	696	0.06
Average	---	12.0	14.8	21.6	24.8	16.7	9.3	5.8	4.1	3.2	3.2	4.4	8.3	128.2	950	0.13

*Note: *1. Since rainfall data is average for 30 years from 1981 to 2010, the above runoff coefficients (RC) are only for reference.*
Source: Re-generated by the JICA Project Team based on the IWRMDP reports and the LVBC study report

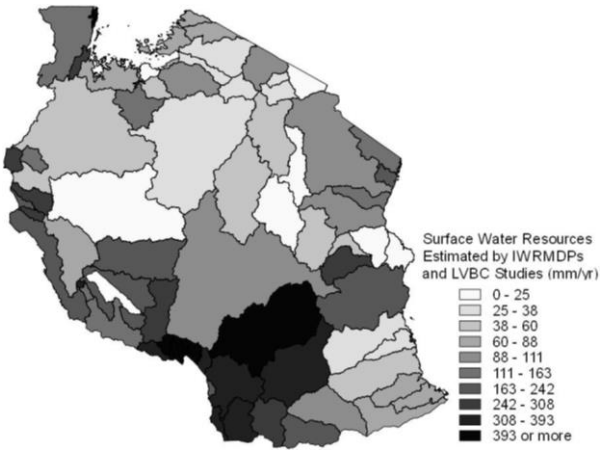


Source: Re-generated by the JICA Project Team based on the IWRMDP reports and the LVBC study report

Figure 3.7.1 Mean Monthly Surface Runoff by Basin for 2015

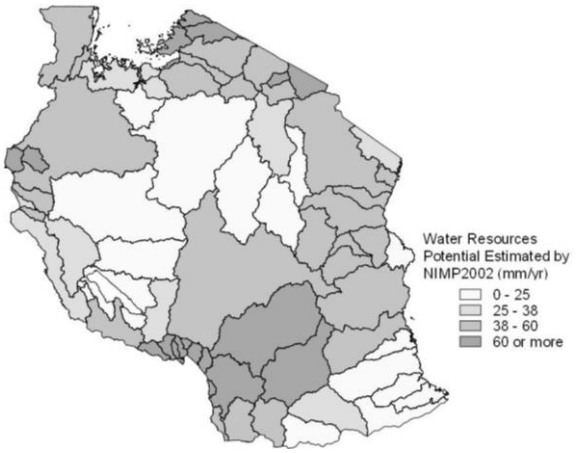
The annual surface water for 2015 by sub-basin is presented in Figure 3.7.2. Besides, water resources potential estimated by NIMP2002, which is presented with the unit of m^3/sec/500 km^2 in Figure 3.1.1 at the beginning of this chapter, is converted to the unit of mm/yr and presented in Figure 3.7.3 by sub-basin. Since the maximum potential value of NIMP2002 is given as 1.0 m^3/sec/500 km^2, which is equivalent to 63 mm/yr, Figure 3.7.3 is able to show only up to 63 mm/yr. Although there is such a difference, both maps indicate relatively high water potential in the Rufiji, Lake Nyasa, and Lake

Tanganyika basins compared with the others from a broader perspective.



Source: JICA Project Team based on the IWRMDP & LVBC reports

Figure 3.7.2 Surface Water Resources for 2015 Compiled by NIMP2018

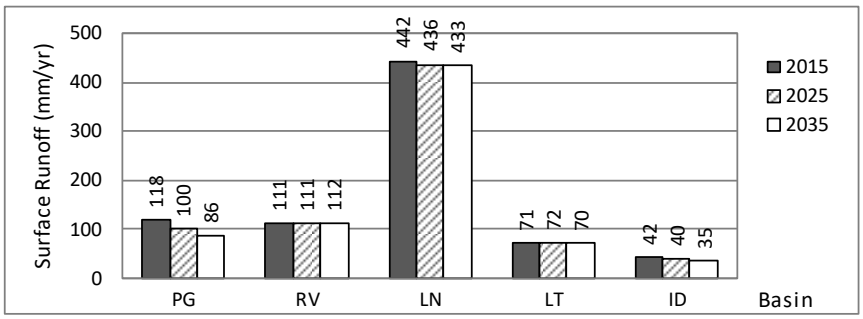


Source: JICA Project Team based on NIMP2002

Figure 3.7.3 Water Resources Potential Compiled by NIMP2002

(c) Impact of Climate Change

Runoff data with climate change effect is available only for five basins. The annual surface runoff for the five basins is presented in Figure 3.7.4. It was found that the rates of increase or decrease from 2015 to 2035 in the Ruvuma (RV), Lake Nyasa (LN), and Lake Tanganyika (LT) basins fall within 2%. On the other hand, the decrease rates are relatively large in the Pangani (PG) and Internal Drainage (ID) basins with the rates of 27% and 17%, respectively.



Source: Prepared by the JICA Project Team based on the IWRMDP reports

Figure 3.7.4 Surface Runoff with Climate Change by Basin

In view of uncertainty of climate change phenomena as well as the relatively small change rates obtained from the above five basins, it would be acceptable for the NIMP2018 study to apply the 2015 surface runoff data for the years 2025 and 2035 in the remaining four basins.

(2) Groundwater Resources

(a) Approach for Utilizing the Previous Study Results

Groundwater resources potential have been assessed in the IWRMDPs studies for the respective basins and the LVBC study. Prior to determining sustainable yield of groundwater resources, firstly, annual groundwater recharge was estimated in all the basins with different methods. However, since there was considerable difference in recharge data between basins, groundwater recharge for the four basins were further reviewed and re-assessed. The basic methods of recharge estimation by each basin and the details

of re-assessment are explained in Appendix A.

(b) Result of Re-assessing Groundwater Data

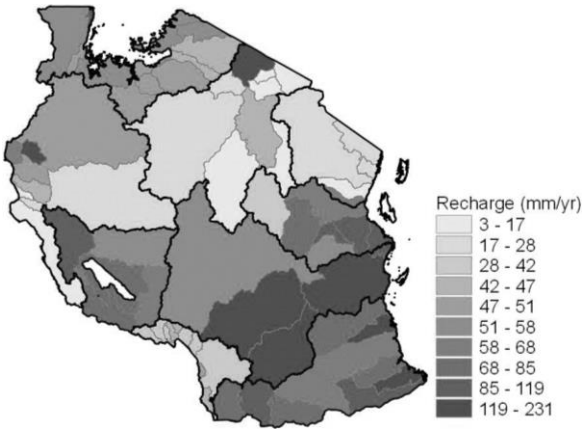
As a result of compiling and re-assessing groundwater (GW) data as above, finally, annual groundwater recharge and sustainable yield of groundwater resources are obtained as given in Table 3.7.2.

Table 3.7.2 Annual Recharge and Sustainable Yield

Basin	Area (km^2)	Annual GW Recharge		Sustainable Yield of GW Resources	
		(MCM/yr)	(mm/yr)	(MCM/yr)	(mm/yr)
Pangani	59,102	1,466	25	587	10
Wami / Ruvu	66,295	4,273	64	1,139	17
Rufiji	183,791	22,533	123	9,021	49
Ruvuma	105,582	8,307	79	3,238	31
Lake Nyasa	27,594	1,070	39	107	4
Lake Rukwa	74,965	5,341	71	2,136	28
Lake Tanganyika	149,500	5,511	37	2,755	18
Lake Victoria	85,630	4,424	52	1,327	15
Internal Drainage	143,100	4,421	31	884	6
Total	895,559	84,322	94	21,195	24

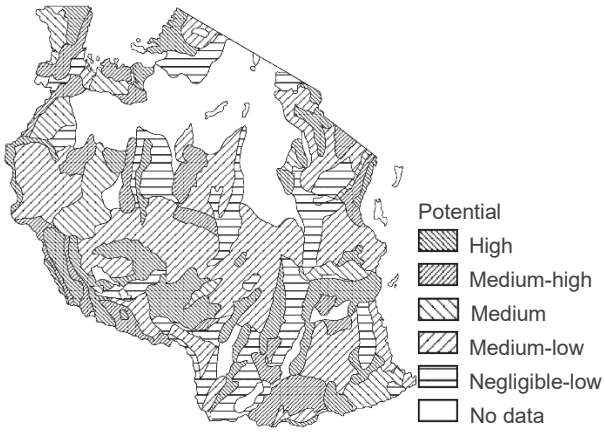
Source: Prepared by the JICA Project Team based on the IWRMDP and LVBC study reports

The annual groundwater recharge by sub-basin is presented in Figure 3.7.5. On the other hand, the NIMP2002 qualitatively assessed groundwater from the viewpoint of hydro-geological features and presents only the general outline of groundwater potential as presented in Figure 3.7.6. Comparing the two maps, almost similar tendency can be seen. Both maps indicated that groundwater potential in the Rufiji, Ruvuma and Lake Rukwa basins are higher than one in the other basins.



Source: JICA Project Team based on IWRMDPs & LVBC reports

Figure 3.7.5 Annual Groundwater Recharge Complied by NIMP2018



Source: NIMP2002

Figure 3.7.6 Groundwater Potential Compiled by NIMP2002

3.7.2 Estimation of Water Demand

(1) Consumptive Water Use

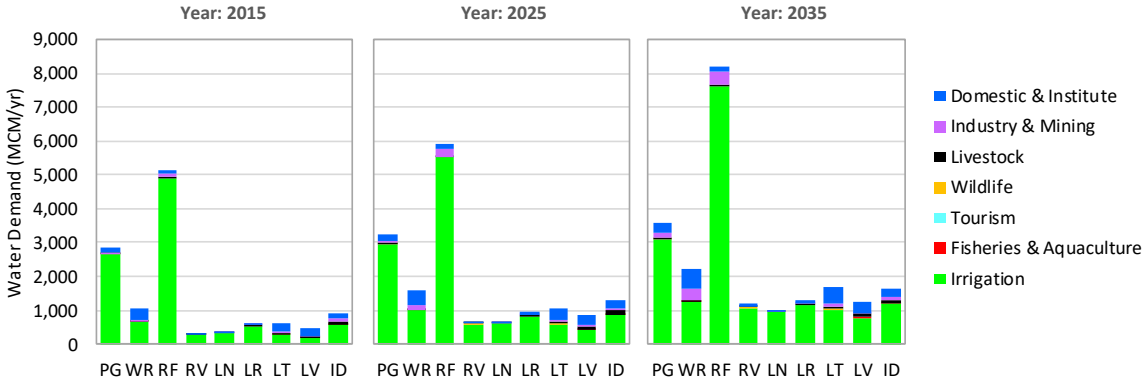
(a) Calculation Basis by Basin

Water demand with different time horizon has been projected in the IWRMDP and LVBC studies. The sectors considered in the respective basins are different depending on the natural and social conditions of the basin. Basically, there are seven sectors for consumptive water uses as shown in Figure 3.7.7.

Since the estimates were made by different consultant firms with due consideration of characteristics of the basin as well as their experiences, in some cases, different methods have been adopted. The major differences in calculation basis between basins are briefed in Appendix A.

(b) Summary of Water Demand by Basin

The water demand by sector by basin for the years 2015, 2025, and 2035 are summarised in Figure 3.7.7. The bar chart graphs offer an indication of the differences between basins and between sectors. As seen in the figure, the irrigation sector accounts for more than 80% of the total water demand, while the wildlife, tourism, and fisheries and aquaculture sectors account for quite small percentages. The projected irrigation areas for 2015, 2025, and 2035 in this water demand estimation are 488,268 ha, 717,054 ha, and 1,046,422 ha, respectively, in total for all the nine basins.



Source: Prepared by the JICA Project Team based on the IWRMDP and LVBC study reports

Figure 3.7.7 Annual Water Demand by Basin for 2015, 2025, and 2035

The numerical figures for the years 2015, 2025, and 2035 corresponding to Figure 3.7.7 are presented in Table 3.7.4, Table 3.7.5, and Table 3.7.6, respectively, in the Subsection 3.7.3(2).

(2) Environmental Flow Requirement

(a) Background

The environmental flow requirement (EFR) is non-consumptive requirement of water. However, it should be considered as part of water resources management in order to preserve normal functions of river flow. In formulating the NIMP2002, no regard was given to EFR possibly because the concept of EFR has not become general yet at that time particularly in developing countries.

As stated in Subsection 3.4.2, currently the Environmental Water Requirements Assessment Guidelines (hereinafter called the EWR Guidelines) is being prepared by the MoWI. Since the existing IWRMDPs have been formulated before the finalization of EWR Guidelines, the EFR studies carried out in the IWRMDPs are not always fully compliant with the EWR Guidelines. In some basins, detailed EFR studies had been conducted before the IWRMDPs and in that cases the results of previous EFR studies were reflected to the IWRMDPs. In the other cases, EFR was assessed with possible methods.

The basic methods of assessing EFR by each basin are briefed in Appendix A.

(b) Summary of Estimated EFR by Basin

In some assessment methods, EFR is estimated based on natural surface runoff. In that case, the future EFR may be changed in accordance with the change of surface runoff due to climate change. However, the EFR for the years 2025 and 2035 was estimated only in the Pangani, Lake Nyasa, and Lake Victoria basins. The NIMP2018 will use the 2015 EFR for the years 2025 and 2035 if unobtainable from the reports.

The monthly EFR estimates for 2015 are summarised into annual basis as presented in Table 3.7.3. The ratio of EFR to surface runoff water ranges from 0.23 to 0.53 except for the Wami/Ruvu basin, where the theoretically desirable EFR that was estimated in the previous study was downwardly adjusted in the IWRMDP study from the viewpoint of actual hydrological conditions.

Table 3.7.3 Annual EFR by Basin for 2015

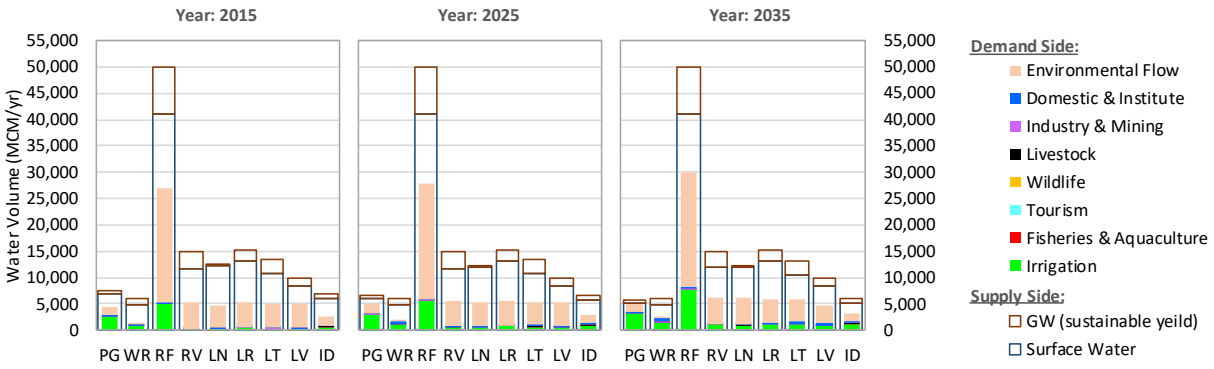
Basin	Catchment Area	Surface Water (SW)		Environmental Flow Requirement (EFR)		Ratio EFR / SW
	km²	MCM/yr	mm/yr	MCM/yr	mm/yr	
Pangani	59,102	6,963	118	1,622	27	0.23
Wami / Ruvu	66,295	4,865	73	298	4	0.06
Rufiji	183,791	41,049	223	21,850	119	0.53
Ruvuma	105,582	11,700	111	4,801	45	0.41
Lake Nyasa	27,594	12,188	442	4,161	151	0.34
Lake Rukwa	74,965	12,982	173	4,674	62	0.36
Lake Tanganyika	149,500	10,641	71	4,271	29	0.40
Lake Victoria	85,630	8,439	99	4,400	51	0.52
Internal Drainage	143,100	5,985	42	1,599	11	0.27
Total	895,559	114,812	128	47,676	53	0.42

Source: Prepared by the JICA Project Team based on the IWRMDP and LVBC study reports

3.7.3 Assessment of Water Stress

(1) Summary of Annual Estimates

The monthly water resources, the monthly EFR, and the monthly water demand estimated in the previous sections 3.7.1 and 3.7.2 are summarised on an annual basis in Figure 3.7.8. The numerical figures for the years 2015, 2025, and 2035 corresponding to Figure 3.7.8 are presented in Table 3.7.4, Table 3.7.5, and Table 3.7.6, respectively, in Subsection 3.7.3(2).



Note: Groundwater in the graph indicated sustainable yield of groundwater resources.
Source: Prepared by the JICA Project Team based on the IWRMDP and LVBC study reports

Figure 3.7.8 Summary of Annual Water Resource and Water Demand by Basin

(2) Assessment based on Water Exploitation Index

For the purpose of understanding the severity of water stress by basin, water exploitation index (WEI) was calculated as percentage of total consumptive water demand to internal renewable water resources, which consist of surface runoff and annual groundwater recharge. The result is presented in the following tables as well as Figure 3.7.9. The figures in the tables are rounded to an integer. Several international organisations including Organization for Economic Co-operation and Development (OECD) define the situation as "under severe water stress" in case the annual WEI exceeds 40%. It was found from the tables and figure that the Pangani basin is almost under severe water stress even in the current condition and the water stresses of all the basins will progressively increase towards 2035.

Table 3.7.4 Summary of Annual Water Resource and Water Demand by Basin for 2015

Basin	Water Resources (MCM/yr)			EFR (MCM/yr)	Water Demand (MCM/yr)								Annual WEI (%)
	SW	GW-S	GW-R		Dom	Ind	Irr	Liv	Wil	Tou	Fis	Total	
PG	6,963	587	1,466	1,622	157	36	2,657	12	0	0	0	2,862	34%
WR	4,865	1,139	4,273	298	345	61	656	15	0	0	0	1,076	12%
RF	41,049	9,021	22,533	21,850	69	131	4,905	19	0	0	0	5,124	8%
RV	11,700	3,238	8,307	4,801	50	0	254	7	25	0	0	335	2%
LN	12,188	107	1,070	4,161	34	11	309	11	0	0	0	365	3%
LR	12,982	2,136	5,341	4,674	54	2	532	13	0	0	0	600	3%
LT	10,641	2,755	5,511	4,271	215	63	273	25	16	1	0	592	4%
LV	8,439	1,327	4,424	4,400	206	15	163	73	0	0	0	456	4%
ID	5,985	884	4,421	1,599	176	89	561	87	4	0	0	917	9%
Total	114,812	21,195	57,345	47,676	1,306	407	10,309	261	45	1	1	12,329	7%

Note-1: SW = Surface Water, GW-S = Groundwater (sustainable yield), GW-R = Groundwater (recharge), EFR = Environmental Flow Requirement, Dom = Domestic & Institute, Ind = Industry & Mining, Irr = Irrigation, Liv = Livestock, Wil = Wildlife, Tou = Tourism, Fis = Fisheries & Aquaculture
Note-2: WEI (water exploitation index) here is calculated as percentage of total water demand to internal renewable water resources, which consist of surface runoff and groundwater recharge.
Source: Prepared by the JICA Project Team based on the IWRMDP and LVBC study reports

Table 3.7.5 Summary of Annual Water Resource and Water Demand by Basin for 2025

Basin	Water Resources (MCM/yr)			EFR (MCM/yr)	Water Demand (MCM/yr)								Annual WEI (%)
	SW	GW-S	GW-R		Dom	Ind	Irr	Liv	Wil	Tou	Fis	Total	
PG	5,881	587	1,466	1,655	204	56	2,959	14	1	0	0	3,234	44%
WR	4,865	1,139	4,273	298	441	142	993	19	0	0	0	1,595	17%
RF	41,049	9,021	22,533	21,850	110	245	5,504	33	0	0	0	5,891	9%
RV	11,755	3,238	8,307	4,801	61	0	568	8	36	0	0	673	3%
LN	12,041	102	1,070	4,545	39	11	606	11	0	0	0	668	5%
LR	12,982	2,136	5,341	4,674	83	3	832	16	0	0	0	934	5%
LT	10,750	2,755	5,511	4,271	318	67	578	30	29	13	0	1,037	6%
LV	8,439	1,327	4,424	4,466	322	23	430	84	0	0	6	865	7%
ID	5,654	884	4,421	1,599	206	95	869	107	4	0	0	1,282	13%
Total	113,417	21,189	57,345	48,159	1,784	642	13,338	323	70	13	7	16,179	9%

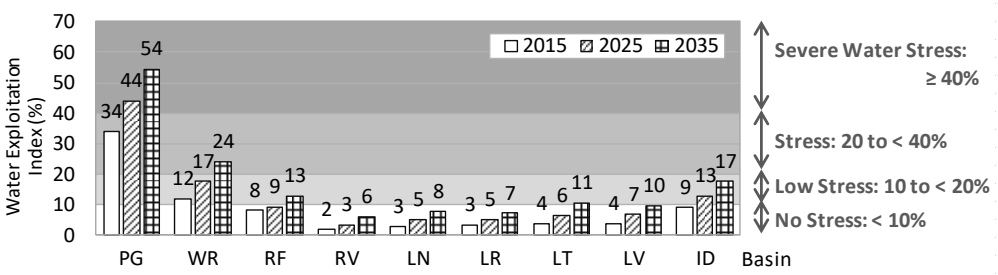
Note: Same as Table 3.7.4
Source: Prepared by the JICA Project Team based on the IWRMDP and LVBC study reports

Table 3.7.6 Summary of Annual Water Resource and Water Demand by Basin for 2035

Basin	Water Resources (MCM/yr)			EFR (MCM/yr)	Water Demand (MCM/yr)								Annual WEI (%)
	SW	GW-S	GW-R		Dom	Ind	Irr	Liv	Wil	Tou	Fis	Total	
PG	5,099	587	1,466	1,667	294	155	3,110	16	1	0	0	3,577	54%
WR	4,865	1,139	4,273	298	552	355	1,268	25	0	0	0	2,201	24%
RF	41,049	9,021	22,533	21,850	149	363	7,619	58	0	0	0	8,188	13%
RV	11,794	3,238	8,307	4,801	76	0	1,056	12	47	0	0	1,191	6%

Basin	Water Resources (MCM/yr)			EFR (MCM/yr)	Water Demand (MCM/yr)								Annual WEI (%)
	SW	GW-S	GW-R		Dom	Ind	Irr	Liv	Wil	Tou	Fis	Total	
LN	11,959	96	1,070	5,019	50	12	938	12	0	0	0	1,012	8%
LR	12,982	2,136	5,341	4,674	110	4	1,164	21	0	0	0	1,298	7%
LT	10,474	2,755	5,511	4,271	520	75	986	37	52	27	0	1,699	11%
LV	8,439	1,327	4,424	3,514	335	24	772	96	0	0	17	1,245	10%
ID	4,981	884	4,421	1,599	229	102	1,177	131	4	0	0	1,644	17%
Total	111,641	21,184	57,345	47,693	2,315	1,090	18,091	408	104	27	18	22,056	13%

Note: Same as Table 3.7.4
Source: Prepared by the JICA Project Team based on the IWRMDP and LVBC study reports



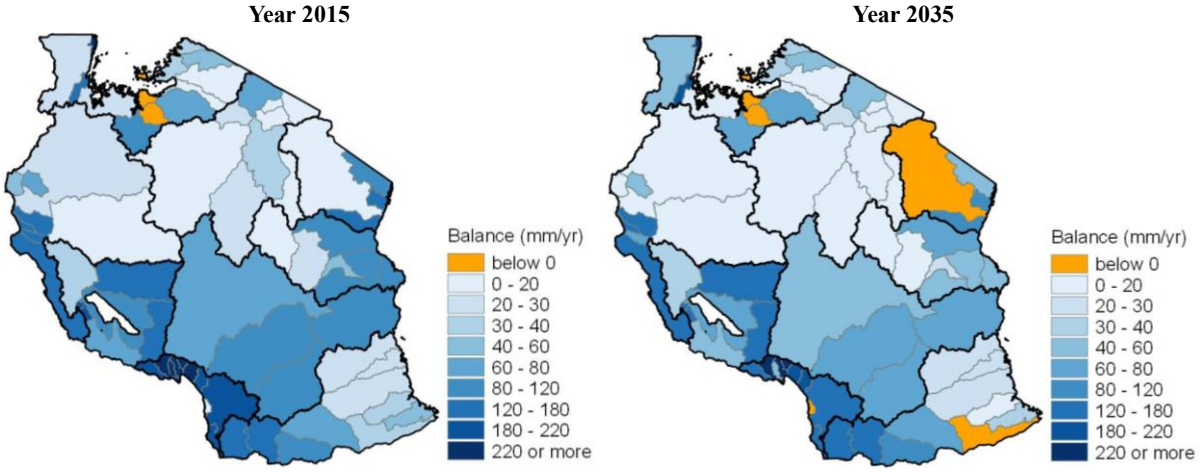
Source: Prepared by the JICA Project Team based on the IWRMDP and LVBC study reports

Figure 3.7.9 WEI by Basin

(3) Assessment based on Annual Water Balance Calculation

Prior to monthly water balance calculation to be made in Section 7.2, annual water balance by sub-basin was calculated under the limited assumption. Considering the fact that groundwater use is still supplementary supply side factor, in this section, water balance was calculated by deducting EFR and all water demand from surface water by sub-basin. The calculation result is presented in Figure 3.7.10.

The legend of below 0 (zero) in the figure means that the EFR and/or water demand are not satisfied by surface water even in annual calculation. Out of the six sub-basins with the balance below zero, the four sub-basins are not recoverable with groundwater supply. In that case, EFR and/or water demand need to be reviewed and adjusted unless inter-boundary transfer of water is considered.



Note: Groundwater use has not been considered in this calculation.
Source: Prepared by the JICA Project Team based on the IWRMDP and LVBC study reports

Figure 3.7.10 Annual Water Balance by Sub-basin

3.8 Challenges in Water Sector

The following challenges were identified through reviewing the IWRMDP reports as well as discussing with the MoWI:

(1) Water Demand Management

The biggest challenge in water sector is the localized seasonal water shortages especially during peak irrigation periods. The situation surrounding water resources has become more difficult due to climate change effect as well as increase in water demands for various sectors. It is important to consider managing the water demands to ensure sustainability of water resources.

(2) Limited Availability of Long-term Hydrological Data

As summarised in Table 3.4.2, the IWRMDPs for some basins were formulated by using non-latest hydrological data due to the limited availability of long-term data. This issue could be attributed to the insufficient hydrological monitoring activities as well as non-systematic data management at basin level.

(3) Undefined Reliability of Water Utilization in IWRMDPs

In general, reliability of water utilization is considered in water resources planning. In many cases, the reliabilities of 1/10-yr for domestic and other sectors and 1/5-yr for irrigation sector are adopted. However, in preparing the IWRMDPs, a long-term mean runoff was utilized as water resources potential in all the basins except for the Wami/Ruvu basin. It is not always necessary to consider the reliability in the form of 1/5-yr or 1/10-yr. However, it is important to understand the reliability in considering the necessity of newly developing water resources.

(4) Careful Consideration on Transboundary Water Use

Abstraction of water from transboundary lakes is not explicitly mentioned in the IWRMDP reports. However, NIRC expect water use particularly in the Lake Victoria. Considering the fact that the lake water is derived partially from rainfall onto the territory of Tanzania, the water may be used for irrigation in Tanzania even after the water flow into the lake. In this regard, water use from transboundary lakes may be one of the conceivable measures subject to agreements among the concerned countries.

Chapter 4 Present Conditions of Agriculture Sector

4.1 General

Irrigation is generally used as a part of agricultural activity, hence, it needs to be in line with the farming system at each site. Here in the Tanzania mainland, the land is vast and has a variety of natural, environmental, and socioeconomic conditions. It means that a wide range of farming systems is practiced according to the farmland conditions at individual sites.

To revise the National Irrigation Master Plan 2002 (NIMP2002), it is indispensable to understand the present agriculture in the mainland. Based on the understanding of the present agriculture together with the data analysis results of other sectors, model cropping patterns on irrigated farmland for the National Irrigation Master Plan 2018 (NIMP2018) are presented in Chapter 7. To grasp the current agriculture features of the Tanzania mainland, various data including agricultural statistics by region/zone were collected and summarised below.

4.2 Topographic Features and Agricultural Ecological Zone

4.2.1 Topographic Features

The mainland of Tanzania comprises nearly 880,000 km^2, about 100,000 km^2 are mountains and waste; another 150,000 km^2 are national parks and game reserves.[1] Apart from a narrow coastal strip, most of Tanzania is above 200 metres. Vast plains and plateaux contrast with spectacular physical features including Mt. Kilimanjaro (5,895 m), Lake Tanganyika (the world's second deepest lake with 1,470 m maximum depth), and the East African Rift Valley. A western branch of the rift runs along the western frontier and is marked by lakes of Tanganyika and Rukwa. The eastern branch is the Great Rift Valley, from the Kenya border in the region of lakes of Eyasi, Natron, and Manyara to Lake Nyasa. The Central Plateau, covering over a third of the country, lies between the two branches of the rift. Although it has numerous lakes, Lake Victoria, the world's second largest freshwater lake, is not part of the Rift Valley. There are no large rivers but two great rivers of Africa arise in Tanzania: the Nile and the Congo. The watersheds of these rivers do not meet and are separated by the Central Plateau. All the main rivers, Ruvuma, Rufiji, Wami, and Pangani drain to the Indian Ocean. The Kagera flows to Lake Victoria. Minor rivers flow into depressions in the Rift Valley.

4.2.2 Agroecological Zone

The Ministry of Agriculture (MoA) provides a variety of maps and one of them is an agroecological zone (AEZ) map. The country is composed of nine agroecological zones and their distributions by region are tabulated below. Given these diverse natural conditions, Tanzania shows a broad range of agricultural activities with greater potentials for further development.

[1] Information here mainly owes to FAO, 2006, "Country Pasture/Forage Resources Profiles: United Republic of Tanzania"..

Table 4.2.1 List of AEZ

No.	Agroecological Zone	Regions
1	Coast Plains	Tanga, Pwani, Lindi, Mtwara, DSM
2	Eastern Plateaux and Mountain Blocks	Arusha, Kilimanjaro, Manyara, Pwani, Morogoro, Iringa, Lindi, Mtwara, Ruvuma, Dodoma
3	High Plains and Plateaux	Iringa, Mbeya, Njombe, Ruvuma
4	Volcanoes and Rift Depressions	Mara, Arusha
5	Central Plateaux (Plains)	Mwanza, Simiyu, Singida, Dodoma, Tabora, Iringa, Mbeya, Katavi
6	Rukwa - Ruaha Rift Zone - Alluvial Flats	Rukwa, Iringa, Mbeya, Tabora
7	Inland Sedimentary Sediments	Lindi, Ruvuma, Morogoro
8	Ufipa Plateau	Rukwa
9	Western Highlands	Kagera, Kigoma

Source: MALF, "AGRO-ECOLOGICAL ZONES" summarised by the JICA Project Team

4.3 Land Holding

The "2014/15 Annual Agricultural Sample Survey" (2014/15 AASS) done by MALF revealed that, in the Tanzania mainland, there were a total of 11,073,679 operators engaged in either farming or livestock keeping and both of them during the 2014/15 agriculture year as shown in Table 4.3.1.

Table 4.3.1 Number of Operators Engaged in Crop Farming, Livestock Keeping, or Both Crop and Livestock Farming by Region (2014/15)

Region	Crop Farming Only (A)	Crops and Livestock (B)	Operators Engaged in Crop Farming (C)= (A)+(B)	Livestock Keeping Only (D)	Total (E)= (C)+(D)	Crop Farming (%) (A)/(E)	Crops and Livestock (%) (B)/(E)	Operators Engaged in Crop Farming (%) (C)/(E)	Livestock Keeping (%) (D)/(E)
Dodoma	243,735	267,900	511,635	22,151	533,786	45.7	50.2	95.9	4.1
Arusha	60,917	128,706	189,623	30,489	220,112	27.7	58.5	86.1	13.9
Kilimanjaro	140,394	136,447	276,841	10,687	287,528	48.8	47.5	96.3	3.7
Tanga	463,880	99,219	563,099	4,490	567,589	81.7	17.5	99.2	0.8
Morogoro	158,918	97,831	256,749	9,224	265,973	59.7	36.8	96.5	3.5
Pwani	275,732	46,590	322,322	12,569	334,891	82.3	13.9	96.2	3.8
Dar-es-salaam	17,598	3,248	20,846	1,009	21,855	80.5	14.9	95.4	4.6
Lindi	583,733	54,563	638,296	12,762	651,058	89.7	8.4	98.0	2.0
Mtwara	225,642	209,727	435,369	24,134	459,503	49.1	45.6	94.7	5.3
Ruvuma	388,378	44,239	432,617	0	432,617	89.8	10.2	100.0	0.0
Iringa	180,991	133,362	314,353	9,773	324,126	55.8	41.1	97.0	3.0
Mbeya	375,651	315,263	690,914	11,213	702,127	53.5	44.9	98.4	1.6
Singida	194,836	219,697	414,533	17,882	432,415	45.1	50.8	95.9	4.1
Tabora	477,214	239,727	716,941	5,396	722,337	66.1	33.2	99.3	0.7
Rukwa	151,352	135,895	287,247	4,586	291,833	51.9	46.6	98.4	1.6
Kigoma	521,283	137,475	658,758	3,895	662,653	78.7	20.7	99.4	0.6
Shinyanga	228,097	289,795	517,892	12,478	530,370	43.0	54.6	97.6	2.4
Kagera	436,970	150,938	587,908	3,307	591,215	73.9	25.5	99.4	0.6
Mwanza	390,936	445,564	836,500	26,056	862,556	45.3	51.7	97.0	3.0
Mara	166,418	205,035	371,453	11,283	382,736	43.5	53.6	97.1	2.9
Manyara	177,038	163,758	340,796	3,406	344,202	51.4	47.6	99.0	1.0
Njombe	203,077	46,069	249,146	10,849	259,995	78.1	17.7	95.8	4.2
Katavi	179,707	98,143	277,850	0	277,850	64.7	35.3	100.0	0.0
Simiyu	126,298	249,297	375,595	8,111	383,706	32.9	65.0	97.9	2.1
Geita	324,427	225,876	550,303	2,494	552,797	58.7	40.9	99.5	0.5
Mainland	6,693,222	4,144,364	10,837,586	236,093	11,073,679	60.4	37.4	97.9	2.1

Note: Data of newly established Songwe Region (2016) are not available. It is included in Mbeya.
Source: NBS, September 2016, "2014/15 Annual Agricultural Sample Survey"

Among the 25 regions in the mainland, Mwanza has the largest number of operators that are only engaged in farming; and both farming and livestock keeping have 836,500 operators, followed by Tabora with 716,941 and Mbeya with 690,914. On the other hand, actual numbers are not so large but almost all the operators are only engaged in farming; and both farming and livestock keeping in Ruvuma, Katavi, and Geita. Although livestock keeping is less common than farming in most of the regions, i.e., Arusha, Mtwara, Singida are considered to be major livestock keeping areas.

The area of land in farms was also measured by ownership and region. Tabora, Dodoma, and Tanga are the top 3 in terms of total land in farms. Analytically, the size of the land rented from others in a region is supposed to be almost equal to the size of the land rented to others in that region, however, some of them are so different (e.g., in Geita, the land rented from others is only 40,851 ha but the size of land rented to others is 108,430 ha, which is 2.5 times larger than the size of land rented from others.) It is possible that some lands are rented out to those operators who live in the neighbouring regions, but it is reasonable that these cases are few. Because there is no clear tendency among the regions, it is impossible to presume why this significant discrepancy occurs.

Mean area of land per farming operator is calculated by region using the above number of operators that are only engaged in farming and both farming and livestock keeping. Mean area of land per farming operator in the mainland is 1.60 ha. Among the 25 regions, mean area of land per one farming operator in Simiyu, Manyara, and Tabora regions is more than 2.6 ha while the mean figure is less than 1.0 ha in the four regions, namely; Katavi, Kagera, Njombe, and Ruvuma.

Table 4.3.2 Area of Land in Farms by Ownership and Region (2014/15)

Region	Land Owned (ha)	Land Rented from Others (ha)	Land Rented to Others (ha)	Total Land in Farms (ha)	Mean Area of Land per Farming Operator (ha)	Land Rented from Others (%)	Land Rented to Others (%)
Dodoma	1,292,275	85,186	146,382	1,231,079	2.41	6.9%	11.9%
Arusha	327,246	13,157	18,918	321,485	1.70	4.1%	5.9%
Kilimanjaro	311,760	31,867	46,335	297,292	1.07	10.7%	15.6%
Tanga	1,197,709	20,960	29,128	1,189,541	2.11	1.8%	2.4%
Morogoro	562,174	65,502	69,009	558,667	2.18	11.7%	12.4%
Pwani	515,976	4,688	1,704	518,960	1.61	0.9%	0.3%
Dar es salaam	35,709	1,088	480	36,317	1.74	3.0%	1.3%
Lindi	795,842	6,864	3,446	799,260	1.25	0.9%	0.4%
Mtwara	698,041	7,515	22,915	682,641	1.57	1.1%	3.4%
Ruvuma	377,527	6,242	966	382,803	0.88	1.6%	0.3%
Iringa	461,384	26,250	103,181	384,453	1.22	6.8%	26.8%
Mbeya	727,226	69,116	6,560	789,781	1.14	8.8%	0.8%
Singida	815,574	54,253	36,464	833,363	2.01	6.5%	4.4%
Tabora	1,895,153	107,616	110,497	1,892,271	2.64	5.7%	5.8%
Rukwa	396,243	16,847	6,616	406,474	1.42	4.1%	1.6%
Kigoma	756,800	26,883	13,884	769,800	1.17	3.5%	1.8%
Shinyanga	1,119,507	57,934	111,928	1,065,512	2.06	5.4%	10.5%
Kagera	444,221	9,909	2,565	451,565	0.77	2.2%	0.6%
Mwanza	869,564	38,666	56,043	852,187	1.02	4.5%	6.6%
Mara	453,023	13,596	6,842	459,777	1.24	3.0%	1.5%
Manyara	998,808	96,244	170,917	924,135	2.71	10.4%	18.5%

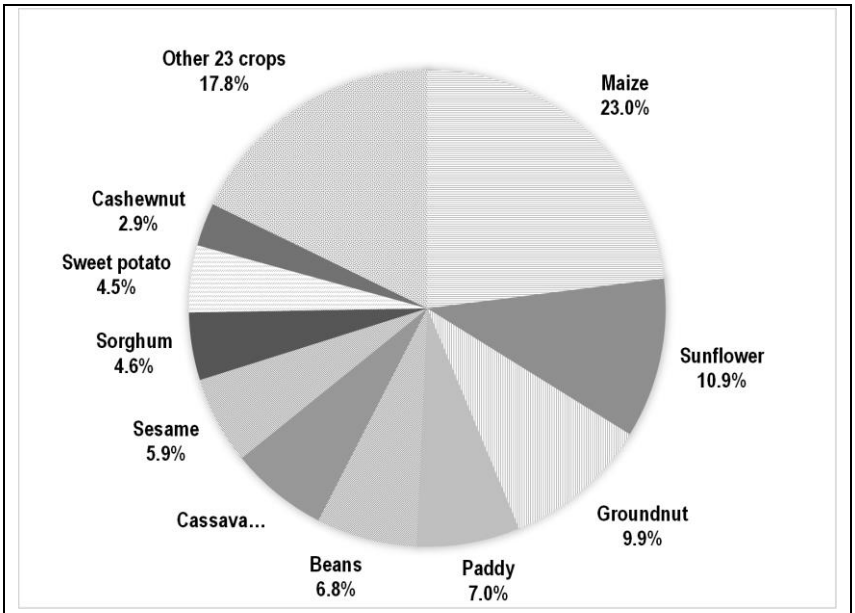
Region	Land Owned (ha)	Land Rented from Others (ha)	Land Rented to Others (ha)	Total Land in Farms (ha)	Mean Area of Land per Farming Operator (ha)	Land Rented from Others (%)	Land Rented to Others (%)
Njombe	215,927	5,042	5,691	215,278	0.86	2.3%	2.6%
Katavi	281,859	7,016	81,970	206,905	0.74	3.4%	39.6%
Simiyu	1,160,701	94,124	81,437	1,173,388	3.12	8.0%	6.9%
Geita	956,908	40,851	108,430	889,329	1.62	4.6%	12.2%
Mainland	17,667,157	907,416	1,242,308	17,332,263	1.60	5.2%	7.2%

Source: NBS, September 2016, "2014/15 Annual Agricultural Sample Survey"

4.4 Crop Production and Farming System

4.4.1 Crop Production

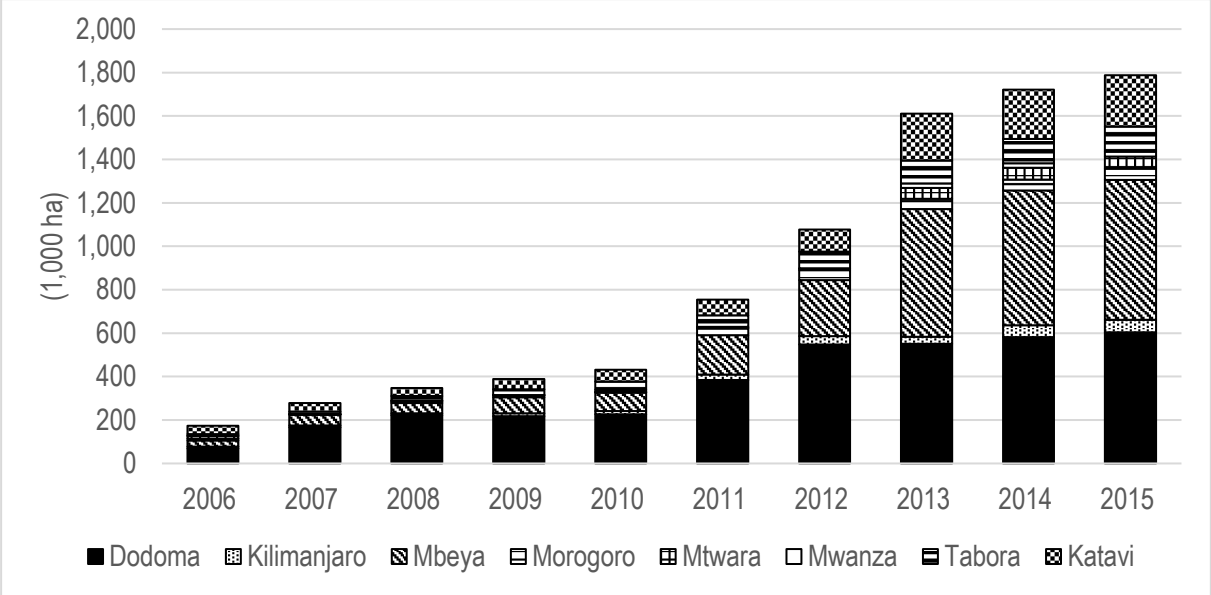
The statistical data obtained from the Statistics Unit, MALF, include planted area, production, and yield of 39 crops. After excluding six crops, which have no area and production data for the agriculture year 2014/15, the remaining 33 crops data were analysed. Maize has the largest planted area with 3.79 million ha occupying 23% of the national planted area followed by two oil crops, sunflower (1.79 million ha) and groundnut (1.63 million ha). Paddy is the fourth largest planted area crop with 1.15 million ha. Beans (1.12 million ha), cassava (1.09 million ha), sesame (0.98 million ha), sorghum (0.76 million ha), sweet potato (0.75 million ha), and cashew nut (0.48 million ha) are the other crops among the top 10 crops. These ten crops represent over 82% of the total planted area and other 23 crops occupy only less than 18%.



Source: Statistical data collected from Statistics Unit, MALF

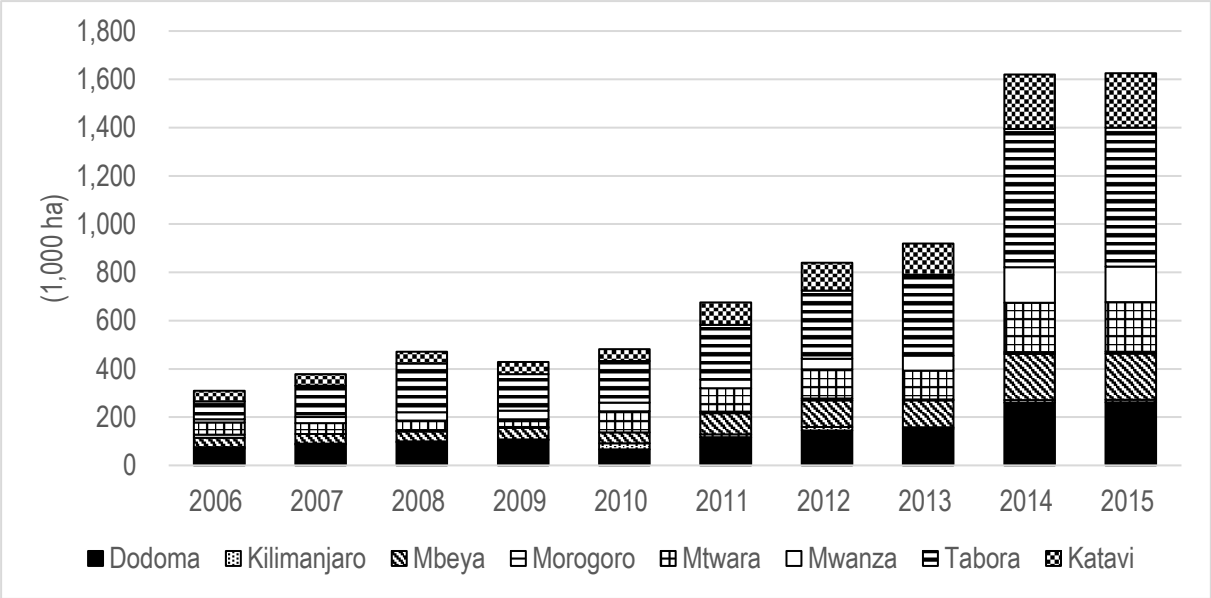
Figure 4.4.1 Major 10 Crops in terms of Planted Area (2014/15)

Among the top 10 crops, there are three cereal crops (maize, paddy, and sorghum) as well as three oil crops (sunflower, groundnut, and sesame) in addition to two tuber crops, i.e., cassava and sweet potato. Recently, the planted areas of the three oil crops are rapidly expanding as shown in figures below. In 2015, the groundnut planted area was five times bigger than the area in 2006. As for the sunflower and sesame, their area of expansion is more rapid, about ten times more than the areas in 2006. However, main production zones are different by crop. Dodoma and Mbeya zones are major production areas for sunflower but Tabora zone is crucial for groundnut production. As for sesame, Mtwara zone is the leading production area. In general, area of the other eight crops increased during the last decade but they have no clear tendencies similar to these oil crops.



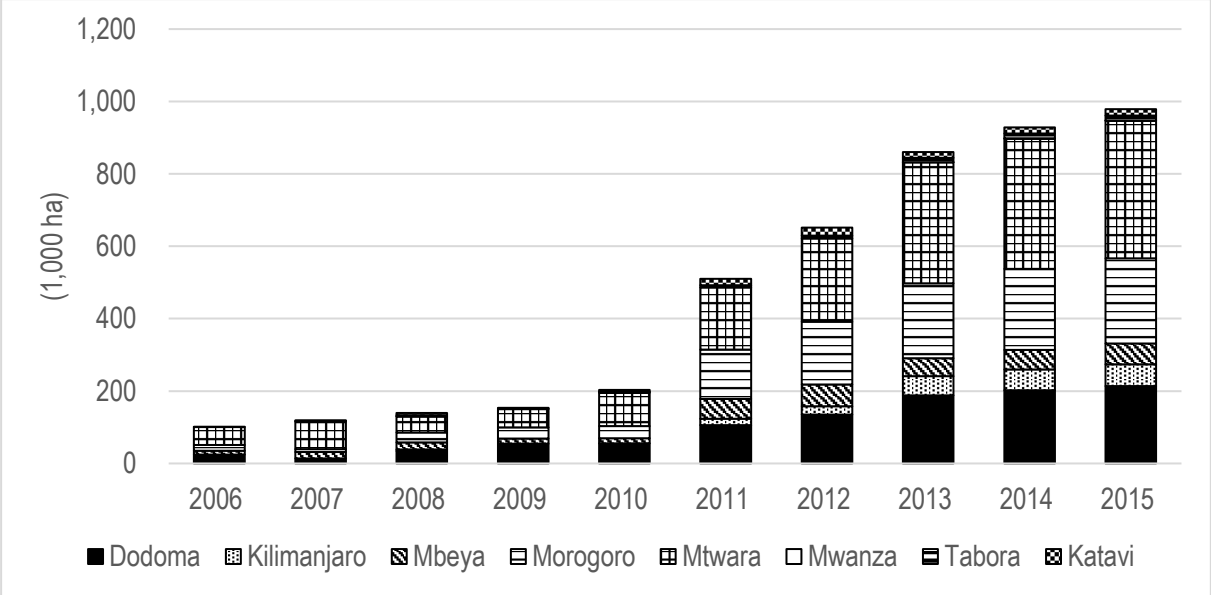
Source: Statistical data collected from the Statistics Unit, MALF

Figure 4.4.2 Change of Sunflower Planted Area by Zone (2006-2015)



Source: Statistical data collected from the Statistics Unit, MALF

Figure 4.4.3 Change of Groundnut Planted Area by Zone (2006-2015)



Source: Statistical data collected from the Statistics Unit, MALF

Figure 4.4.4 Change of Sesame Planted Area by Zone (2006-2015)

4.4.2 Farming System

(1) Cropping Intensity by Region

Current cropping intensities are estimated by region and season based on the 2014/15 AASS data, which are considered as the latest planted area statistics by crop and region.

Table 4.4.1 Planted Area and Cropping Intensity by Region and Season

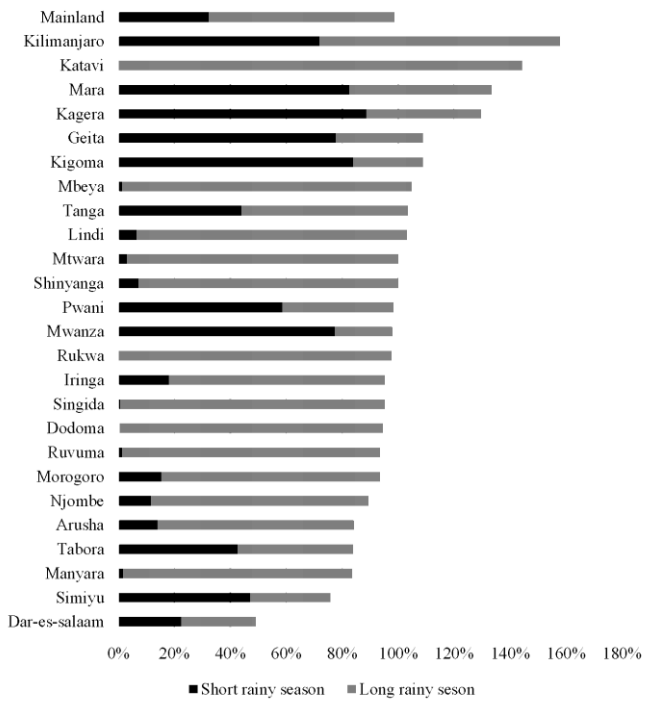
Region	Total Land in Farms (ha) (A)	Planted Area (ha)			Cropping Intensity		
		Short Rainy Season (B)	Long Rainy Season (C)	Total Area Planted (D=B+C)	Short Rainy (B/A)	Long Rainy (C/A)	Total (D/A)
Dodoma	1,231,079	3,560	1,160,914	1,164,474	0.3%	94.3%	94.6%
Arusha	321,485	45,309	225,384	270,693	14.1%	70.1%	84.2%
Kilimanjaro	297,292	214,285	255,525	469,810	72.1%	86.0%	158.0%
Tanga	1,189,541	521,462	708,898	1,230,360	43.8%	59.6%	103.4%
Morogoro	558,667	85,133	436,765	521,898	15.2%	78.2%	93.4%
Pwani	518,960	304,942	204,907	509,849	58.8%	39.5%	98.2%
Dar es salaam	36,317	8,191	9,676	17,867	22.6%	26.6%	49.2%
Lindi	799,260	51,257	773,104	824,361	6.4%	96.7%	103.1%
Mtwara	682,641	19,778	663,601	683,379	2.9%	97.2%	100.1%
Ruvuma	382,803	5,235	352,584	357,819	1.4%	92.1%	93.5%
Iringa	384,453	69,603	296,969	366,572	18.1%	77.2%	95.3%
Mbeya	789,781	11,686	816,621	828,307	1.5%	103.4%	104.9%
Singida	833,363	5,146	788,572	793,718	0.6%	94.6%	95.2%
Tabora	1,892,271	807,694	783,344	1,591,038	42.7%	41.4%	84.1%
Rukwa	406,474	1,856	395,094	396,950	0.5%	97.2%	97.7%
Kigoma	769,800	646,181	192,035	838,216	83.9%	24.9%	108.9%
Shinyanga	1,065,512	75,185	990,341	1,065,526	7.1%	92.9%	100.0%
Kagera	451,565	400,093	185,562	585,655	88.6%	41.1%	129.7%
Mwanza	852,187	658,906	174,282	833,188	77.3%	20.5%	97.8%
Mara	459,777	378,536	234,261	612,797	82.3%	51.0%	133.3%
Manyara	924,135	15,407	757,817	773,224	1.7%	82.0%	83.7%
Njombe	215,278	24,831	167,989	192,820	11.5%	78.0%	89.6%
Katavi	206,905	0	298,859	298,859	0.0%	144.4%	144.4%

Region	Total Land in Farms (ha) (A)	Planted Area (ha)			Cropping Intensity		
		Short Rainy Season (B)	Long Rainy Season (C)	Total Area Planted (D=B+C)	Short Rainy (B/A)	Long Rainy (C/A)	Total (D/A)
Simiyu	1,173,388	551,647	336,020	887,667	47.0%	28.6%	75.6%
Geita	889,329	689,580	279,484	969,064	77.5%	31.4%	109.0%
Mainland	17,332,263	5,595,503	11,488,608	17,084,111	32.3%	66.3%	98.6%

Note: Songwe is included in Mbeya. Short rainy season: from October to January, Long rainy season: from February to May
Source: National Bureau of Statistics, URT, Sep. 2016, 2014/15 Annual Agricultural Sample Survey Report

Average cropping intensity in short rainy season was 32.3%. The regions with high intensity in short rainy season are located around Lake Victoria (Kagera, Kigoma, Mara, Geita, and Mwanza). The regions with low intensity were mainly located in the Dodoma and Mbeya zones. Average cropping intensity in long rainy season was 66.3%. The regions with high intensity in long rainy season are in the south and south west (Katavi, Mbeya, Rukwa, Mtwara, and Lindi). The regions with low intensity were in the Mwanza and Tabora zones.

Total cropping intensity varied from 49% in Dar es Salaam to 158% in Kilimanjaro and average cropping intensity in the mainland was 99%. Katavi (144%) and Mara (133%) follow Kilimanjaro. Both Kilimanjaro and Mara had relatively high intensities in the short rainy season while Katavi recorded 144% only in long rainy season with 0% in short rainy season. Those regions with more than 100% cropping intensity accounted to 11 out of 25 regions. There were six regions with more than 105% (Kilimanjaro, Katavi, Mara, Kagera, Geita, and Kigoma) and many regions with high cropping intensity had high intensity in the short rainy season except for Katavi and Mbeya.



Source: National Bureau of Statistics, URT, Sep. 2016, 2014/15 Annual Agricultural Sample Survey Report

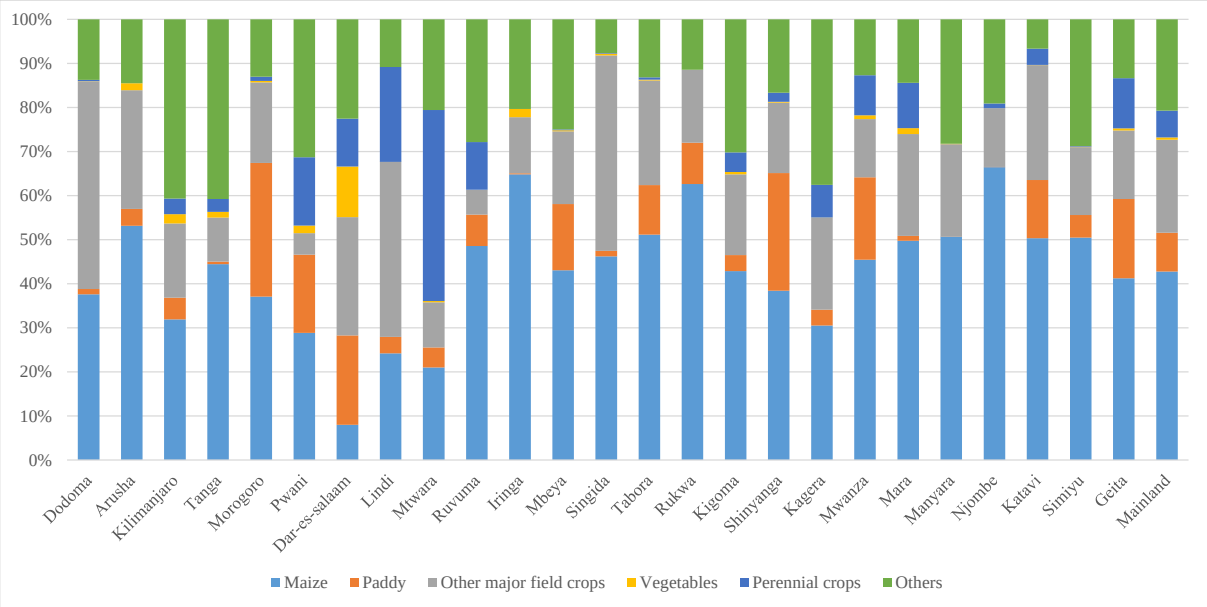
Figure 4.4.5 Cropping Intensity by Region (2014/15)

On the other hand, Simiyu (76%) and Manyara (84%) were those with low intensity after Dar es Salaam. There were six regions with less than 90% cropping intensity (Dar es Salaam, Simiyu, Manyara, Tabora, Arusha, and Njombe).

(2) Cropping Patterns

Cropping patterns were analysed by region with the same data, 2014/15 AASS. The planted data of 17 crops were categorized into six groups: (1) maize, (2) paddy, (3) other major food and oil crops (sunflower, groundnut, beans, sesame, sorghum and sweet potato), (4) vegetables (tomato, okra, onion, watermelon, pumpkin, cabbage and amaranths), (5) perennial crops (cassava and cashew nut), and (6)

others. (The total planted area of these 17 crops in each region represented 59-93% of the total planted area. Therefore, it is considered that these data are representative crops in each region.)



Note: Songwe is included in Mbeya.
Source: National Bureau of Statistics, URT, Sep. 2016, 2014/15 Annual Agricultural Sample Survey Report

Figure 4.4.6 Current Cropping Pattern by Region (2014/15)

As a whole, 42.8% of planted area was cropped with maize on the mainland in 2014/15, followed by other major food and oil crops at 21.1%. Together with paddy (8.8%), these three categories which include essential food crops for the Tanzanian people represented nearly three quarters, 72.7% of planted area in 2014/15.

Maize was popularly planted in Njombe, Iringa, and Rukwa, where it covered more than 60% of planted area. Paddy was widely planted in Morogoro (30.3%) and Shinyanga (26.7%). In Dar es Salaam, 11.5% of planted area was occupied by vegetables, which was the highest among the regions. Although the farmland area size was relatively small in Dar es Salaam, many vegetables were being supplied to the population in the capital instead maize planted area represented the least (8%) among all the regions. After Dar es Salaam, Kilimanjaro recorded the second largest but it was only 2.1%. Mtwara and Lindi were characterized by the concentration of perennial crops, at 43.3% and 21.5%, particularly, cashew nut planted area of 221,000 ha and 158,000 ha, respectively.

(3) Farming System

Tanzania has a considerable variation in the farming systems due to the various differences in climatic and agro-ecological conditions. Rainfall patterns in Tanzania are generally classified into two categories; namely; unimodal and bimodal[2]. Unimodal refers to areas with one rainy season and bimodal refers to those with two rainy seasons. The unimodal rainy season occurs between October/November and April/May (*Msimu*) and is common to the southern, south-western, central, and western areas of the country. In bimodal areas, the long rainy season is experienced between March and June (*Masika*) and

[2] FEWS NET, August 2005, "Tanzania Food Security Update"

the short rains occur between October and January (*Vuli*). Bimodal areas are located in the northern coast, North-Eastern Highlands and Lake Victoria areas. Because of these rainfall patterns, agricultural statistics are normally described in two-year form such as 2014/15. There are ten major farming systems in Tanzania as shown below.

Table 4.4.2 Major Farming Systems in Tanzania

No.	Farming System	Location of the System	Remarks
1	Banana/Coffee/ Horticulture System	Kagera, Kilimanjaro, Arusha, Kigoma and Mbeya regions	Tree crops, high intensive land use, volcanic soils with high fertility, land scarcity
2	Maize/Legume System	Rukwa, Ruvuma, Arusha, Kagera, Shinyanga, Iringa, Mbeya, Kigoma, Tabora, Tanga, Morogoro, Kahama, Biharamulo	Land not scarce, shifting cultivation, maize and legumes, beans and groundnuts intercropped, Arabica coffee
3	Cashew/Coconut/Cassa va System	Coast Region; Eastern Lindi and Mtwara	Low rainfall, low soil fertility, cassava, coconut and cashew, land is not scarce, shifting cultivation
4	Rice/Sugarcane System	Alluvial river valleys	Rice and sugarcane
5	Sorghum/Bulrush millet/Livestock System	Sukuma land; Shinyanga and rural Mwanza	Sorghum, millet, maize and cotton, oilseeds and rice, intense population pressure, declining soil fertility
6	Tea/Maize/Pyrethrum System	Njombe and Mufindi districts in Iringa Region	Tea, maize, Irish potatoes, beans, wheat, pyrethrum, wattle trees and sunflower
7	Cotton/Maize System	Mwanza, Shinyanga Kagera, Mara, Singida, Tabora and Kigoma, Morogoro, Coast, Mbeya, Tanga, Kilimanjaro and Arusha	Cotton, sweet potatoes, maize, sorghum and groundnuts, intensive cultivation, livestock kept
8	Horticulture-based System	Lushoto District; Tanga Region, Morogoro rural; Morogoro Region and Iringa rural in Iringa Region	Vegetables, (cabbages, tomatoes, sweet pepper, cauliflower, lettuce, and indigenous vegetables) and fruits, (pears, apples, plums, passion fruits, and avocado), maize, coffee, Irish potatoes, tea, and beans
9	Wet-rice and irrigated System	River valleys and alluvial plains, Kilombero, Wami Valleys, Kilosa, Lower Kilimanjaro, Ulanga, Kyela, Usangu and Rufiji	
10	Pastoralists and Agropastoralist System	Semi-arid areas i.e., Dodoma, Singida, parts of Mara and Arusha; Chunya districts, Mbeya and Igunga District in Tabora	Deep attachment to livestock and simple cropping system, shifting cultivation of sorghum millet, moderate population density 30 per km^2, limited resource base and poor and variable rainfall

Source: Global Yield Gap Atlas, http://www.yieldgap.org/tanzania, Accessed on 13 December 2016

4.5 Agricultural Research

In September 2016, the National Assembly passed the Tanzania Agricultural Research Institute Act 2016. It seeks to promote crop protection and make effective administration of trade, commerce, and export of agricultural produces. The draft legislation is also expected to push budget allocation for research activities to at least one percent of the gross domestic product (GDP).

This act established the Tanzania Agricultural Research Institute (TARI) as a corporate body and provides with respect to its functions, powers, administration, etc. The act also established the Agricultural Research Development Fund and provided for registration of agricultural research projects and service providers. According to the act, there are 16 agricultural research institutes across the country, see Table 4.5.1.

Table 4.5.1 List of 16 Tanzania Agricultural Research Institutes

S/ N	Former Name of the Institute	Name of the Centre	Location
1	Ilonga Agricultural Research Institute	TARI-Ilonga Centre	Kilosa, Morogoro
2	Mlingano Agricultural Research Institute	TARI-Mlingano Centre	Muheza, Tanga
3	Kibaha Sugarcane Research Institute	TARI-Kibaha Centre	Kibaha, Pwani
4	Mikocheni Agricultural Research Institute	TARI-Mikocheni Centre	Kinondoni, Dar es Salaam
5	KATRIN Agricultural Research Institute	TARI-Ifakara Centre	Kilombero, Morogoro
6	Dakawa Agricultural Research Institute	TARI-Dakawa Centre	Mvomero, Morogoro
7	Makutupora Veticultural Research Institute	TARI-Makutupora Centre	Dodoma
8	Hombolo Agricultural Research Institute	TARI-Hombolo Centre	Chamwino, Dodoma
9	Ukiriguru Agricultural Research Institute	TARI-Ukiriguru Centre	Misungwi, Mwanza
10	Maruku Agricultural Research Institute	TARI-Maruku Centre	Bukoba, Kagera
11	Selian Agricultural Research Institute	TARI-Selian Centre	Meru, Arusha
12	Tengeru Agricultural Research Institute	TARI-Tengeru Centre	Meru, Arusha
13	Naliendele Agricultural Research Institute	TARI-Naliendele Centre	Mtwara, Urban Mtwara
14	Uyole Agricultural Research Institute	TARI-Uyole Centre	Mbeya
15	Kifyulilo Experimental Station	TARI-Kifyulilo Centre	Mufindi, Iringa
16	Tumbi Agricultural Research Institute	TARI-Tumbi Centre	Uyui, Tabora

Source: Tanzania Agricultural Research Institute Act, 2016

Priority crop commodities for research by zone are summarised below. Maize is a priority commodity in all the seven zones while rice is so in the six zones. Sorghum and cassava are priority crops in five zones followed by beans in four zones.

Table 4.5.2 Priority Crop Commodities for Research by Zone

S/N	Zone	Regions	Research Institutes	Priority Crop Commodities
1	Central	Dodoma, Singida	Makutupora (Zonal HQ), Hombolo	Maize, Sunflower, Sorghum, Pearl Millet, Groundnuts
2	Eastern	Dar es Salaam, Morogoro, Pwani, Tanga	Ilonga (Zonal HQ), Ifakara, Dakawa, Kibaha, Mikocheni, Mlingano	Maize, Rice, Cassava, Sugarcane, Sorghum, Cotton, Phaseolus Bean, Coffee, Soil research centre (Mlingano)
3	Lake	Kagera, Mara, Mwanza, Shinyanga, Simiyu, Geita	Ukiriguru (Zonal HQ), Maruku	Maize, Banana, Sorghum, Cotton, Sweet potato, Rice, Cassava, Beans, Coffee
4	Northern	Arusha, Kilimanjaro, Manyara	Selian (Zonal HQ), Tengeru	Phaseolus beans, Maize, Pigeon peas, Onions, Sunflower, Banana, Wheat, Cabbages, Lima bean, Mangoes, Finger millet, Cassava, Sweet potato, Barley, Safflower, Tomatoes, Carrots, Irish potatoes, Sorghum, Rice, Cowpeas, Coffee, Spices.
5	Southern	Lindi, Mtwara	Naliendele	Sesame, Maize, Rice, Cassava, Sorghum, Cashewnut, Pigeon pea, Groundnut
6	Southern Highlands	Iringa, Katavi, Mbeya, Njombe, Rukwa, Ruvuma	Uyole (Zonal HQ), Kifyulilo	Maize, Rice
7	Western	Kigoma, Tabora	Tumbi	Maize, Rice, Plantains, Cassava, Coffee, Beans, Tobacco, Groundnuts, Agroforest

Source: Interview to Division of Research and Development, MALF, and http://www.erails.net/TZ/drd/drd-mafc/research-network-of-drd/

Details of some main research institutes[3] are described below.

TARI-Ilonga Centre

Established in 1943 as a Central Research Centre to improve cotton production in the Eastern Cotton Growing Area and later in 1989, it embarked into food crops for the Eastern Zone of Tanzania. The institute has seven commodity research sub-programs namely: maize, grain legumes (cowpea, green gram, soybean and pigeon peas), sorghum and millets, oilseeds (sunflower, sesame and groundnuts), cotton, soil and natural resource and crop protection. One of the oldest

[3] Information of this part mainly owes to "http://www.erails.net/TZ/organisation/".

research institutes in Tanzania. Coordinates research activities for research institutes of MALF in the Eastern Zone.
TARI-Mlingano Centre
Established in 1934 with the objective to conduct research for improvement of sisal yield. Since then Mlingano has been a well-known institute for sisal growers. Nearly, all sisal varieties grown in the country were developed at Mlingano. At present, Mlingano has a collection of over 120 varieties of sisal (the largest collection in the world). Nearly all activities in the country related to land evaluation and land use planning, fertilizer recommendations, agro-ecological zones and soil analysis have had a connection with this institute.
TARI-Ifakara Centre
Founded in September 1963 under the provision of an agreement between the two governments of Tanganyika and the Federal Republic of Germany. After the establishment of commodity research programs in 1975, the institute was mandated to coordinate rice research activities in Tanzania. Although rice is cultivated all over the country, the regions where rice is produced more includes Eastern zone (Morogoro and Coast regions), Southern highlands (Mbeya and Rukwa) and Lake zone (Shinyanga, Mwanza and Mara). After 2000, research activities mainly concentrated on rice and spices. However, in collaboration with other institutes, the station acts as a testing site for other crops such as maize, oil seeds (groundnuts, sesame, soybeans, sunflower), sugarcane, cowpeas, pigeon peas, and chickpeas. The rice research program has been working on improving varieties with best response to production attributes and more specifically by selecting breeding lines which are resistant to rice yellow mottle virus (RYMV) to meet farmers' priorities. In 2008, the institute was chosen to be the headquarters of the Regional Rice Centre of Excellence of the Eastern Africa Agricultural Productivity Program.
TARI-Ukiriguru Centre
The oldest research station and the main cotton research centre in Tanzania. As a native authority seed farm, it was opened in December 1930, and agricultural research activities began in November 1932 with the selection of varieties of sorghum, groundnuts, and cotton. The Empire Cotton Growing Corporation, at the request of the Ministry of Agriculture, began some research at Ukiriguru in 1939. When the Tanzanian Research services were reorganised into four zones in 1956, Ukiriguru became the centre for the Western Zone which consisted of Mwanza, Singida, Shinyanga, Tabora, Mara, Kagera and Kigoma regions. A formal program for training of junior agricultural staff was established in 1939, but the research and training wing were in 1974 split into separate units under a director and a principal, respectively.
TARI-Tengeru Centre
The history dates back to 1942, when a group of Polish refugees settled there during the 2nd World War, starting a dairy and beef cattle farm. In 1952, the Ministry of Agriculture took over the land and established a research and training institute. The research function became the Northern Research Centre, specialising in coffee and agricultural mechanisation. Seed testing began there in 1961, and two years later the Seed Testing Laboratory became a member of the International Seed Testing Association.
TARI-Naliendele Centre
Established in 1970 as a scientific institution of the ministry on a strong base of cashew research development shifted from Nachingwea and is now one of the world leaders in cashew research, boasting of a research database that could be useful not only to Eastern and Central Africa, but to a wider audience, including researchers from other countries interested in cashew. It coordinates cashew and oilseed crops at the national level and collaborates within and outside Tanzania in verifying research outputs. The institute consists of eight programs, namely: cashew research, oilseeds, roots and tubers, cereals and legumes, socio-economics, soils and land use, zonal research-extension-farmer linkage and zonal communication.

There are also several parastatal research institutes by subject as described below.

i) Tanzania Coffee Research Institute (TaCRI), Kilimanjaro
ii) Tea Research Institute of Tanzania (TRIT), Dar es Salaam
iii) Tobacco Research Institute of Tanzania (TORITA), Tabora
iv) Tropical Pesticides Research Institute (TPRI), Arusha

Some important policy statements on research and development in the National Agriculture Policy (October 2013) are shown below.

i) The agricultural research system shall be reformed to enhance the participation of a wide spectrum of stakeholders in identifying and setting research priorities.
ii) National research agenda on agriculture shall be regulated and coordinated.
iii) Public-Private Partnership (PPP) in research activities shall be facilitated.
iv) In collaboration with R&D institutions, research on irrigation and development of appropriate

smallholder agricultural mechanization and agro-processing technologies shall be promoted.

4.6 Agricultural Extension Services

In the Agricultural and Livestock Policy (1997), decentralization of the public agricultural extension services and transfer of administrative responsibility to Local Government Authorities (LGAs) were included. As a result of the year 1997 decentralization processes, agricultural extension services were divided into two; local government and central government. The major activities of the central government cover policy formulation, preparation of guideline and supervision while the local governments become the implementers of improved technology under supervision of the ministry. The National Agriculture Policy (October 2013) also stipulated the need for the government to deliver extension services to (primarily small-scale) farmers at the village level and to strengthen agricultural extension services to increase production, productivity, and profitability.

The MALF[4] is now formulating eight extension guidelines (e.g., Farmer field school guideline including how to implement extension guideline and ward resource centre guideline). The guidelines will be disseminated to local governments for implementation.

According to the Extension Services Section, MALF, there are currently 8,756 extension officers working at the field in addition to 63 extension officers working at the HQ, as of December 2016. In 2007, there were only 3,379 extension officers so the number of officers increased more than double during the recent ten years. However, the ministry's targets to have some 20,000 extension officers. (At each village, there is at least one extension officer and one extension officer at each ward.) So far various efforts have been made but there are still insufficient extension officers at the field due to the limited budget.

In order to fill the gap of deficit in extension officers, the following approaches are being applied.

- Training the lead farmers by using farmer field school (One-week training at the Training Centre and then they will train other fellow farmers).
- Farmer to farmer extension approach (From 1 to 1, from 1 to several farmers).
- Exchange visit approach (Invite farmers from other areas).
- Farmer field day (One farmer who learned at the learning field teach what he learned to other five farmers. The ministry also supports improved seeds, fertilizer, and farm machinery work for one model plot. Many farmers are invited to the plot at least twice– planting and harvesting. It happened that some 250 farmers came to the plot).
- Ward resource centre (So far 224 training centres are opened for extension staff).
- Agricultural exhibition (Once a year in August at one of the seven zones. In 2016, it was held in Lindi).
- Local radio program for Q&As.
- Planning to have a help desk where farmers can contact directly to the ministry through mobile

[4] Interview results with Crop Development Division, Extension Services Section, on 15 December 2016

phones asking for extension services (in collaboration with a private firm).

Some of the policy statements on extension services in the National Agriculture Policy 2013 are:

i) Extension services shall be transformed to ensure provision of quality services with increased private sector participation;
ii) Farmers' education and publicity services shall be strengthened for effective linkage and dissemination of technologies and information; and
iii) Specific commodity extension services shall be promoted and strengthened.

4.7 Farm Input Supply

(1) Seeds

Until the early 1990s, the Tanzanian government had a monopoly on the seed sector[5]. The 1989 National Seed Industry Development Programme started breaking state control in the seed sector, allowing private seed companies to operate in the country. Since then, the private sector started maize seed production and trade as well as importing maize and sorghum hybrid seed. Other seeds (sorghum, rice, legumes, and some open pollinated maize) are produced by small local seed companies or by a parastatal seed organisation, the Agricultural Seed Agency (ASA, rice in particular). Because Tanzania tries to support the development of a strong private sector, it also applies to the seed sector. Hence, the private sector (agro-dealers and seed companies) is increasingly involved in the promotion and demonstration of improved varieties, field days, etc.

At present, there are a variety of actors from public, private sector, as well as civil society in the Tanzanian seed sector. The public sector is involved in the primary chain functions as shown below.

- Genetic resource management: National Plant Genetic Resource Centre
- Variety development: Research organizations of MALF and universities
- Basic seed and certified seed production and distribution: ASA
- Quality control: Tanzania Official Seed Certification Institute (TOSCI)

The private seed companies produce and sell certified and basic seed. Agro-dealers are involved in the retail of certified seed produced by various seed companies. Individual farmers or farmer organisations are both on the end-user side of the seed chains but can also work for various seed production on contract. Several non-governmental organisations (NGOs) support farmers through training on seed production and marketing.

The formal seed system mainly consists of public agricultural variety development and early generation seed production, certified seed multiplication by public and private seed companies, marketing by registered agro-dealers and agricultural offices. Certified seed is normally available for maize, sorghum, beans, and rice, as well as vegetables and some oil crops.

[5] Information of this part mainly owes to (1) ASARECA/KIT, 2014, "Tanzania Seed Sector Assessment: A Participatory National Seed Sector Assessment for the Development of an Integrated Seed Sector Development (ISSD) Programme in Tanzania. April 2014, Entebbe, Uganda" and (2) World Bank, 2012, "Agribusiness Indicators: Tanzania, Agriculture and Environmental Services".

In Tanzania, there are 54 registered seed companies, which are also members of Tanzania Seed Trade Association, as well as some 1,500 registered agro-dealers. The registered seed companies and ASA produce and import certified seed of hybrid and open pollinated varieties. Majority of improved seeds are cereals and cash crops, vegetables and some pulses. In 2011/12, more than 25% of all required maize seeds, half of all vegetable seeds, and almost 80% of all cash crop seeds (cotton, tobacco, etc.) originated from the formal seed system. All other crops largely relied on the informal seed system. Only for rice, sorghum, wheat and sunflower production, some certified seeds are being used.

The 2010/11 National Panel Survey found that just 16.8% of households used improved seed. A large percentage of farmers retain seed from their prior year cereal or legume crop for planting and are less likely to buy new seeds every year. Nearly 70% of farmers pointed out the reason for not using improved seeds in the past as its higher cost. Despite the increase in availability of improved seed, only 27% of cropped area for maize was estimated to be used as improved seed in 2010. For rice, this proportion is very low, with only 1% of cropped area estimated to be planted with improved seed.

(2) Fertilizer

In Tanzania, the National Agricultural Input Voucher Scheme (NAIVS) started in 2008, which was a government input subsidy in response to the sharp rise in global grain and fertilizer prices[6]. The main aim of the program was to raise maize and rice production, and thus preserve Tanzanian households and national food security. In total, about USD 300 million had been invested in providing more than 2.5 million smallholder farmers with a 50% subsidy on a one acre package of maize or rice seed, and chemical fertilizer.

The program helped Tanzanian smallholders harvest more than 2.5 million tons of additional maize and rice grain. Independent surveys confirmed that farmers receiving subsidized maize seed and fertilizer increased their maize yields by an average of 433 kg per acre. Farmer receiving subsidized rice seed and fertilizer increased their average paddy yields by 263 kg per acre. However, the NAIVS program had multiple logistical challenges and ended in 2013/14 cropping season.

In the National Agriculture Policy 2013, the fertilizer use in Tanzania is summarised as follows:

> "The Agricultural Sector Review of 2008/2009 revealed that, over the last 12 years, the comparison of demand and supply of fertilizers shows there was a gap of about 33%. In Tanzania, only 10 kg of fertilizer is used per hectare as compared with as high as 50 kg per hectare in South Africa, while the Southern Africa Development Community average is 16 kg/hectare and Vietnam is 365 kg/hectare."

Recent fertilizer use data are not available but the World Development Indicators (2014) include change of fertilizer consumption (kg per hectare of arable land) from 2003 to 2012 as shown in Table 4.7.1.

Table 4.7.1 Change of Fertilizer Consumption (2003-2012)

Year	2003	2006	2009	2010	2011	2012
Fertilizer consumption (kg per hectare of arable land)	4.46	5.40	7.52	6.57	7.98	4.40

Source: World Development Indicators (WDI), November 2014

[6] Information of this part mainly owes to the World Bank, February 2014, "Tanzania Public Expenditure Review National Agricultural Input Voucher Scheme (NAIVS)".

The data indicated even less figures than the figure in NAP 2013 and the consumption per hectare in 2012 decreased as compared with that of 2011. In addition, the Household Budget Survey of 2011/12 surveyed percentage of plots applied with organic and inorganic fertilizer by sex of head and area.

Table 4.7.2 Percentage (%) of Plots Applied with Fertilizers by Sex of Head and Area, 2011/12

Item	Dar es Salaam			Other Urban Areas			Rural Areas			Mainland		
	Male headed	Female headed	Total	Male headed	Female headed	Total	Male headed	Female headed	Total	Male headed	Female headed	Total
Organic fertilizer	34.0	1.1	29.3	12.4	10.6	12.0	12.0	9.9	11.5	12.2	9.9	11.7
Inorganic fertilizer	6.4	7.1	6.5	22.8	27.2	23.8	8.1	6.0	7.7	9.4	8.2	9.1

Source: NBS, July 2014, Household Budget Survey 2011/12

Both types of fertilizers were not popularly applied, only 9-12% of plots. As compared with the rural area, plots with fertilizer application increased in urban areas. More male-headed households applied both fertilizers in their plots than female-headed households in general. These data indicated that application of both organic and inorganic fertilizer is still at a low level among the farmers in spite of various efforts/measures introduced by the government.

4.8 Marketing

(1) Rice

As for irrigation, rice[7] is the most important crop in Tanzania and there are multiple horizontal and vertical links from the producer to the consumer. The rice value chain involves: primary producers, traders in paddy and milled rice, processors, wholesalers, retailers, and consumers. Most actors are not specialized and their functions are related to various segments of the value chain. The value chain is fragmented, uncoordinated, disorganised, and uncontrolled.

Production is dominated by a large number of small-scale producers and a large number of middlemen operate across the country. There are also enormous number of small processors and individual sellers who supply restaurants, cafés, and street vendors (or otherwise put products on the market for the consumer). The horizontal and vertical linkages of the value chain are generally weak and uncompetitive.

Rice is an important staple food and is consumed in both urban and rural areas. The urban area of greater Dar es Salaam is the principal end market and accounts for about 60% of the national consumption. Quality differentiation is limited mainly to the amount of broken rice present, to whether it is aromatic or non-aromatic and to whether it is local or imported.

There are also regional preferences among consumers and rice is often labelled as being from regions that are perceived by consumers as special qualities:

- Rice from Kyela is considered to be the best, followed by rice from Mbeya;
- Morogoro rice is viewed as good quality, but inferior to Kyela and Mbeya; and
- Shinyanga rice is viewed as low quality as it is not aromatic.

Annual per capita rice consumption increased from 20.5 kg in 2001 to 25.4 kg in 2011. Increased rice

[7] Information of this part mainly owes to FAO (R. Trevor Wilson and I. Lewis), 2015, "The Rice Value Chain in Tanzania - A Report from the Southern Highlands Food Systems Programme".

consumption is both the result of population growth and an increasing preference among higher income urban households for rice. It is easier to prepare and a symbol of increased social and economic status as compared with sorghum and maize.

Officially, export of rice is very limited and is principally to neighbouring countries (Uganda, Rwanda, Kenya and Burundi, and occasionally to Malawi and Zambia). Tanzanian official export figures varied very much with official data from the importing countries. Informal trade bypassing customs posts is quite considerable and official data seemed to be under reported. The export markets are located in the main producing areas, and are very close to the borders with the importing countries. Good quality Tanzanian rice is in high demand in these markets but is not always available as a result of export bans and high export tariffs imposed by the Tanzanian authorities.

(2) Maize

Maize[8] is the staple food for the majority of Tanzanians. Most maize (80%) is produced by small-scale farmers and is grown both for subsistence and as a cash crop. Between 65-80% of harvested maize is consumed within the producing households: only 20-35% enters commercial channels.

Despite the importance of maize to Tanzania, the value chain is fragmented and poorly coordinated. There are many layers and inefficient connections between producers and consumers. Trust, reliable information systems, and the benefits of economies of scale are not well established. The majority of marketed maize is delivered to local collection hubs, accumulated by traders who sell on to local, regional, and urban markets. Some is also sold to processors and grain traders who accumulate and export. This works to the advantage of larger-scale operators in the business and to the disadvantage of most farmers. There are only a limited number of larger roller mills that produce high quality flour products, and all operate below capacity. Small-scale hammer mills are mainly used throughout the country to convert grain to low-cost and low-quality flour.

(3) Irish Potato

Irish potato[9] in Tanzania is essentially a food crop and consumed at household and through food service outlets like restaurants and cafés. About 90% of the national production comes from the Southern Highlands, especially from Iringa, Njombe, and Mbeya. The production system is mixed farming, rainfed based and exclusively by smallholder. Due to the recent increased demand, particularly in urban areas, potato production is expanding within the Southern Highlands Region, and is spreading into central (Morogoro) and north eastern (Kilimanjaro, Arusha, and Manyara) regions. Urban centres near Lake Victoria receive most of its potato importing from Kenya and Uganda and western urban centres rarely receive fresh potato due to poor road infrastructure.

The bulk of potato is sold into the market without grading and the marketing system is not well organised. Retailers and subsequent consumers pay high prices due to the high transaction costs of farmers and

[8] Information of this part mainly owes to FAO (R. Trevor Wilson and J. Lewis), 2015, "The Maize Value Chain in Tanzania - A Report from the Southern Highlands Food Systems Programme.".
[9] Information of this part mainly owes to the "Southern Agricultural Growth Corridor of Tanzania - Appendix IV: Value Chain and Market Analysis (Draft)" obtained from http://www.sagcot.com/resources/downloads-resources/.

traders. Marketing of potato in the Southern Highlands is unregulated and producers and traders have developed long-term relationships that are built on trust. The relationships and the systems in general appear to work and there are equitable gains among chain actors. Village traders/brokers get only about 2% of the end market price because they have no substantial investment apart from their time/labour.

4.9 Livestock and Fisheries

4.9.1 Livestock

In December 2016, livestock statistics by animal and district/region were collected from Monitoring and Evaluation Section, PPD, Livestock and Fisheries Department, MALF. The summarised data are shown in Table 4.9.1.

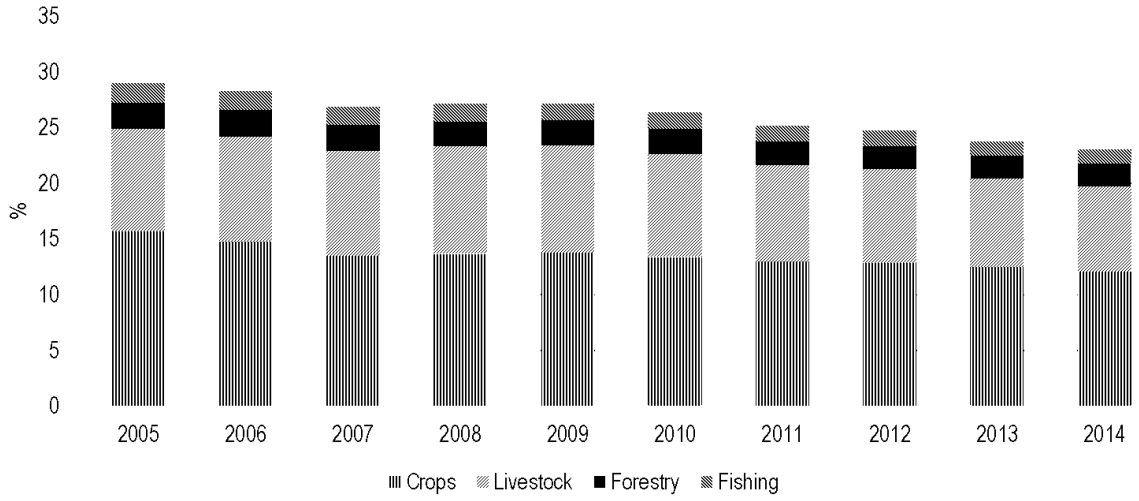
Table 4.9.1 Livestock Data by Animal and Region (As of August 2012)

Region	Number				Distribution			
	Cattles	Goats	Sheep	Chicken	Cattles	Goats	Sheep	Chicken
Arusha	1,605,735	1,884,783	842,453	1,094,205	6.7%	12.6%	19.2%	3.1%
Dar es salaam	272,937	160,367	17,043	1,957,649	1.1%	1.1%	0.4%	5.5%
Dodoma	1,504,632	1,025,756	258,011	1,549,452	6.3%	6.9%	5.9%	4.3%
Geita	817,195	427,622	47,692	1,183,162	3.4%	2.9%	1.1%	3.3%
Iringa	664,272	201,648	43,147	1,131,241	2.8%	1.4%	1.0%	3.2%
Kagera	845,449	730,300	75,478	1,172,304	3.5%	4.9%	1.7%	3.3%
Katavi	363,036	177,808	25,703	550,571	1.5%	1.2%	0.6%	1.5%
Kigoma	506,929	361,526	53,137	796,001	2.1%	2.4%	1.2%	2.2%
Kilimanjaro	654,468	693,824	246,210	1,640,672	2.7%	4.7%	5.6%	4.6%
Lindi	264,163	98,328	6,968	1,125,695	1.1%	0.7%	0.2%	3.2%
Manyara	1,807,094	1,542,414	581,246	1,103,236	7.5%	10.3%	13.2%	3.1%
Mara	1,651,355	757,428	342,892	1,612,672	6.9%	5.1%	7.8%	4.5%
Mbeya	1,452,698	557,030	76,967	2,452,569	6.1%	3.7%	1.8%	6.9%
Morogoro	881,766	489,060	128,360	2,077,975	3.7%	3.3%	2.9%	5.8%
Mtwara	167,200	226,077	15,886	1,134,864	0.7%	1.5%	0.4%	3.2%
Mwanza	1,333,569	574,942	129,678	1,829,259	5.6%	3.9%	3.0%	5.1%
Njombe	267,681	113,681	21,747	851,730	1.1%	0.8%	0.5%	2.4%
Pwani	535,289	191,472	43,395	1,271,132	2.2%	1.3%	1.0%	3.6%
Rukwa	640,014	233,399	35,488	747,384	2.7%	1.6%	0.8%	2.1%
Ruvuma	465,058	315,626	25,828	1,456,422	1.9%	2.1%	0.6%	4.1%
Shinyanga	1,299,261	620,795	196,998	1,634,373	5.4%	4.2%	4.5%	4.6%
Simiyu	1,595,889	929,895	389,366	1,673,455	6.7%	6.2%	8.9%	4.7%
Singida	1,371,975	829,155	292,579	1,387,484	5.7%	5.6%	6.7%	3.9%
Tabora	2,227,637	953,991	269,456	2,477,071	9.3%	6.4%	6.1%	6.9%
Tanga	772,600	816,588	223,149	1,765,218	3.2%	5.5%	5.1%	4.9%
Mainland	**23,967,902**	**14,913,515**	**4,388,877**	**35,675,796**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: Statistical data collected from the Livestock and Fisheries Department, MALF

In total, there are about 24.0 million cattle, 14.9 million goats, 4.4 million sheep, and 35.7 million chickens in the mainland. Tabora, Manyara, Mara, Arusha, and Simiyu are the major raising areas since these five regions occupy 37% of the total cattle. There are also many goats and sheep in Arusha and Manyara where 23% of goats and 32% of sheep are kept in these two areas, respectively. Chicken is more evenly distributed than cattle, goat, and sheep but there are some regions (e.g., Katavi and Rukwa) where raising number of chicken is relatively smaller than other regions.

About 90% of the livestock population is of indigenous types, which are known for their low genetic potential in milk and meat production. In 2014, the livestock subsector still represented 7.6% of GDP at 2001 prices but it decreased from 9.2% in 2005.



Source: National Bureau of Statistics website, http://www.nbs.go.tz/nbstz/index.php/english/2015-09-24-23-59-10

Figure 4.9.1 Shares of GDP (2001 Prices) by Economic Activity

4.9.2 Fisheries

Tanzania is endowed with fishery resources, both marine and inland[10]. Freshwater fisheries cover 62,000 km^2 including the shared waters of the great lakes, namely Victoria, Tanganyika, and Nyasa. The country has also other small natural lakes, man-made lakes, river systems, and many wetlands with fisheries potential.

The industry has been dominated by small-scale fishermen and fish farmers who normally uses traditional technology. According to the Fisheries Sector Development Strategy (2010), the fisheries sector provided substantial employment, income, livelihood, foreign earnings, and revenue to the country. It employs more than 4,000,000 people engaged in fisheries and fisheries-related activities while more than 400,000 fisheries operators are directly employed in the sector. It is an important economic subsector of the Tanzanian economy. In 2014, the growth rate of fisheries subsector was 2.0% and was 5.5% in 2013. The contribution of fishing activities to GDP almost remained constant with a slight change of 0.1%. In 2010, the share of fishing activities was 1.5% before decreasing to 1.4% in 2011 and 2012; it further decreased to 1.3% in 2013 and 2014.

Table 4.9.2 shows catchment volume and values by water body from 2012 to 2015. Since 2013, both catchment volume and values remained almost at the same level. In 2012, Lake Victoria represented over 70% of catchment volume and values but it occupied about two-thirds of both data since 2013. In 2013, several new water bodies started fish production but the decrease of distribution to Lake Victoria mainly resulted from the increase of catchment volume and values at Lake Tanganyika (from 8-9% to

[10] Information of this part mainly owes to (1) MALF, December 2010, "Fisheries Sector Development Strategy" and (2) URT, May 2016, "Agricultural Sector Development Programme Phase Two (ASDP2)".

15-16%). Catchment on rivers is very limited, namely, just 1% of the total catchment and values.

Table 4.9.2 Fisheries Production Data by Water Body

Year	2012		2013		2014		2015	
Water Bodies	**Catches (ton)**	**Values (TZS)**	**Catches (ton)**	**Values (TZS)**	**Catches (ton)**	**Values (TZS)**	**Catches (ton)**	**Values (TZS)**
Lake Victoria	240,256	872,822,786	234,530	938,119,720	236,287	980,591,752	237,097	983,954,580
Lake Tanganyika	31,568	101,018,955	59,912	233,276,569	59,281	237,123,929	54,161	216,642,255
Lake Nyasa	11,305	35,044,470	9,913	38,165,050	9,387	35,669,080	10,095	38,362,449
Lake Rukwa	4,196	13,428,174	3,661	13,911,800	3,040	11,550,480	3,221	12,239,083
Mtera Dam	744	2,380,026	913	3,285,000	504	1,812,687	598	2,152,860
Nyumba ya Mungu Dam	993	3,375,884	246	921,375	233	873,759	258	967,014
Lake Kitangiri	1,412	3,812,961	295	1,033,900	213	850,000	213	870,307
Lake Singidani			136	462,094	117	479,123	120	490,314
Lake Kindai			69	234,260	59	243,267	57	232,899
Lake Burunge			41	141,795	6	21,914	6	24,189
Minor waters (Lake Babati, Lake Eyasi, Lake Jipe)			390	1,460,625	194	724,851	192	786,136
River Kilombero			4,902	17,891,205	4,742	17,307,971	3,903	15,947,330
Small-scale Marine	50,592	166,954,953	52,846	195,529,127	51,912	207,649,600	52,723	210,892,897
Total	**341,066**	**1,198,838,208**	**367,854**	**1,444,432,520**	**365,974**	**1,494,898,413**	**362,645**	**1,483,562,313**

Source: Statistical data collected from Livestock and Fisheries Department, MALF

4.10 Agricultural Cooperatives

In Tanzania, cooperatives[11] were first introduced into the cash crop growing at the beginning of the early 1920s. In 1933, the first cooperative union in the country, the Kilimanjaro Native Cooperative Union, was registered with its eleven affiliated primary cooperatives. Cooperatives increased rapidly in the country with support from the government. Marketing cooperatives also expanded their business tremendously in the early 1960s. The number of cooperatives exceeded 1,600 in 1966 and reached 2,500 in 1974.

However, radical changes in government policy on cooperatives occurred after the introduction of socialism to all macroeconomic and social programs. In 1976, all primary cooperatives were abolished by the government and their crop marketing functions were taken over by communal villages. At the same time cooperative unions were also abolished and their functions were taken over by parastatal crop authorities, which had to buy crops directly from villages. However, the crop authorities failed in buying peasant crops and in providing price incentives, and their activities for the supply of farm inputs and credit were not well functioned. Facing this serious situation, the government formally announced the re-introduction of cooperatives and cooperative unions in 1982. However, the damage was too heavy. Cooperatives lost much of their property and highly trained manpower during the abolition period.

Saving and credit cooperatives (SACCOS) were not as many as the crop marketing cooperatives in the pre-abolition period. However, SACCOS grew rapidly after the 1980s and as institutions they have

[11] Information of this part mainly owes to (1) ILO (Sam Maghimbi), 2010, "Cooperatives in Tanzania mainland: Revival and growth" and (2) University of Helsinki, 2013, "Cooperatives as a tool for poverty reduction and promoting business in Tanzania"

remained more stable than the crop marketing cooperatives. In the 1980s and 1990s when most crop marketing cooperatives collapsed, the SACCOS continued to survive. The Cooperative Development Policy (2002) led to the 2003 Cooperative Societies Act. The Cooperative Rules of 2004, which are part of the Act, provided an elaborate list and definition of the various kinds of cooperatives which can be established. As of June 2016, there are about 4,400 SACCOS in the country while the number of crops cooperatives is about 2,900.

Table 4.10.1 Number of Cooperatives by Type and Region (As of June 2016)

S/N	Region	Crops	Irrigation	Bee Keeping	Fishery	Livestock	SACCOS	Con-sumers	Unions	Fede-ration	Others	Total
1	Arusha	52	4	-	-	28	351	8	1	-	15	459
2	Dar es Salaam	34	-	-	3	-	719	17	3	1	120	897
3	Dodoma	28	2	7	-	2	168	-	-	-	21	228
4	Geita	158	-	9	5	5	281	-	1	-	73	532
5	Iringa	85	-	1	2	3	149	-	1	-	96	337
6	Kagera	250	-	-	-	4	82	1	3	-	6	346
7	Katavi	11	-	2	-	-	27	-	2	-	2	44
8	Kigoma	79	-	3	1	-	151	1	1	-	22	258
9	Kilimanjaro	49	32	-	1	14	234	298	2	-	35	665
10	Lindi	117	2	-	-	-	104	3	1	-	10	237
11	Manyara	56	-	1	-	16	101	-	1	-	8	183
12	Mara	83	1	2	1	8	217	2	2	-	41	357
13	Mbeya	202	18	-	29	28	139	5	6	-	36	463
14	Morogoro	49	-	2	-	2	139	-	4	1	14	211
15	Mtwara	261	-	-	-	-	60	-	2	-	14	337
16	Mwanza	198	-	-	14	-	189	3	1	-	20	425
17	Njombe	85	-	1	-	5	120	-	2	-	9	222
18	Pwani	79	2	-	4	5	74	-	3	-	13	180
19	Rukwa	37	-	-	4	5	88	4	-	-	-	138
20	Ruvuma	98	-	-	-	1	86	-	6	-	-	191
21	Shinyanga	184	-	-	-	6	255	-	2	-	24	471
22	Simiyu	154	-	-	-	6	53	1	-	-	-	214
23	Singida	94	-	9	2	2	107	1	2	-	16	233
24	Tabora	397	7	16	6	10	329	7	3	-	8	783
25	Tanga	68	8	1	3	27	223	1	2	-	32	365
	TOTAL	**2,908**	**76**	**54**	**75**	**177**	**4,446**	**352**	**51**	**2**	**635**	**8,776**

Source: Statistical data collected from Cooperative Development Commission

In Tabora, there are nearly 400 crops cooperatives which occupied 51% of the regional total number. Mtwara has 261 crops cooperatives, which is the second largest number among the 25 regions, representing 77% of the total regional number, 337 cooperatives. Kagera is similar to Mtwara, 250 crops cooperatives occupying 72% of the regional total, 346. On the other hand, crops cooperatives are not so popular in Katavi (11 crops cooperatives) and Dodoma (28 crops cooperatives), which is smaller than Dar es Salaam, 34 crops cooperatives.

4.11 Agricultural Processing

The manufacturing production index, a rate that measures changes in commodities production in real terms over time (1985=100), is summarised in Table 4.11.1. Over the six years from 2007 to 2012, the index of food, beverages, and tobacco gradually increased. Rapid growth was observed in activities of wood and wood products, paper and paper products as well as fabricated metal products. On the contrary,

the performance of textiles, leather, and chemicals and plastic products decreased during the same period.

Table 4.11.1 Manufacturing Production Index of Tanzania (1985=100, 2007-2012)

Year	2007	2008	2009	2010	2011	2012	Average Increase Rate over 5 Years
Food, beverages & tobacco	388.8	351.3	375.5	407.0	397.8	455.3	3.21%
Textiles & leather	667.8	285.5	229.3	243.5	228.5	201.5	-21.31%
Wood & wood products	82.0	263.5	246.5	248.3	347.8	707.3	53.87%
Chemicals & plastic products	183.5	107.3	124.8	137.5	144.5	140.0	-5.27%
Basic metal products	152.3	177.0	203.5	236.0	270.3	293.8	14.04%
Non-metallic products	387.0	415.5	458.8	526.0	536.0	574.0	8.20%
Paper & paper products	42.8	310.3	295.3	317.3	343.5	359.8	53.08%
Fabricated metal products	13.5	74.3	72.0	76.3	81.5	104.0	50.43%
Other manufacturing industries	227.0	297.8	385.3	433.5	575.8	582.5	20.74%

Source: E Manuel A. M Waigomole, Journal of Social and Economic Policy, Vol. 11, No. 2, December 2014, pp. 145-157, Manufacturing Sector as an Engine of Growth in Tanzania: A Critical Approach,

Table 4.11.2 indicates the number of agro-processing[12] establishments that employ more than 10 workers in 2009. Agro-processing subsector occupied more than one-third of total manufacturing establishments with more than ten employees.

Table 4.11.2 Number of Agro-processing Establishments by Activity (2009)

Industrial Activity	No. of Establishments	Percentage
Processing and preserving of meat	1	0.4%
Processing and preserving of fish, crustaceans and molluscs	13	5.3%
Processing and preserving of fruit and vegetables	3	1.2%
Manufacture of vegetable and animal oils and fats	34	13.9%
Manufacture of grain mill products, starches and starch products	58	23.8%
Manufacture of other food products	91	37.3%
Manufacture of prepared animal feeds	6	2.5%
Manufacture of beverages	35	14.3%
Manufacture of tobacco products	3	1.2%
Subtotal of Agro-processing	244	100.0%
Total of Manufacturing	686	-
Percentage of Agro-processing to Total Manufacturing	35.6%	-

Source: The Agro-Food Industry Measurement - FAO-UNIDO Expert Group Meeting in Rome, Italy, November 2015

The agricultural processing subsector is the largest manufacturing subsector in terms of contribution to production and employment based on the Tanzania Industrial Competitiveness Report 2015. Hence, the subsector was identified as a priority area for achieving sustainable industrial development in the national policy framework. Because of (1) its relatively rich natural resources, (2) labour-intensive nature, and (3) low technology required in production process, it seems that the subsector has a comparative advantage as compared with other subsectors.

However, value added of the subsector has been growing slowly and there has been a reduction in the number of workers between 2008 and 2010. For instance, the tobacco products and processing/ preserving of fish, etc., sectors lost 20% and 27% of its workers, respectively, in the same period as

[12] Information of this part mainly owes to (1) Ministry of Industry, Trade and Investment of the United Republic of Tanzania, 2016, "Tanzania Industrial Competitiveness Report 2015," and (2) Fadhili S. Khalfani, Tanzania National Bureau of Statistics, 23-24 November 2015, "The Agro-Food Industry Measurement - FAO-UNIDO Expert Group Meeting in Rome, Italy".

shown below.

Table 4.11.3 Employment Distribution in Agricultural Processing Subsector (2008-2010)

Industrial activity	Share of Employment in 2010	Change between 2008 and 2010
Sugar	33%	8%
Tobacco products	8%	-20%
Softdrinks, mineral waters	7%	1%
Grain mill products	7%	28%
Cocoa, chocolate, and sugar confectionery	6%	-11%
Processing/preserving of fish, etc.	4%	-27%
Vegetable and animal oils and fats	3%	31%
Malt liquors and malt	2%	3%
Distilling, rectifying and blending of spirits	2%	8%
Bakery products	1%	8%
Other agro-processing	26%	-12%
Total	100%	

Source: Ministry of Industry, Trade and Investment, Tanzania Industrial Competitiveness Report 2015

Among the various industrial activities, sugar production has the largest share, 33%. Rapid growth in employment is observed in the activities of grain mill products and vegetable and animal oils and fats. This trend accords with the recent production increase of cereal and oil crops in the MALF statistics.

Table 4.11.4 Number of Persons Engaged by Industrial Activity and Sex (2009)

Industrial Activity	Male	Female	Total	Female %
Processing and preserving of meat	21	17	38	44.7%
Processing and preserving of fish, crustaceans and molluscs	1,384	443	1,827	24.2%
Processing and preserving of fruit and vegetables	72	72	144	50.0%
Manufacture of vegetable and animal oils and fats	1,166	461	1,627	28.3%
Manufacture of grain mill products, starches and starch products	2,313	880	3,193	27.6%
Manufacture of other food products	22,047	8,030	30,077	26.7%
Manufacture of prepared animal feeds	90	49	139	35.3%
Manufacture of beverages	4,518	932	5,450	17.1%
Manufacture of tobacco products	2,665	1,150	3,815	30.1%
Total Agro-Food Manufacturing	34,276	12,034	46,310	26.0%
Total Manufacturing	67,607	29,474	97,081	30.4%
Percentage of Agro-Food to Total Manufacturing	50.7%	40.8%	47.7%	-

Source: The Agro-Food Industry Measurement - FAO-UNIDO Expert Group Meeting in Rome, Italy, November 2015

Although the industrial activity categories are not same as those in the tables shown so far, the data in Table 4.11.4 indicate that, as of 2009, agro-food manufacturing activities occupied about a half of the total employees in the manufacturing sector. This means that agricultural processing subsector was quite important and significant for the Tanzanian industry sector as well as it provided many job opportunities for people including women.

4.12 Agricultural Credit and Rural Finance

Rural financing is an important stimulant for technology adoption because it mitigates challenges encountered by farmers who face seasonal cash fluctuations and it allows immediate consumption for future benefits. Rural finance and credit systems are considered to be very significant and indispensable for improved technology use, such as fertilizer and high yielding varieties of seed.

In Tanzania, what has been commonly referred to as agricultural credit[13] typically means supply led loans packaged into inputs supplies. The single marketing chain linking primary cooperative societies, marketing boards and state-owned banks, acted as a promoter for such loans. Agricultural credit packaged in this way has decreased following the reforms of input delivery systems and the restructuring of state-owned banks.

Following the privatization policies during latter half of 1990s, the National Microfinance Bank (NMB) which has a broad national branch network, and the Cooperative Rural Development Bank (CRDB) were established, and these banks made efforts since then to provide credits to agricultural sector. The level of credit provision to the agricultural sector against the whole country is shown in the table below. For the 11-year period until 2015, the average share of agricultural lending in the whole country is about 11%. Parallel to the overall expansion of domestic lending, the amount of credits to agricultural sector is increasing. But the pace of expansion is dropping since 2012.

Table 4.12.1 Amount of Lending to Agricultural Sector by Commercial Banks (2005-2009)

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Amount of lending to agricultural sector (TZS billion)	177	292	328	541	501	757	1,011	983	1,017	1,156	1,258
Amount of lending in the whole country (TZS billion)	1,425	2.094	2.976	4,376	4,806	5,798	7.399	8.722	10.153	11.267	13,746
Share of agricultural lending in the whole (%)	12.4	13.9	11.0	12.4	10.4	13.1	13.7	11.3	10.0	10.3	9.1

Source: FAO Statistics, Agricultural Credit (http://www.fao.org/economic/ess/investment/credit/en/)

Financial institutions that cater various financial products such as credit and savings are still heavily urban biased in Tanzania. As of 2011, there were 32 commercial banks (which offer checking or other demand deposit accounts) and 18 other financial institutions in Tanzania. The former includes CRDB, NMB, National Bank of Commerce (NBC), Akiba, Barclays and EXIM Bank, among others. All but one of these are headquartered in Dar es Salaam. The latter include community and cooperative banks such as the Njombe Community Bank and Kagera Farmers Cooperative Bank, and are headquartered around the country. The latter financial institutions usually have a development focus.

Thus, vast rural areas in Tanzania still remain seriously underserved. The very few financial institutions (banks) are found in rural areas, and mainly provide services to civil servants and salary earners. Rural small producers have a harder time accessing these financial institutions, and have to walk long distances to branches. According to the National Sample Census of Agriculture 2007/2008, only 2.4% of the total agricultural households borrowed money for agricultural activities. The reasons for not acquiring credit include the following: (1) no knowledge on how to get credit for agriculture, 31.1%, (2) credit is not available, 18.3 %, and (3) no knowledge about credits, 18.0 %. For the households who borrowed money in 2007/08 in Tanzania, the main agricultural credit providers to them were (1) cooperatives which

[13] Information of this part mainly owes to (1) Temu, A. E., Nyange, D., Mattee, A. Z. and Kashasha, L. K., 2005, "Assessing Rural Services, Infrastructure and their Impact on Agricultural Production, Marketing and Food Security in Tanzania Final Donor Report of a Research Project funded under IFPRI Eastern African 2020 Vision Network" and (2) IFAD, October 2011, "Rural Financial Services Programme and Agricultural Marketing Systems Development Programme - Interim Evaluation".

provided credit with 28%, (2) family, friends or relatives with 23%, and (3) savings and credit, 19%.

Household Budget Survey 2011/12 also indicated low accessibility of credit in rural areas. Overall, in the mainland, 21% of households reported running a business. Households living in rural areas were much more likely to run their own business (62%) while Dar es Salaam has the lowest (13%). The main source of start-up capital of those who run businesses was summarised as below.

Table 4.12.2 Percentage of Household Businesses by Main Source of Start-up Capital and Area, 2011/12

Source of Capital	Rural Areas	Dar es Salaam	Other Urban Areas	Tanzania Mainland
Proceeds from agricultural production	46.5	1.8	13.7	32.4
Own savings	23.6	66.5	50.8	36.2
Gift from family/friends	8.0	14.1	14.6	10.5
No need	6.2	0.5	1.1	4.1
Loan from family/friends	4.7	7.0	6.1	5.4
Other	4.7	3.0	4.9	4.5
Proceeds from non-agricultural production	2.7	0.3	1.0	2.0
From inheritance	2.1	1.8	2.1	2.0
Sale of assets owned	0.7	0.5	1.1	0.8
Loan from SACCOS	0.5	2.4	2.2	1.2
Loan from banks	0.3	2.2	2.3	1.0
Total	100.0	100.0	100.0	100.0

Source: Household Budget Survey 2011/12, NBS, July 2014

In rural areas, agricultural production was the dominant source with 46.5% of household business owners. While the household members who secured loans from SACCOS and banks for starting their business investments in Dar es Salaam and other urban areas accounted 4.5%, those who did in rural areas represented only 0.8%, less than one-fifth. Up to now, there still very limited number of rural residents seemed to have access to finance institutions.

4.13 Private Sector in Agricultural Sector

In the following, private sector situation is described from viewpoints of production/processing and investment and development.

4.13.1 Private Sector in Production and Processing

Patterns of private companies' engagement in agricultural production and processing vary according to types of crops. In food crops such as maize, rice and cassava, because farmers produce primarily for their own consumption, they are mostly produced by smallholder farmers, and the degree of processing is low. It sometimes said that such farmers are also private actors. But this is not what usually meant by the word. In this type of crop, so-called middlemen or traders are major private actors, buying crops on farm and carry them to wholesale markets. These stakeholders (farmers, middlemen, traders, and millers) interact each other at numerous local settings, constituting a highly fragmented value chain. There are no significant value chains in food crop subsector which are controlled by a single player, either millers or retailers.

As for cash crops, there are several cases where private companies manage the production and

processing. Such crops as tea, cotton, tobacco and sugarcane often observe a contract farming type of arrangement organised by a processor, private firm. In tea production, private firms advance into large scale plantation operation where farmers become just employees of the firm. At another end of the spectrum of cash crop production arrangement, coffee and cashew nut are produced by more independent farmers. Processors or middlemen purchase the commodity from individual or group of farmers and send to international market after processing. There are some occasions where private processors enter into the contract farming arrangement. Rice is sometimes produced solely for market sales (i.e., cash crop). In such a case, production turns to be of large-scale plantation where the company occupies large plot and operate capital intensive production. In the subsector of cash crop, there is a trend especially for the last several years that private players gradually expand their roles along value chains. As described in the next section, when the government promotes private sector involvement in agricultural development, it is likely to involve cash crops such as rice or sugarcane.

Vegetables are also good cashable crops. But because of perishability, any scalable value chain management requires some level of investment. Therefore, at present the crops are typically produced by individual or small group of farmers and purchased and carried by middlemen to markets. There are however, a few examples of active private companies forming an out-grower relation (contract farming) with farmers. They are emerging in specific niches as exporting to neighbouring countries or marketing of high value vegetables.

In the subsector of oil seeds such as sunflower and groundnut whose production have expanded rapidly last several years, traders or processors (oil extractors) often organise farmers into a group and set up contractual relationship with the farmers. The organisers often supply seeds and other inputs and purchase the harvest from member farmers. However, at present, the scale of such arrangements is still small and the value chain is characterized by limited activities of private companies.

There are few large-scale private operations in milk production and distribution. Such private companies organise farmers and manage collection, processing, packaging, distribution, and retailing. The extent of such operation is widening. However, conventional livestock commodities such as meat and egg are still handled by a traditional mode where individual farmers/ keepers produce, process (slaughter) and bring to nearby markets, although there are a few exceptions of large-scale operators.

As described above, there are in general only limited engagements by private sector in agricultural production and processing. They are played by middlemen and traders as used to be in the past. However, for a few specific crops such as horticulture, oil seeds, and dairy products, where demands are expanding rapidly, there are increasing, if not of full scale, activities of private companies. Due to these activities, value chains of the crops are gradually improving with respect to efficiency and product quality. However, for more tangible impacts of private sector involvement, one still needs to look for large-scale private engagement, which is typically brought about by foreign direct investments (FDI).

4.13.2 Private Sector in Agricultural Investment and Development

Basic policy of private sector involvement in agricultural sector was already claimed by a form of “PPP” in the 2001 Agricultural Sector Development Strategy. This policy was placed into action by the first

ASDP (2006/07 – 2013/14). Parallel to this, the government declared a proclamation "Kilimo Kwanza (Agriculture first)", followed by such initiatives as SAGCOT (2011 – present) and Big Result Now (BRN) (2013/14 – 2015/16). These actions were primarily intended to solicit foreign investments in Tanzania's development process, in particular into the process of transforming agriculture from subsistence to commercial undertaking.

According to the data of FDI since 2008, major destinations of FDI inflow are sectors of mining and quarrying, manufacturing, finance and insurance, and electricity and gas. Unfortunately, despite the government initiatives above, agricultural sector is not included in the major targets, receiving less than 3% of whole FDI both in terms of inflow and accumulation. Worse, the share has declined in 2012 and 2013 indicating decreasing trend.

Table 4.13.1 Stock and Flows of FDI by Activity, 2009 – 2013 (USD in Million)

Activity	FLOWS						STOCK					
	2008	2009	2010	2011	2012	2013	2008	2009	2010	2011	2012	2013
Mining and quarrying	669.8	385.1	909.9	406.5	889.3	520.4	3,714.1	4,099.2	5,009.1	5,415.5	6,304.8	6,825.2
Manufacturing	277.6	214.5	157.1	217.3	563.7	386.6	870.7	1,085.2	1,242.3	1,459.5	2,023.3	2,409.9
Financial and insurance	81.7	95.9	95.5	121.1	148.1	752.2	416.3	512.2	607.6	728.7	876.8	1,629.0
Electricity and gas	1.0	2.1	290.5	209.4	618.3	37.3	24.7	26.8	317.3	526.7	1,145.0	1,182.3
Accommodation	129.7	35.9	21.1	165.6	5.4	47.0	388.7	424.6	445.7	611.3	616.8	663.8
Wholesale and retail trade	21.1	-16.9	36.9	114.5	-35.2	123.5	372.0	355.1	392.0	506.5	471.3	594.8
Information and communication	127.6	185.1	83.5	-98.3	-420.1	195.9	532.4	717.4	801.0	702.7	282.6	478.5
Agriculture	21.2	29.0	22.9	31.4	11.2	10.3	202.3	231.3	254.2	285.6	296.8	307.1
Professional activities	-0.7	0.5	213.0	6.1	20.1	-0.1	1.1	1.6	214.6	220.6	240.7	240.6
Construction	-3.7	14.9	-23.5	30.7	-28.1	13.8	119.5	134.4	110.9	141.5	113.4	127.2
Real estate activities	26.5	1.5	1.5	12.0	23.4	-0.6	79.7	81.2	82.8	94.7	118.1	117.5
Transportation and storage	2.7	3.9	4.0	10.4	-1.0	19.5	28.8	32.7	36.7	47.1	46.1	65.6
Other service activities	1.4	1.4	-0.8	1.1	3.9	22.9	3.8	5.2	4.4	5.5	9.4	32.3
Education	0.4	0.3	1.6	1.8	0.5	2.2	2.0	2.3	3.9	5.7	6.2	8.4
Grand Total	1,383.3	953.1	1,813.3	1,229.4	1,799.6	2,130.9	6,945.6	7,898.7	9,711.9	10,941.3	12,740.9	14,871.8

Source: Bank of Tanzania, NBS, 2013 and 2014, Tanzania Investment Report

Table 4.13.2 Stock and Flows of FDI by Activity, 2009 – 2013 (%)

Activity	FLOWS (Share by Activities)						STOCK (Share by Activities)					
	2008	2009	2010	2011	2012	2013	2008	2009	2010	2011	2012	2013
Mining and quarrying	48.4	40.4	50.2	33.1	49.4	24.4	53.5	51.9	51.6	49.5	49.5	45.9
Manufacturing	20.1	22.5	8.7	17.7	31.3	18.1	12.5	13.7	12.8	13.3	15.9	16.2
Financial and insurance	5.9	10.1	5.3	9.9	8.2	35.3	6.0	6.5	6.3	6.7	6.9	11.0
Electricity and gas	0.1	0.2	16.0	17.0	34.4	1.8	0.4	0.3	3.3	4.8	9.0	7.9
Accommodation	9.4	3.8	1.2	13.5	0.3	2.2	5.6	5.4	4.6	5.6	4.8	4.5
Wholesale and retail trade	1.5	-1.8	2.0	9.3	-2.0	5.8	5.4	4.5	4.0	4.6	3.7	4.0
Information and communication	9.2	19.4	4.6	-8.0	-23.3	9.2	7.7	9.1	8.2	6.4	2.2	3.2
Agriculture	1.5	3.0	1.3	2.6	0.6	0.5	2.9	2.9	2.6	2.6	2.3	2.1
Professional activities	-0.1	0.1	11.7	0.5	1.1	0.0	0.0	0.0	2.2	2.0	1.9	1.6
Construction	-0.3	1.6	-1.3	2.5	-1.6	0.6	1.7	1.7	1.1	1.3	0.9	0.9
Real estate activities	1.9	0.2	0.1	1.0	1.3	0.0	1.1	1.0	0.9	0.9	0.9	0.8
Transportation and storage	0.2	0.4	0.2	0.8	-0.1	0.9	0.4	0.4	0.4	0.4	0.4	0.4
Other service activities	0.1	0.1	0.0	0.1	0.2	1.1	0.1	0.1	0.0	0.1	0.1	0.2
Education	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.1
Grand Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Computed by the JICA Study Team from the original data (Bank of Tanzania, NBS, 2013 and 2014, Tanzania Investment Report)

Further observations are made by looking into the details of the outputs of BRN (agriculture)[14]. This initiative was aspired by the government with clear goal of rapid changes by intensive interventions by the government and mobilization of foreign investments. Agricultural BRN consisted of three components: 25 large-scale private sector agricultural investments (plantation type operation), 78 private sector led irrigation management, and 275 warehouse rehabilitation/construction and their operation, all of which were expected to complete in three years from 2013/14. Among the components, the 25 investments were particularly noted with high expectation that agricultural modernization would soon be achieved. Unfortunately, however, until now, there have not been many achievements except for four projects that secured partial transfer of land title to investors. The results are summarised in Table 4.13.3.

Table 4.13.3 Outputs of BRN (Agriculture) as of June 2016

Activity	Status (as of June 2016)
Development of 25 Commercial Farms	Only four projects had some progress: ・ Bagamoyo, (Bagamoyo DC), (Sugarcane): Land title was acquired by investor. ・ Mkulazi, (Morogoro DC), (Sugarcane): Land title was acquired by investor. ・ Lukulilo (Rufiji DC), (Rice): Land title was acquired by investor. ・ Kitengule (Karagwe DC), (Sugarcane): Land title was acquired by investor. Other 21 projects are still in the process of finding interested investors.
78 Privately Managed Irrigation Schemes	Out of 78 schemes, 39 have been given some supports (funds for facility rehabilitation or training, etc.). However even the 39 schemes are still incomplete due to not-sufficient funds for rehabilitation etc.
275 Warehouse management	Out of 275 warehouses, 75 have been given some support (funds for warehouse rehabilitation, equipment or training).

Source: Prepared by the JICA Project Team

As described above, mobilisation of private sector has been limited in agricultural sector. In the current economic situation of the country where the national economy has been growing steadily at a sound rate, the policy of private sector mobilization is very timely and suitable. However, as actual attempts revealed, the country needs to overcome several challenges to really effectively attract foreign investments.

The greatest challenge is the land title and ownership. Even now vast majority of Tanzanian land is subject to traditional village ownership or customary arrangement. The government is making efforts to accelerate land registration, but the undertaking so far covers only 10% of total area, as of 2015. Without clear measurement and records of land ownership, large-scale investments especially those by foreign companies are handicapped by uncertainty of the transfer of land title.

Another challenge is the securing agreements with and compensation to local people. Although investors usually take great care of supplying information and explaining the project to stakeholders, the latter often feel it indispensable to have consultation or negotiation opportunities with investors. Moreover, the stakeholders sometimes show concerns when politicians and government officials are involved in such occasions. If such consultation is not sufficient, investment project sometimes encounters difficulties in securing necessary agreements with stakeholders along the process of implementation.

In addition to the two issues above, investment into Tanzania is subject to other difficulties such as inefficient administrative process of permits and licenses, prolonged time for procurement, unexpected

[14] BRN has 6 components: Infrastructure, energy, water, agriculture, education, and financial mobilisation.

change in policies (export ban), inconsistency among policies and regulations, and inadequacy of public infrastructure like road and electricity. According to the World Bank "Ease of Doing Business Rank" (June 2016)[15], Tanzania is positioned at 132 out of 190 countries. The government needs to carry out further reforms and improvements in order to attract private investments into agricultural sector.

[15] World Bank, 2016 June, Doing Business Ranking, access to http://www.doingbusiness.org/rankings

Chapter 5 Present Conditions of Irrigation Sector

5.1 General

Since the current National Irrigation Master Plan 2002 (NIMP2002) was prepared in 2002, there have been many changes in the circumstances surrounding the irrigation sector for the last 15 years, such as the government development policies, government administrative system and regulations, climate change, and global economy. The National Irrigation Commission (NIRC) is currently leading the irrigation development and management in the mainland of Tanzania as an independent government agency established in 2015 under the Ministry of Water and Irrigation (MoWI). The NIRC reportedly has achieved the development target set out in the current NIMP2002 by 2014/15, and is now facing a challenge to formulate the next long term irrigation development plan towards the future.

This part reviewed the present conditions, problems, and constrains in the irrigation sector, which provide the basis for the formulation of National Irrigation Master Plan 2018 (NIMP2018).

5.2 National Irrigation Policy and Act

(1) National Irrigation Policy 2010

The National Irrigation Policy 2010 (NIP2010) was officially published in February 2010 in response to the recommendation of the present NIMP2002. The outline of NIP2010 is summarised in Table 5.2.1.

Table 5.2.1 Outline of National Irrigation Policy 2010

Item	Description	
1. Vision	A sustainable and dynamic irrigation sector that is a driving force in transforming agriculture into a stable, highly productive, modernised, commercial, competitive, and diversified sector which generates higher incomes; increases food security and stimulates economic growth.	
2. Mission	To facilitate a participatory demand driven irrigation development through Integrated Water Resources Management to enhance water use efficiency for increased and sustainable agricultural production, productivity and profitability to ensure food security, poverty reduction, and national economic development.	
3.1 Objectives	The main objective is to ensure sustainable availability of irrigation water and its efficient use for enhanced crop production, productivity, and profitability that will contribute to food security and poverty reduction.	
3.2 Major Subjects	・ Investment for irrigation development in Tanzania ・ Management of irrigation schemes ・ Irrigation research and development ・ Institutional capacity ・ Financing mechanism ・ Cross-sectoral issues	・ Cross-cutting issues ・ Institutional arrangement for policy implementation ・ Legal and regulatory framework for accelerated development of the irrigation sector ・ Coordination, monitoring, and evaluation

Sources: NIRC, 2010, NIP

It is noted that the Strategic Environmental and Social Assessment (SESA) for NIP2010 and NIMP2002 was conducted in 2011.

(2) National Irrigation Act 2013

The National Irrigation Act 2013 (NIA2013)[1] was publicly issued in January 2014 as the legal grounds

[1] http://www.lrct.go.tz/download/Laws-of-Tanzania.../ActNo-5-2013.pdf

to implement NIP2010. NIA2013 is comprised of 10 parts and 75 sections. The Irrigation Regulations 2015 (IR2015) was made under Section 74 of NIA2013 and the Government published it on 11th September 2015. IR2015 is comprised of 108 sections to supplement NIA2013. The outline of NIA2013 is shown in Table 2.5.3.

(3) Draft National Irrigation Development Strategy

The draft National Irrigation Development Strategy (NIDS-draft) was once drawn up in November 2013 to incorporate NIP2010 into the development strategy. The outlines of NIDS-draft are shown in Table 2.5.3. However, the final version has not come out yet until now. According to the NIRC, the NIDS-draft will be reviewed and finalized upon receiving the final report on the NIMP2018.

5.3 Definition of Irrigation and Irrigation Schemes

It is first important to understand the definition of irrigation-related technical terms introduced in NIP2010 and NIA2013, which are often defined in the context of Tanzania.

5.3.1 Definition of Irrigation

Irrigation is generally defined as a method to control applications of water required to crops to supplement rainfall. However, it includes a farmer-made traditional irrigation in Tanzania as shown in Table 5.3.1

Table 5.3.1 Definition of Irrigation

Technical Term	NIA2013	FAO
Irrigation	The application of a specific amount of water at a location in order to meet the requirements of a crop growing at that location in amounts that are appropriate to the crop's stage of growth, it can also involve the application of water in amount necessary to bring soil to the desired moisture level prior to crop planting. *1	Controlled applications of water to supplement the rainfall (note that flooded land is not termed 'irrigated' unless the water is in some way controlled).
Irrigation Area	An area irrigated or capable of being irrigated either by gravitational flow or by lift irrigation or by any other method so declared by the Minister responsible for land under the provisions of Section 16 of this Act.	(Area actually irrigated) The area which is actually irrigated at least once in a given year. Often, part of the equipped area is not irrigated for various reasons such as lack of water, absence of farmers, land degradation, damage, and organisational problems. It only refers to physical areas, meaning that irrigated land that is cultivated twice a year is counted once.
Irrigation Potential	Total area which is technically feasible, economically and financially profitable, socially viable and environmentally acceptable that is irrigated or capable of being irrigated on the basis of water availability, land availability and suitability. *1	Area of land which is potentially irrigable. Country/regional studies assess this value according to different methods, for example some consider only land resources suitable for irrigation, others consider land resources plus water availability, others include in their assessment economic aspects (such as distance and/or difference in elevation between the suitable land and the available water) or environmental aspects, etc. Whatever the case, it includes the area already under agricultural water management.

*Note: *1= The same defined in Irrigation Policy 2010*
Source: National Irrigation Act 2013 and FAO Glossary http://www.fao.org/nr/water/aquastat/irrigationmap/glossary.pdf

5.3.2 Definition of Irrigation Schemes

The irrigation schemes defined in NIP2010 is summarised as Table 5.3.2. As it is a feature of Tanzania, there are so many traditional irrigation systems built and operated by farmers.

Table 5.3.2 Definition of Irrigation Schemes

Technical Term	NIP2010
Irrigation Scheme	The area where crops are grown under irrigation through any method including flood recession; gravity or pump fed canal systems supplying either surface or groundwater; water harvesting and pressurised systems such as drip and sprinkler. Irrigation schemes include traditional schemes, rehabilitated or upgraded schemes, new smallholder investment and purely private commercial investment.
Scale of Irrigation Scheme	(a) Smallholders' Irrigation Schemes: are schemes with area of 500 ha or below; (b) Medium Scale Irrigation Schemes are schemes having area between 500 ha and 2,000 ha; (c) Large Scale Irrigation Schemes are schemes with areas of over 2,000 ha. Although it is difficult to develop strict rules for categorising irrigation into classes based on area, the above three classes of irrigation schemes will be adopted.
Traditional Irrigation Scheme	An irrigation scheme with irrigation system comprising of temporary infrastructure and/or facilities that are not technically constructed/installed.
Upgraded/Improved Irrigation Scheme	An existing irrigation scheme that is subjected to works resulting into better irrigation infrastructure and performance.
Rehabilitated Irrigation Scheme	An irrigation scheme initially developed or improved but then rehabilitated after its previous infrastructure had worn out or damaged.
Developed Irrigation Scheme	An irrigation scheme that is provided with technically constructed or installed irrigation infrastructure and facilities.
New Irrigation Scheme	An irrigation scheme that is developed in an area that has never been provided with irrigation infrastructure. The new irrigation scheme is further divided into (a) smallholder scheme and (b) commercial scheme.
Gravity-fed Irrigation Schemes	Schemes whereby farmers have diverted water from a surface water source be it a perennial, intermittent or ephemeral stream; a small, medium or large dam or any other source of water and convey it to the command area by gravity via a system of canals or conduits.
Pumped Irrigation Schemes	Schemes whereby water is pumped from a source which may include a river stream, a well, a borehole, a water reservoir and convey it to the command area under pressure. The method for irrigation at the scheme could be surface, drip, or sprinkler system.
Rainwater Harvesting (RWH) Irrigation Schemes	Schemes whereby farmers construct water retaining bunds, harvest rainwater and store the water at the foot of mainly paddy crop. Despite their simple technology, such schemes are significant in production of rice in Tanzania.
Micro Irrigation Schemes	Schemes whereby farmers draw water from a source by hand and use it mainly for vegetables and high value crops. They include cases where water is harvested from roof tops and stored in tanks and where farmer's pond the water diverted from a stream and convey it to their fields through a piped network where it is applied to the crops through drip emitters or low pressure sprinklers (sometimes called localised irrigation). These types of schemes include those developed using the bucket drip irrigation kits or the treadle pumps.
Flood Recession Irrigation Schemes	These are the schemes established by farmers whereby crops, usually paddy, are grown on flood plain of the rivers and are watered by the frequent flooding of the river.
Wetland Irrigation Schemes	These are the schemes developed by farmers in valley-bottoms whereby the soils are inundated by surface or ground water sufficient to support a prevalence of vegetable or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction.
Backyard Irrigation	This refers to a small garden under irrigation around a house using water from domestic supply system or water harvested from roof tops.

Source: NIRC, NIP 2010

Based on Table 5.3.2, a matrix to show the relationship between the category of irrigation schemes and irrigation methods is developed as follows. First of all, the traditional schemes will be upgraded and improved with some extension of irrigation area if any. In this case, a drastic increase of irrigation area cannot be expected in comparison with new irrigation scheme development. Therefore, new irrigation schemes are also needed to develop in parallel to the improvement in order to expand the irrigation area.

As shown in the Table 5.3.3, the irrigation development under NIMP2018 would be four categories; traditional, improved, extension or new.

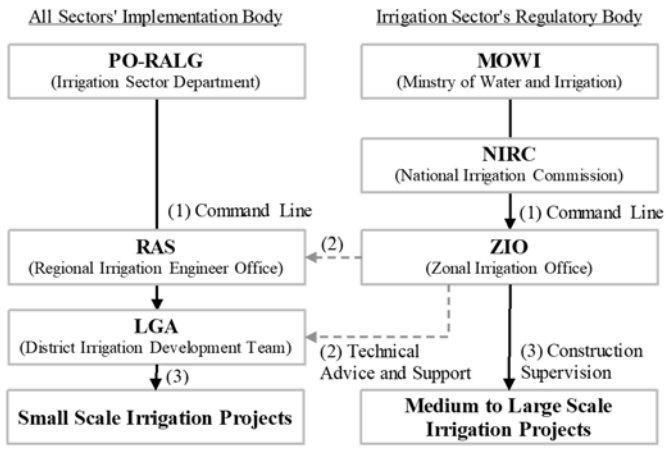
Table 5.3.3 Matrix of Irrigation Category and Irrigation Method

Irrigation Method	Traditional	Developed		
		Improved	Extension	New
Gravity-fed Irrigation	○	●	●	●
Pumped Irrigation	○	●	●	●
RWH Irrigation	○	●	●	●
Micro Irrigation	-	-	●	●
Flood Recession Irrigation	○	●		
Wetland Irrigation	○	●		
Backyard Irrigation	○	●		

Note: ○= Traditional scheme, ●= Developed scheme
Source: JICA Project Team

5.4 Government Administrative Organisation for Irrigation Development and Management

As illustrated in the Figure 5.4.1, there are two chains of command for irrigation development and management. One is for small scale irrigation projects under President's Office Regional Administration and Local Government (PO-RALG). After the decentralization of the government administration, the Local Government Authorities (LGA) bears the responsibility of development and management of small scale irrigation project. In this case, the funds (DIDF) will be transferred from the Ministry of Finance and Planning (MOFP) to the LGA based on the approved annual budget by PO-RALG. The other is for medium and large-scale irrigation projects under NIRC who is fully responsible for implementation of the irrigation development projects. In this case, the funds (NIDF) will be transferred from MoFP to NIRC/ZIO according to the approved annual budget. NIRC/ZIO will also support LGA technically in implementation of small scale irrigation projects.



Source: JICA Project Team

Figure 5.4.1 Government Organisation Structure for Irrigation Development and Management

(1) NIRC

NIRC is established under Section 3 of the NIA2013 as an independent department of the government under the ministry responsible for irrigation. The NIRC is a government agency and its day to day activities are managed by the director general under the guidance of the governing board of ten members. Thus, it is the government's effort to address the current agricultural practices that have in most cases been characterised by crop production influenced by erratic and unreliable rainfalls. The development of the irrigation sector has an unprecedented opportunity to facilitate the Tanzania agriculture sector to be transformed from subsistence to a modern and highly commercial sector. The government is currently

giving high priority into irrigation development which is emphasized within the national policy frameworks. The government is also giving high priority to the management of the nation's water resources. This offers strong synergies between the water and irrigation sectors in irrigation development.

(a) Mandate and Functions of NIRC

The NIRC is mandated for coordination, promotional and regulatory functions in the development of the irrigation sector, which is briefly as Table 5.4.1.

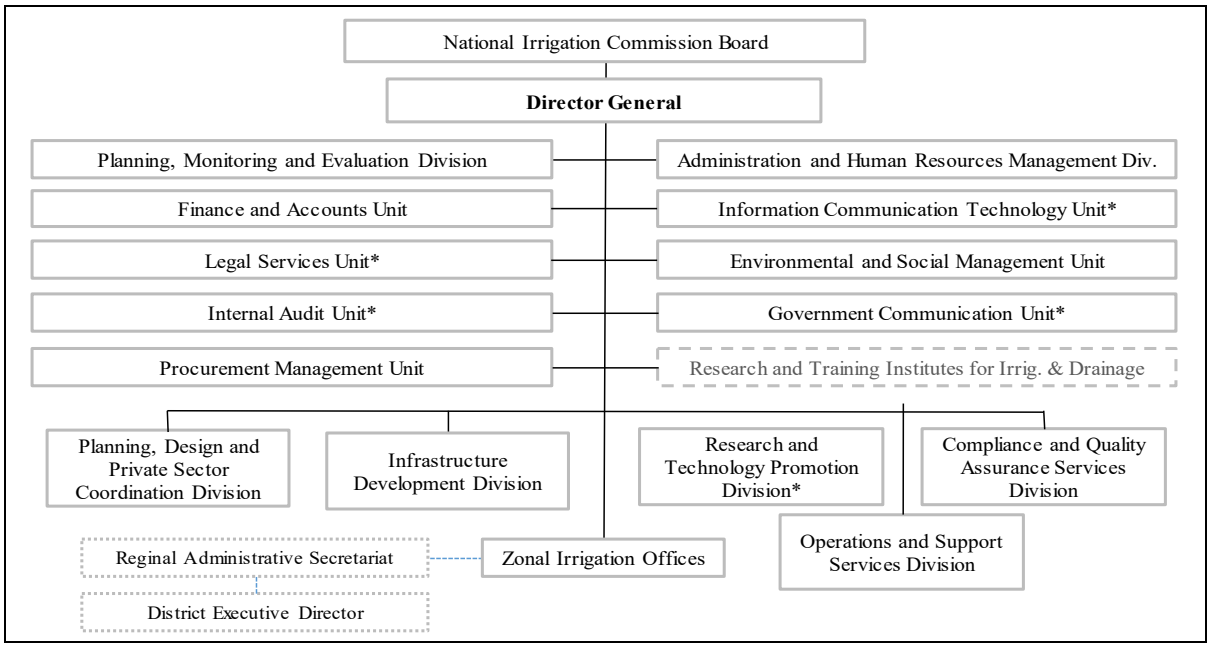
Table 5.4.1 Mandate and General Functions of NIRC

Type of Services	General Functions
Administrative management services	・ Advise the government on the implementation and review of the national irrigation policy, strategy, national irrigation master plan and related legislation; ・ Represent the government in the national and international fora and collaborate with both local and international firms and organisations in all matters pertaining to irrigation development and management; ・ Coordinate all interventions in irrigation sector conducted by the development partners and other stakeholders; ・ Promote and maintain cooperation in irrigation and drainage with similar bodies in other countries and with international bodies connected with irrigation and drainage; and ・ Advise the minister on declaration of irrigation areas.
Technical services	・ Plan, carryout studies, design, construct, supervise and administer implementations of the irrigation projects; ・ Register and maintain a register of all irrigators; ・ Promote institutional linkages training programs and support the recruitment of persons for purposes of employment in connection with the irrigation sector; ・ Build capacity of the irrigators for effective participation at all levels in irrigation planning, implementation, operation and management; ・ Undertake and coordinate research, disseminate appropriate technologies emanating from the research findings and provide technical support services on irrigation; ・ Promote development of multipurpose water storage facilities for irrigation purposes and other social economic activities; ・ Regulate all matters related to irrigation development and to oversee collaborations among different players in the development of irrigation and drainage; ・ Approve construction of irrigation works, standards and guideline for development and management of irrigation and drainage; ・ Promote efficient water use in irrigation systems and ensure compliance with the integrated water resources management approach in irrigation development; and ・ Advise the government in all matters relating to development and management of irrigation sector in the country.

Source: The Functions and Organisation Structure of the National Irrigation Commission, (Approved by the President on 12th February, 2015), President's Office, Public Service Management, Dar es Salaam, February 2016

(b) Organisation Structure and General Functions of NIRC

The NIRC's organisation is broadly divided into two parts: administrative management and technical support for irrigation development and management, the former has two divisions and seven units, and the latter has five divisions as shown in the Figure 5.4.2.



Note: **= Vacant post as of March 2017*
Source: *NIRC, 2016, The Functions and Organisation Structure of the National Irrigation Commission, (Approved by the President on 12th February, 2015), President's Office, Public Service Management, Dar es Salaam, February 2016*

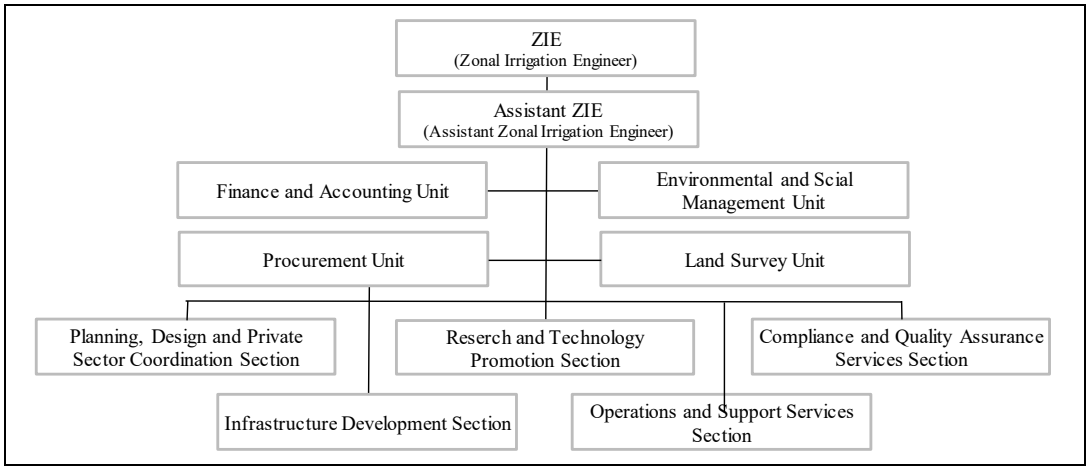
Figure 5.4.2 Organisation Structure of NIRC

(2) ZIO

There will be eight ZIOs established for providing irrigation technical backstopping closer to LGAs and stakeholders. These are Morogoro ZIO, Mwanza ZIO, Katavi ZIO, Dodoma ZIO, Mbeya ZIO, Tabora ZIO, Mtwara ZIO, and Kilimanjaro ZIO at present. According to NIA2013, ZIOs will be changed into a new Regional Irrigation Office (RIO) to be established in each region in future. It is now a transition period for the organisational reform.

(a) Organisation Structure of ZIO

The ZIO organisation is almost similar to that of NIRC. Usually a ZIO comprises three to four administrative management units and five technical supporting section under the control of Zonal Irrigation Engineer (ZIE) and Assistant ZIE as indicated in the Figure 5.4.3.



Source: *NIRC, 2016, The Functions and Organisation Structure of the National Irrigation Commission, (Approved by the President on 12th February, 2015), President's Office, Public Service Management, Dar es Salaam, February 2016.*

Figure 5.4.3 Organisation Structure of ZIO

(b) Mandate and General Functions of ZIO

The general functions of ZIO are summarised in the Table 5.4.2.

Table 5.4.2 Mandate and General Functions of ZIO

Type of Services	Mandate and General Functions
Administrative management services	・ Provide administrative and human resources management services. ・ Provide finance and accounts services. ・ Provide logistics and procurement services, etc.
Technical services	・ Perform as irrigation experts the project identification and formulation, feasibility study and detailed design, tendering and project management for medium and large-scale irrigation development projects (500 ha or above). ・ Assist LGAs irrigation staff in the project identification and formulation, feasibility study and detailed design, tendering and project management for small scale irrigation development projects (below 500 ha). ・ Assist LGAs in the formulation of irrigator's organisations. ・ Ensure dissemination and utilisation of operation and maintenance manuals and other irrigation guidelines. ・ Mainstream environmental and social safeguards in irrigation and drainage plans and designs. ・ Undertake data collection for irrigation data bank. ・ Promote of water saving irrigation technologies, renewable energies for irrigation and drainage purposes, Integrated Water Resources Management (IWRM) in collaboration with basin water boards regarding irrigation water use permits. ・ Liaise between the commission headquarters, region, districts, LGAs and the private sector on irrigation matter, etc.

Source: The Functions and Organisation Structure of the National Irrigation Commission, (Approved by the President on 12th February, 2015), President's Office, Public Service Management, Dar es Salaam, February 2016

As many LGAs are facing a shortage of irrigation staffs in number and capacity, ZIO is often assisting LGAs in the engineering works, such as feasibility study, detailed design, and project management on condition that the fund is provided by LGAs.

(3) RIO

As stipulated in the NIA, ZIOs will be absorbed into a new RIO. It intends to make closer communication and provide finely tuned technical support to LGAs. Having discussed in the above however, ZIO will continue its functions until RIO would be established in the regions. At this moment, the Regional Irrigation Engineer (RIE) has mandated as a coordinator between LGAs to PO-RALG, including but not limited i) to scrutinise the annual irrigation development plan and budget submitted by LGAs and submit it to PO-RALG if acceptable and ii) to monitor the physical progress and financial progress based on the plan and budget approved by PO-RALG. The funds will be transferred into the specific bank accounts of the respective LGAs from MOFP. At the same time, a copy of issue of notification will be forwarded to RIE of RAS.

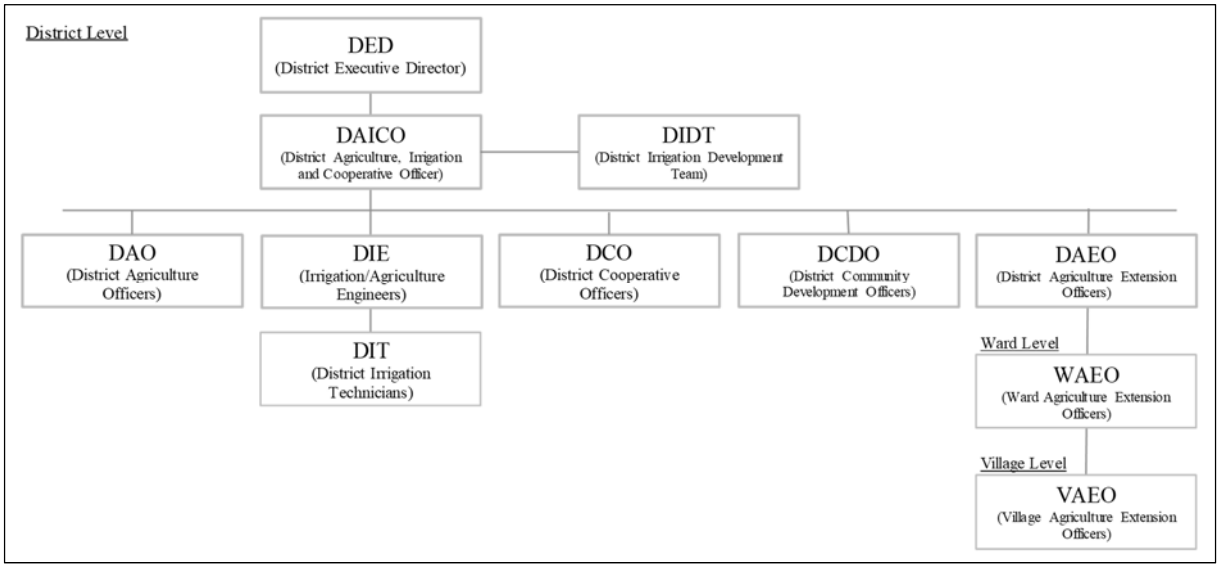
As LGA is not a chain of command of ZIO/NIRC, ZIO is often obliged to request RIE to guide LGAs to provide data and information whenever necessary.

(4) DAICO Office at LGA Level

LGA is responsible for small scale irrigation development (500 ha or below). The head of district council, District Executive Director (DED) who has the authority to make the final decision including payments to the contractors. However, in practice, the District Agriculture, Irrigation and Cooperatives Officer (DAICO) in each district council office oversees all agriculture development and management activities

including irrigation development in his/her district with support of his/her staffs. The District Irrigation Engineers (DIEs) and District Irrigation Technicians (DITs)[2] usually work on irrigation-related engineering services, formulation of Irrigators' Organisation (IOs) and capacity building trainings to IOs. When necessary, the District Community Development Officer (DCDO), District Agriculture Extension Officer (DAEO), Ward Agriculture Extension (WAEO), and Village Agriculture Extension Officer (VAEO) will provide trainings to IOs.

Whenever making an important decision for the district irrigation development, DAICO will organise the District Irrigation Development Team (DIDT) consisting of DIE, DIT, DCDO, DAEO, District Agriculture Officer (DAO), District Planning Officer, District Cooperative Officer (DCO), District Procurement Officer, etc. in compliance with CGL (Comprehensive Guidelines for Irrigation Scheme Development under District Agricultural Development Plan). The organisational structure of DAICO office is shown in Figure 5.4.4..



Source: Mbarali DC edited by JICA Project Team

Figure 5.4.4 Organisation Structure of DAICO Office (Example)

It is stated in the NIA that the District Irrigation Department (DID) shall be established to strengthen the implementation capacity of LGAs for irrigation development and management.

LGAs are now working on community development planning at village level in participatory manner by using the Opportunities and Obstacles to Development (O&OD) technique. A Village Development Plan (VDP) of O&OD will be integrated finally with the District Agriculture Development Plan (DADP) In this process, the development funds tend to be allocated thinly and broadly in accordance with the VDP. That is why no clear development effect of DADP could be seen. From now on, LGAs will allocate the DADP funds to implement a development plan with selection and concentration under the comprehensive and strategic district development policy.

The Local Government Development Grant (LGDG) will be a main fund source for the district

[2] As academic qualification, irrigation engineers hold a bachelor's degree in engineering and are capable of designing irrigation facilities and schemes. Irrigation technicians are supposed to complete an ordinary diploma in irrigation and support the irrigation engineers in project implementation such as construction management.

agriculture and irrigation development, which includes i) District Agriculture Development Grant (DADG), ii) Agriculture Extension Development Grant (AEDG), and iii) Agriculture Capacity Building Grant (ACBG). LGAs could implement, at his discretion, small irrigation schemes by using DADG of LGDG. Apart from that, there are irrigation development funds on a project basis; District Irrigation Development Fund (DIDF) for implementation of small scale irrigation schemes (500 ha or below) and National Irrigation Development Fund (NIDF) for implementation of medium and large-scale irrigation schemes (over 500 ha). The former will be transferred from MoFP to the LGAs concerned whereas the latter from MoFP to NIRC/ZIOs.

5.5 Irrigation Development Performance

5.5.1 NIRC's Budgets and Expenditures

Table 5.5.1 shows the approved annual budget and expenditure of NIRC for the last five fiscal years. It indicates that the percentage of expenditure against the approved budget for development is 21.1% on the average, declining from 46.7% in 2012/13 to 9.4% in 2016/17. Similarly, the operation expenditure has drastically decreased to TZS 300 million in 2016/17 from TZS 751 million in 2012/13. It implicates that most of NIRC's staff might be compelled to wait for works in their offices because of small fund disbursement for development and operation especially during 2015/16 and 2016/17.

Table 5.5.1 Budget and Expenditure of NIRC

Type of Fund	Item	2012/13	2013/14	2014/15	2015/16	2016/17
Development NIDF (Local and Foreign)	Total Approved Budget (1)	16,414	26,392	33,933	53,395	35,370
	Local	11,000	10,000	15,000	6,000	6,000
	Foreign	5,414	16,392	18,933	47,395	29,370
	Total Expenditure (2)	7,672	8,490	10,659	5,131	3,341
	Local	2,258	3,400	0	0	2,240
	Foreign	5,414	5,090	10,659	5,131	1,101
	Percent of (2) / (1)	46.7%	32.2%	31.4%	9.6%	9.4%
Recurrent Operation and Salary	Operation	751	699	671	382	300
	Personal Emolument	NA	NA	NA	2,806	4,207

Note: "NA" indicates the data for irrigation staffs is not available because it was part of the total MAFC salary as NIRC was under MAFC.
Source: NIRC, 2017

5.5.2 Irrigation Development

Irrigation area in the mainland of Tanzania has reached 461,326 ha by 2014/15 as shown in Table 5.5.2.

Table 5.5.2 Irrigation Area Developed in the Past 10 Years

Item	Unit	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Cumulative Irrigation Area	ha	264,388	273,945	289,245	310,745	331,490	345,690	354,602	363,514	450,392	461,211
Annual Increment	ha	-	9,957	15,300	21,500	20,745	14,200	8,912	8,912	86,878	10,819

Source: NIRC, 2016

Irrigation area is estimated based on the data from each ZIO who compiled the data reported by LGAs in his/her jurisdiction. It should be noted that the irrigation area in the mainland is reported to be 277,820

ha in the National Sample Census of Agriculture 2007/08[3], and 325,276 ha in the Annual Agricultural Sample Survey Report 2014/15[4]. There is a significant gap in data of NIRC, i.e., 11,425 ha in 2007/08 and 136,050 ha in 2014/15, respectively.

The irrigation area by various parameters is calculated based on the NIRC database updated as of December 2015, which is discussed hereunder.

(1) Irrigation Area by Development Category

Kilimanjaro Zone (31%) is the largest in irrigation area, followed by Mbeya (22%), Morogoro (20%), Mwanza (11%), Dodoma (8%), Mtwara (4%) and Tabora (4%). By irrigation category, the improved schemes account for 75% of the total irrigation area, 21% by traditional scheme and 4% by RWH scheme. It is characterized that improved and traditional schemes are more observed in Kilimanjaro, Morogoro, and Mbeya, while RWH schemes are more developed in Mwanza, Dodoma, and Tabora as shown in Table 5.5.3

Table 5.5.3 Irrigation Schemes by Irrigation Category (As of December 2015)

Irrigation Zone*1	Improved		Traditional		RWH		Total		
	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)	(%)
Dodoma	157	31,295	66	2,931	28	2,792	251	37,018	(8%)
Kilimanjaro	508	114,590	418	28,209	2	64	928	142,863	(31%)
Mbeya	212	69,966	163	29,743	8	63	383	99,772	(22%)
Morogoro	106	81,868	63	9,482	2	204	171	91,554	(20%)
Mtwara	62	9,375	103	10,402	5	445	170	20,222	(4%)
Mwanza	180	28,986	84	8,120	105	13,915	369	51,021	(11%)
Tabora	55	10,029	42	6,010	46	2,722	143	18,761	(4%)
Total	1,280	346,109 (75%)	939	94,897 (21%)	196	20,205 (4%)	2,415	461,211 (100%)	(100%)

*Note: *1= Total number of Irrigation Zone is currently eight (8) but Katavi Zone is not operational yet.*
Source: NIRC Irrigation Database, 2015 updated version based on 2009 Database

(2) Irrigation Area by Water Source

As for the irrigation area by water source, the vast majority is river (88%), followed by RWH (6%), spring (3%), dam (2%) and others (0.4%). There is a tendency in water source for irrigation that three zones (Kilimanjaro, Mbeya, and Morogoro) depend largely on river, while the rest of the four zones depend on other sources such as RWH, spring, dam, lake, and Groundwater (GW). As shown in Table 5.5.4.

Table 5.5.4 Irrigation Area by Water Sources (As of December 2015)

Irrigation Zone	River		Dam		GW		Lake*1		Spring		RWH*2		Total		
	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)	(%)
Dodoma	150	28,843	18	2,498	14	527	1	25	38	2,572	30	2,553	251	37,018	(8%)
Kilimanjaro	878	131,272	6	2,534	1	10	1	100	38	8,881	4	66	928	142,863	(31%)
Mbeya	360	98,914	3	1,245	5	110	-	-	1	10	14	213	383	99,772	(22%)
Morogoro	145	90,563	4	454	13	60	2	35	-	-	7	442	171	91,554	(20%)
Mtwara	147	16,468	3	350	4	380	-	-	5	830	11	2,194	170	20,222	(4%)

3 NBS, April 2012, National Sample Census of Agriculture 2007/08, Small Holder Agriculture, Volume II: Crop Sector-National Report. The number of samples was 51,226 in total.
4 MALF, September 2016. This is a first annual agricultural sample survey in Tanzania. The number of samples was 21,210 in total.

Irrigation Zone	River		Dam		GW		Lake*1		Spring		RWH*2		Total		
	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)	(%)
Mwanza	144	28,404	15	1,708	28	51	51	976	-	-	131	19,882	369	51,021	(11%)
Tabora	199	13,778	12	1,440	-	-	-	-	1	40	21	3,503	143	18,761	(4%)
Total	1,933	407,522 (88%)	61	10,229 (2%)	65	1,138 (0.2%)	55	1,136 (0.2%)	83	12,333 (3%)	218	28,853 (6%)	2,415 (100%)	461,211	(100%)

*Note: *1= Lake includes a lagoon, *2= RWH includes a rain water*
Source: NIRC Irrigation Database, 2015 updated version based on 2009 Database

(3) Irrigation Area by Ownership

Eighty-three percent of irrigation schemes are managed by smallholders against 16% by private commercial farms. Private commercial farms are operating more in Morogoro, Kilimanjaro, Mwanza, and Mbeya as shown in Table 5.5.5.

Table 5.5.5 Irrigation Schemes by Ownership (As of December 2015)

Irrigation Zone	Government		Smallholder		Commercial		Total		
	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)	
Dodoma	2	15	223	34,299	26	2,704	251	37,018	(8%)
Kilimanjaro	6	1,053	823	124,138	99	17,672	928	142,863	(31%)
Mbeya	4	457	361	89,403	18	9,912	383	99,772	(22%)
Morogoro	11	3,046	146	56,653	14	31,855	171	91,554	(20%)
Mtwara	-	-	170	20,222	-	-	170	20,222	(4%)
Mwanza	1	5	360	38,671	8	12,255	369	51,021	(11%)
Tabora	2	235	141	18,526	-	-	143	18,761	(4%)
Total	26	4,811 (1%)	2,224	382,002 (83%)	165	74,398 (16%)	2,415	461,211 (100%)	(100%)

Source: NIRC Irrigation Database, 2015 updated version based on 2009 Database

The private commercial farms include the ex NAFCO farms[5], which were sold off by the government during the 1990s to 2000s in compliance with the government privatisation policy.

(4) Irrigation Area by Irrigation Type

Gravity irrigation is mainstream in Tanzania, accounting for 92% in terms of irrigation area. Out of the irrigation area of 20,872 ha, pump irrigation occupies 70% in Mwanza, and 25% in Morogoro zones. The Table 5.5.6 shows the Irrigation Area by Irrigation Type.

Table 5.5.6 Irrigation Area by Irrigation Type (As of December 2015)

Irrigation Zone	Gravity		Gravity +Pump		Pressurised		Pump		Total (%)		
	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)	(%)
Dodoma	236	36,342	2	35	7	520	6	121	251	37,018	(8%)
Kilimanjaro	689	140,468	4	97	11	1,781	18	517	928	142,863	(31%)
Mbeya	371	95,855	1	300	5	3,202	6	415	383	99,772	(22%)
Morogoro	130	75,150	2	8,220	4	3,057	35	5,127	171	91,554	(20%)
Mtwara	168	20,118	-	-	1	100	1	4	170	20,222	(4%)
Mwanza	261	36,331	-	-	5	110	103	14,580	369	51,021	(11%)
Tabora	140	18,403	-	-	1	250	2	108	143	18,761	(4%)
Total	2,201	422,667 (92%)	9	8,652 (2%)	34	9,020 (2%)	171	20,872 (4%)	2,415	461,211 (100%)	(100%)

Source: NIRC Irrigation Database, 2015 updated version based on 2009 Database

5 National Agriculture and Food Cooperation (NAFCO), the farms include such as Kapunga rice farm (3,200 ha) and Mbarali rice farm (3,000 ha).

(5) Irrigation Area by Irrigation Method

Surface irrigation is mainstream in Tanzania, covering 92% of the irrigation area. New water saving irrigation technology such as sprinkler, drip, and centre pivot irrigation has been introduced to five zones other than Mtwara and Tabora zones. The largest irrigation area is Kilimanjaro for surface irrigation, sprinkler irrigation in Morogoro, drip irrigation in Kilimanjaro, and centre pivot irrigation in Mwanza as shown in Table 5.5.7.

Table 5.5.7 Irrigation Area by Irrigation Method (As of December 2015)

Irrigation Zone	Surface		Sprinkler		Drip		C-Pivot		Others		Total (%)		
	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)	No.	Area (ha)	(%)
Dodoma	247	36,833	-	-	4	185	-	-	-	-	251	37,018	(8%)
Kilimanjaro	909	133,835	2	170	17	8,858	-	-	-	-	928	142,863	(31%)
Mbeya	367	95,876	5	688	11	3,208	-	-	-	-	383	99,772	(22%)
Morogoro	168	81,004	3	10,550	-	-	-	-	-	-	171	91,554	(20%)
Mtwara	170	20,222	-	-	-	-	-	-	-	-	170	20,222	(4%)
Mwanza	326	38,699	2	185	39	135	1	12,000	1	2	369	51,021	(11%)
Tabora	143	18,761	-	-	-	-	-	-	-	-	143	18,761	(4%)
Total	2,330	425,230 (92%)	12	11,593 (2%)	71	12,386 (3%)	1	12,000 (3%)	1	2 (0%)	2,415	461,211 (100%)	(100%)

Source: NIRC Irrigation Database, 2015 updated version based on 2009 Database

5.6 Participatory Irrigation Water Management and IOs

5.6.1 History of Irrigation Development and Management

The years between 1700s and 1800s in Tanzania, there were an existence of pockets of well-defined irrigated cultures in the current administrative regions of Morogoro, Ruvuma, Iringa, Mbeya, Arusha, and Kilimanjaro (Mwanitu Kagubila 1993). These systems, later known as “traditional irrigation systems”, have survived until today. They were owned, controlled, and managed by smallholder farmers themselves. In each system, there were furrow committees. Originally, the system was owned by clans. Later, they changed and were renamed as “village irrigation system” due to their importance to the economic life of each household.

In 1993 there were about 200,000 ha under irrigated agriculture, with about 600 irrigation schemes functions at different levels. About 80% of those schemes were owned, controlled and managed by the small-scale farmers themselves. The remaining 20% were a combination of the parastatal large scale types under the National Agriculture and Food Corporation (NAFCO), Sugar Development Corporation (SUDECO) and large and small privately owned ones. The pace of rehabilitation of traditional irrigation schemes increased in late 1990s, the organisation and management also changed especially in the establishment of orrigation committees. There are two different organisations in Tanzania; Water Users Association (WUA) and IO. WUA is formed by all types of water users from one source (usually large river) while IO is a sub-set of WUA with a specific use of water for irrigation.

5.6.2 Procedure of District Irrigation Plan

Currently the irrigation activities at the LGAs are led by the District Agricultural, Irrigation, and Cooperative Officer (DAICO). The DAICO is normally assisted by an irrigation or agricultural engineer. The district receives technical advice from the Zonal Irrigation Office. For the purposes of irrigation

planning, a team is established at the district, known as District Irrigation Development Team (DIDT). The composition of the team includes an irrigation/agricultural engineer, agricultural extension officer, community development officer, planning officer, cooperative officer and land officer.

The district irrigation plans are conducted following the Comprehensive Guidelines (CGL). The Guidelines stipulates that application of all irrigation schemes should be made by village governments taking into account the real demand of farmers through a methodology known as O&OD. The guidelines have several steps, whereby following such steps, from long lists of identified schemes from different villages and latter wards, priority irrigation schemes for development in a district are established by the DIDT.

The Irrigation schemes formulated by the DIDT are validated by the ZIO through a Zonal Review Committee (ZRC). Thereafter, the schemes are submitted to the Council Management Team (CMT) for soliciting budget for implementation. In case budget is not available in full then phase wise development is instituted where implementation is separated into several packages considering progressive expansion of the irrigation and drainage canal network.

5.6.3 IOs

According to the NIRC data[6], there are 458 IOs in mainland Tanzania, and yet only eight IOs are registered under the NIA regulations. Conventionally, there are two types of irrigators' organisations: Irrigators Associations (IA) and Irrigators Cooperatives (IC). Besides these registered irrigators, there are traditional irrigators groups engaged in smaller scale irrigation practice. Normally, irrigators in an irrigation scheme form a group, which can be categorized as one of the above. The main characteristics of IA and IC are shown in Table 5.6.1.

Table 5.6.1 Types and Characteristics of Irrigators' Organisations

Type	Registration	Membership	Main Function	Land Title	Water Use Permit	Main Source of LGA Support	Major Challenge
IA	NIRC*	Compulsory	Water management, O&M	Individual/ Group	Permit obtained at BWO	Technical: DAICO office/AEO Management: CDO	- Incentives for group activities. -Administrative / financial management
IC	TCDC/ NIRC	Voluntary	Water Management, O&M, Cooperative Activities	Individual/ Group	Permit obtained at BWO	Technical: DAICO office/AEO Management: Cooperative Officer	- Involvement of non-members in O&M activities.

*Note: * After the negotiation between the NIRC and MoHA, mandate of IA registration is transferred to the NIRC*
Source: JICA Project Team

IAs and ICs have several differences in their objectives and features. First, IAs maintain compulsory membership as a rule among all irrigators in the irrigation scheme while ICs are voluntarily formed groups. That is, there might be non-member irrigators in an irrigation scheme managed by an IC. Second, IAs' activities are in principle limited to O&M and water management of irrigation schemes. Besides such activities, ICs are also engaged in collective activities of production, input purchase, harvesting, processing, marketing and distribution (so-called business practice). In general, the IC members are regarded to be more committed to group activities, pursuing profit out of collective actions.

[6] DOSS and DCQA, NIRC (as of June 2016).

Yet their major challenge is how to urge non-member irrigators to pay for operational costs, such as O&M and water use permit.

The NIA Regulations (2015) allows ICs to be registered under the NIA by obtaining a certificate of compliance while remaining as a cooperative established under the Cooperative Societies Act (CSA, 2013) only if they abide by the NIA. Yet there is a need for further adjustments between the NIA and CSA, such as compulsory or voluntary membership, fees, and audit conditions.

LGA's support system for ICs and IAs also differ. For ICs, district cooperative officers are assigned to monitor their activities, providing training on financial management and annual auditing. That is partly why cooperatives are considered to be better in financial management than the associations. For IAs, community development officers often provide the support as part of their role for supporting group activities. Technical support is provided by irrigation technicians or extension officers with a background on irrigation for both IAs and ICs. In reality, however, few LGAs can afford to attach technicians to each irrigation scheme, and the supports of zonal officers are provided mainly in the construction phase. As such, LGA's support system to IO is especially weak in O&M as well as technical inputs to crop production and marketing.

5.6.4 Operation and Maintenance

For the past years, through different programs including the Agricultural Sector Development Programme (ASDP), more efforts have been put in allocating funds for irrigation infrastructure development where several irrigation schemes have been improved, but fewer efforts have been put in ensuring the software part for irrigation facilities (i.e., operation and maintenance) is being emphasised. However, there are few irrigation schemes which are well managed in terms of O&M, these include: Mombo irrigation scheme in Korogwe District, Tanga Region, Igomelo irrigation scheme, Madibira irrigation scheme in Mbarali District, Mbeya Region, and Dakawa Irrigation scheme in Mvomero District, Morogoro Region.

In these well managed schemes, farmers prepare budgets for operation and maintenance funds. Farmers make contributions to this fund either by paying cash or contributing crop harvests worth the monetary required amounts. Water distribution to different parts of the scheme is made by observing the schedule which have been prepared and agreed among the farmers. Normally, the distribution is made by a paid water person; guidelines are put for him or her to observe in order to eliminate the element of biasness during water distribution. The money collected in the O&M fund is used to pay for the water person, basic office management needs of the IO and repairs of the irrigation facilities.

Recently, there have been efforts of inculcating the importance of O&M of irrigation schemes to IOs through the TANCAID project by utilizing the CGL[7]. Currently there are four schemes which are being used as O&M demo sites. These schemes are: Ulyanyama irrigation scheme in Sikonge District, Tabora Region, Nyida irrigation scheme in Shinyanga District, Shinyanga Region, and Msemembo irrigation scheme in Manyoni District, Singida Region, Lemkuna irrigation scheme in Simanjiro District, Manyara Region. The main activities of these schemes are the transparency among the leaders and members, having O&M plan which covers all activities including time for meetings, record keeping, availability

[7] Refer to Table 8.3.5 in Chapter 8.

of Constitution which is adhered, and strong IO leaders.

After the utilisation of the CGL in schemes, the IOs themselves start preparing O&M plan, making budget as per O&M form, collect O&M fee, transparency and accountability of IOs, conducting meetings as per O&M plan and writing reports to LGAs. The LGAs will follow-up, provide technical backstopping to IOs, and write reports to the Zonal Irrigation Offices as well as to NIRC headquarters. NIRC headquarters through the Capacity Development for the Promotion of Irrigation of Scheme Development under the District Agricultural Development Plan (TANCAID) project provides technical backstopping and follow-ups.

Box 5.6.1：Water Use Fees and Irrigation Service Fees

IO is obliged to register at Basin Water Office (BWO) as water users, and at NIRC as irrigation beneficiary, respectively.

(1) Water Use Fees: The current water use fee structure is set by the Revised Act 2002 as shown in the table below. In addition, it is stipulated that the water use fee is paid to the BWOs.

Table 5.6.2 Fees according to Water Utilisation (General) Amendment Regulation 2002

Item of Water Use	Application Fees (USD)	User Fee (USD)	
		Flat Rate	Increment Rate
Domestic / Livestock	40	35	0.035/100 m^3, above 3.7 lit/s
Small-scale Irrigation	40	35	0.035/100 m^3, above 3.7 lit/s
Fish Farming	40	35	0.035/100 m^3, above 3.7 lit/s
Large-scale Irrigation	150	70	0.070/100 m^3, above 3.7 lit/s
Industrial	150	35	0.035/100 m^3, 1.10 lit/s
Commercial	150	35	0.15/100 m^3, 0.94 lit/s
Mining	150	-	0.17/100 m^3

Source: Water Rights and Water Fees in Rural Tanzania, (https://ageconsearch.umn.edu/bitstream/158013/2/H040605.pdf)

(2) Irrigation Service Fees: Various fees shown in the table below are set by the Irrigation Act, Regulation 2015. Also, these fees are set to pay to the NIRC.

Table 5.6.3 Fees for IOs based on Irrigation Act, Regulation 2015

Matter	Fee (TZS)
1. On application for registration	15,000
2. Registration fee	60,000
3. Annual fee	100,000
4. On notification change of constitution / by-laws	25,000
5. On notification charge of name for irrigators organisation	25,000
6. Surcharge for delay to furnishing annual reports to the Commission	100,000
7. Delay of paying annual fee	40,000
8. Application for certificate of compliance	15,000

Source: Irrigation Act, Regulation 2015, 2nd Schedule

In addition to the above, according to the Irrigation Act 2013 norm, irrigation members and non-members are required to pay O&M fee set by IOs, or Irrigation Act 2013 recommends paying IOs a minimum of 5% of the average harvest.

5.7 Field Observation and Findings by JICA Project Team

JICA Project Team visited six (6) Zones intensively from the end of January 2017 to the beginning of March 2017, except the Mtwara Zone and Katavi Zone. The team had several meetings with ZIE and their staff, DED and DAICO, IO and farmers to learn the present situation, challenges and future

development plans, etc. This is followed by site visits to irrigation schemes arranged in each Zone. Major observation and findings related to irrigation development in each Zone are summarised in Table 5.7.1.

Table 5.7.1 Field Observation and Findings by the JICA Project Team

Major Division	Minor Division	Observation and Findings
I. Observation and Findings Related to Existing Irrigation Schemes		
Project Formulation and Design Stages	Design Standards and Criteria	There are no national design standards and criteria for irrigation scheme design, which are required to maintain a quality of design.
	Documents and Back Up Data Keeping	Documents and data are not properly kept at NIRC, zonal and district offices. Proper documents and data keeping system would be useful for future improvement work. Common understanding of technical terms related to irrigation areas would be important for scheme development and NIRC database.
	Definition of Technical Terms	LGA staff and IO members understand the meaning of "Potential Irrigation Area" as the area can be irrigated.
	Inadequate Study on Available Water for Irrigation	Through discussion with a zonal engineer, the team found that the study on available water for irrigation is made not in a scientific manner but in an empirical way. In one irrigation scheme, the design was made without data and technical calculation.
	Lack of Drainage Canals	In many irrigation schemes, drainage canals are often neglected in design and construction. The main reason may be farmers refuse to give their lands for drainage canals not to reduce cultivation areas. However, a drainage canal system is crucial for sustainable irrigation system particularly in wet land.
	Sedimentation is a Serious Problem especially in Reservoirs and Canals	In general, sediment load is decided without actual measurement in a river. Usually, engineers estimate sediment load by applying an empirical equation which is described in a textbook, or they do not take it into account at all. An estimate of sedimentation needs to be conducted carefully to avoid abandonment of an irrigation scheme.
	Difference between Developed Area and Irrigated Area	It is often observed that the actual irrigated area is smaller than the developed area. It might be caused by insufficient water or uncompleted irrigation facilities. Thus, farmers might be discouraged to participate in operation and maintenance activities.
Project Implementation	Poor Performance of Contractors	Many defects were observed especially in reinforced concrete work and in compaction of embankments. For example, protective covering for reinforcement bars is not enough, and reinforcement bars are exposed from concrete. Several pieces of wooden form remain in the concrete. Water leakage from the decayed wooden form remained was reported at intake structure under the Inala embankment. Many gullies were found in embankment slopes of dams. The cause of the problem would be loose compaction of embankment material. In relation to the poor performance, supervision by zonal or district office would be a problem. It seems that the supervisor was not in place when the concrete was placed.
	Project Committee	As for O&M, the CGL guides IO's Project Committee to use a "PC checklist," which allows its members, who are non-professional, to supervise simple construction works. With the PC checklist, the PC members can support LGA or ZIO irrigation staff for supervision. Under the circumstances where NIRC or LGAs cannot afford to attach officers for construction, it is recommended that the training for construction supervision is properly conducted from LGA/ZIO technical staff to the PCs and utilize them.
	Completion of Scheme	In many cases, an irrigation scheme used to be constructed partially. Consequently, irrigation area was reduced from the original plan. This reduction of farm land discourages farmers very much. Each scheme needs to be completed as soon as possible.
Project O&M and Water Management	High Electricity Charge for Irrigation and	Among irrigation schemes the team visited, three schemes receive the supply of electricity form TANESCO for pump operation. Two schemes, namely, Chinangari and Nyatwali, are in operation. However, pumps were not fully utilised because of

<table>
<tr><th>Major Division</th><th>Minor Division</th><th>Observation and Findings</th></tr>
<tr><td></td><td>Drainage Pumps</td><td>high electricity charges.</td></tr>
<tr><td></td><td>Utilisation of Solar Power System</td><td>Related to the electric pump, the team observed two solar pump systems. First one is operating in the lower Moshi upland area of Rau ya Kati system. Another scheme is Serengeti in Bunda District. Both solar pumps are working properly without trouble. A solar pump system would be useful for small horticulture schemes.</td></tr>
<tr><td></td><td>Lack of O&M Fee</td><td>The following table calculates the ratio between the total O&M fee and assumed construction cost:
<table>
<tr><th>Name of Scheme</th><th>Name of IO</th><th>No. of Member</th><th>Irrigation Area (acre)</th><th>O&M Fee (acre/year)</th><th>O&M Total (TZS)</th><th>O&M ration in Const. cost</th></tr>
<tr><td>Igomelo</td><td>Igomelo Irrigators Org.</td><td>382</td><td>800</td><td>25,000</td><td>20 million</td><td>0.95 %</td></tr>
<tr><td>Dakawa</td><td>UWAWAKUDA</td><td>850</td><td>5,000</td><td>74,000</td><td>370 million</td><td>2.80 %</td></tr>
<tr><td>Kikafu Chini</td><td>UWAKICHI</td><td>759 (farmer 1500)</td><td>1,125</td><td>17,470 (average)</td><td>19.7 million</td><td>0.66 %</td></tr>
<tr><td>Chinangarli</td><td>CHABUMA</td><td>296</td><td>300</td><td>360,000</td><td>22.2 million</td><td>2.80 %</td></tr>
<tr><td>Irienyi</td><td>UWAIRO</td><td>170</td><td>300</td><td>50,000</td><td>8.5 million</td><td>1.07 %</td></tr>
</table>
Note: In this estimate, construction cost is assumed to be 3,000 US$/ha. IO data are the result of interview survey.
Source: RNIMP Team based on interview survey</td></tr>
<tr><td></td><td>O&M by IOs</td><td>In operation of modern irrigation systems, gates should be closed when floods occur in order to not intake flood flow which contains considerable sand, silt, and clay. However, most of the irrigation systems in Tanzania use flood flow as a water source. Consequently, sedimentation is inevitable, resulted in serious problems. IOs should remove deposited materials from canal sections as part of routine maintenance work. As for a canal design, designers should consider providing a sand trap structures for easy removal of deposited materials.</td></tr>
<tr><td></td><td>Lack of Water Management Tools and Water Management</td><td>In order to save water and get good produce, water management is one key technology. For proper water management, measuring devices or staves shall be provided. However, no devices and staves were found in all the schemes the team visited except Dakawa Scheme (under improvement).</td></tr>
<tr><td>IO</td><td>Registration of IO</td><td>There are three forms of farmers group; (i) Groups registered to NIRC, (ii) Groups registered to MoHA as Associations, and (ii) Groups registered as Cooperatives. Under NIA2013, IOs shall register to NIRC with necessary fees. So far, the number of IOs registered under NIA2013 is reported as only eight (8) out of 458 formerly registered as association or cooperative.</td></tr>
<tr><td></td><td>Capacity Building of IOs</td><td>During the site visits, the LGA staff pointed out necessity of capacity building of IO management members especially for financial accounting.</td></tr>
<tr><td></td><td>Strengthening of By-law</td><td>In the case that land ownership belongs to farmers, IO management staff encounter difficulty in controlling farmers. For instance, in Uyanyama case, three farmers took land issues to court. (Recently, IO won the case.) Many IOs plan to strengthen their constitutions and by-laws.</td></tr>
<tr><td colspan="3">II. Observation and Findings Related to Future Irrigation Development</td></tr>
<tr><td>General</td><td>Potential Irrigation Scheme</td><td>Tabora Zonal Office have identified many potential irrigation schemes which have not yet been developed. NIMP2018 needs to include those identified potential schemes into the scheme list. Therefore, the team recognizes the necessity of data collection on potential schemes for future development, which have been identified but not yet developed in the other zonal offices as well.</td></tr>
<tr><td></td><td>Study by Nile Basin Initiative</td><td>Under the Nile Basin Initiative program (NELSAP) feasibility studies were conducted on Mara and Ngono valley basins. Development of large irrigation schemes were studied. Water demand of the aforesaid schemes would be necessary to take into account in a future development plan.</td></tr>
<tr><td></td><td>Water Harvesting Technology</td><td>There are many small earth dams especially in the jurisdiction of Tabora and Mwanza Zonal Offices, where water is scarce. Small earth dams as a water harvesting facility would be a useful tool to secure agricultural production.</td></tr>
<tr><td></td><td>Lake Water Use</td><td>Use of Victoria Lake water for irrigation is one of the key strategies in Mwanza Zonal Office.</td></tr>
<tr><td></td><td>Traditional Irrigation Scheme as a Potential Area</td><td>There are many traditional irrigation schemes with vast areas. If new water sources such as groundwater and RWH ponds could be found, these schemes would become promising potential schemes.</td></tr>
</table>

Major Division	Minor Division	Observation and Findings
III. Other Observation and Findings		
General	Definition of Traditional Irrigation Scheme	Traditional irrigation scheme is defined in the National Irrigation Policy 2010 as "an irrigation scheme with irrigation system comprising of temporary infrastructures and/or facilities that are not technically constructed/installed." The team visited one of the traditional irrigation systems in Simbo village. The system utilizes rainwater which flows down from the upstream area by forming so-called a "sheet flow". There is no canal and division structure. Water flows from a farm plot to a farm plot. Judging from the manner of water use, it seems to be a "Rain-fed Scheme". Accordingly, it is necessary to pay attention that traditional irrigation schemes might include "Rain-fed Schemes".
	Basin Water Board Member	ZIE is not a member of the Basin Water Board, although the irrigation sector is a major water user. ZIE should be a member of the Basin Water Board as a representative of giant water users.

Source: JICA Project Team (Jan. to Mar. 2017)

5.8 Irrigation Human Resources

5.8.1 Demand Side

(1) NIRC

If compared with the data in 2011 (the Division of Irrigation and Technical Services (DITS) of the MoWI at that time), the number of engineers (irrigation, agricultural, mechanical, civil and environmental) of the NIRC have decreased from 91 to 81. The number of land surveyors have also decreased from 16 to 11. While there were two hydrologists in 2011, there is none in 2018. Under the current condition, the ZIOs' supports to the LGAs for small-scale irrigation development are rather extensive and stretched. The ZIO engineers attentively support the LGAs along project formulation and implementation. In other words, the ZIOs practically function as a consultant for the LGAs. Meanwhile, the number of LGAs cover ranges from 17 to 31 for each ZIO even under the eight-zone system. Together with the problem of aging technical staff, excessive workload of NIRC poses a serious threat to NIMP 2018 implementation.

Table 5.8.1 shows the allocation of irrigation/agricultural engineers, irrigation technicians and other technical staff at the NIRC headquarters and ZIOs.

Table 5.8.1 NIRC Technical Staff Allocation (As of February 2018)

	HQ	Dodoma	Kilimanjaro	Mbeya	Morogoro	Mtwara	Mwanza	Tabora	Katavi
Irrigation/ Agricultural Engineer	10	9	6	14	12	8	8	7	1
Irrigation Technician	0	5	5	0	4	1	3	4	0
Others	54	15	20	14	18	4	10	9	4
Total	64	29	31	28	34	13	21	20	5

Source: Data obtained from NIRC (February 2018).

(2) LGA

LGAs are the main implementers of small-scale irrigation development. Yet they are understaffed with technical officers in the irrigation sector. It is not the case that each LGA secures at least one engineer

or one technician. 37% of all LGAs (66 out of 180 LGAs[8]) do not have an irrigation/agricultural engineer or an irrigation technician. With regard to engineers, 116 out of 180 LGAs (64%) have no irrigation/agriculture engineers. As the LGA's capacity in irrigation development is low, most of the technical tasks along the irrigation development process is commissioned to the zonal office as mentioned above. For the establishment of District Irrigation Department, as suggested in NIA, will require an intensive investment under such circumstances.

Table 5.8.2 shows the allocation of irrigation/agricultural engineers, irrigation technicians and other technical staff at the LGA level.

Table 5.8.2 LGA Irrigation Staff Allocation (As of February 2017)

	Dodoma	Kilima-njaro	Mbeya	Moro-goro	Mtwara	Mwanza	Tabora	Katavi
Number of LGAs	22	25	22	20	23	31	20	17
Irrigation/ Agricultural Engineer	14	13	13	14	10	14	7	8
Irrigation Technician	12	48	35	21	15	22	8	14

Source: Data obtained by JICA Project Team with the support of NIRC (February 2017).

(3) Region

There are few experts assigned at the Regional Secretariats to provide technical advice to LGAs in the irrigation sector. As such, the regions only function as an administrative supervisor of LGAs when there is a miscommunication between zones and LGAs.

(4) IO

Only a few LGAs can afford to attach technicians to each irrigation scheme, and the support of zonal officers are mainly in the construction phase. As such, the support system of LGA to IOs is especially weak during operation and maintenance in accordance with the CGL as well as technical input to their production and marketing activities up to the level of perceiving the benefit of maintaining irrigation schemes properly.

(5) Private Sector

There are only a few local engineering firms specialising in irrigation development[9]. Hence, the demand for irrigation engineers or technicians are not high among private engineering firms. This is partly due to the fact that the ZIOs undertake most of the consulting works for small-scale irrigation scheme construction, and thus, there is little market demand or incentive for private sector involvement. As for the contractors, there are several civil contractors which have been awarded with LGA-level irrigation constructions. However, there are few contractors specialised in irrigation development. As a result, civil contractors do not selectively employ irrigation engineers or technicians but merely as "civil engineers/technicians".

5.8.2 Supply Side

There are several educational and training institutes which provide irrigation engineers and technicians.

[8] The number of LGAs excludes those which are not yet operational, i.e., Dar es Salaam City, Ubungo MC, Kigamboni MC, Kibiti DC, and Songwe DC. Hence the total is 180.
[9] According to the ERB, there are only two local firms registered for irrigation engineering field. There are 211 registered local engineering firms and 86 foreign firms in Tanzania (as of December 2016).

Table 5.8.3 shows the current degree and diploma courses aimed directly at developing irrigation human resources. Intake capacity of diploma courses is less than half of degree courses, that is, more engineers are produced than technicians at present. It should also be noted that the numbers are on an intake capacity basis, and actual supply of engineers and technicians are less than the figures shown in Table 5.8.3.

Table 5.8.3 Degree and Diploma Courses for Irrigation Engineers and Technicians (2016/17)

Skill Level	Institution	Course	Admission Capacity
Engineer	ATC	B. Eng. in Civil and Irrigation Engineering	66
	WI	B. Sc. in Water Resources and Irrigation Engineering	300
	SUA	B. Sc. in Agricultural Engineering	65
		B. Sc. in Irrigation and Water Resources Engineering	65
	UDSM	B. Sc. in Agricultural Engineering and Mechanization	30
	Total		**526**
Technician	ATC	Ordinary Diploma in Civil and Irrigation Engineering	75
	WI	Ordinary Diploma in Irrigation Engineering	120
	MATI Igurusi	Ordinary Diploma in Irrigation	62
	Total		**257**

Note: The figures are on an annual admission capacity basis.
Source: Data from Tanzania Commission for Universities (TCU) and individual education and training institutes

5.9 Research and Development

5.9.1 Arusha Technical College

Arusha Technical College (ATC) is under the jurisdiction of the Ministry of Education and Vocational Training (MoEVT) and specialises in civil and irrigation engineering. There is a small demo plot for showcasing various types of irrigation methods (drip, sprinkler, border, furrow, basin and pipe). Besides this, there is a plan to develop a training farm outside the campus, which will feature RWH, water reservoir and groundwater as sources of irrigation. The main concept of these farms is the introduction of water efficient irrigation methods in semi-arid areas in Tanzania.

5.9.2 Water Institute

Water Institute (WI) is a research, consultancy, and educational institution under the Ministry of Water and Irrigation. The WI provides bachelor's and diploma courses on water resources and irrigation, water supply and sanitation hydrology, and hydrogeology. The WI has laboratories on soil mechanics, hydrology, and water quality.

5.9.3 Sokoine University of Agriculture

Sokoine University of Agriculture (SUA), under the jurisdiction of MoEVT, deals with various disciplines of research topics in the agriculture sector. Especially, the College of Agriculture specializes in agricultural engineering and irrigation and water resources engineering. The SUA has a test field of about 100 ha in the main campus premise with an earth dam and drip irrigation demo plots. In addition, the university owns 1,500 ha land for test fields at Mazimbu campus. The university also has conducted the consultancy work on irrigation development.

5.9.4 The Nelson Mandela African Institution of Science and Technology

The Nelson Mandela African Institution of Science and Technology (NM-AIST) belongs to a network of Pan-African Institutions of Science and Technology and is a graduate university. Its Hydrology and Water Resources Engineering (HWRE) program conducts a series of studies on water accounting, water resources modelling and water productivity in irrigation. The institution also conducted a consultancy work on the reuse of waste water for irrigation, and an environmental flow assessment for an irrigation project.

5.9.5 National Irrigation Research and Training Centre

(1) National Irrigation Research and Training Centre Plan

The NIRC has a plan to establish a research and training institute to disseminate new technologies and knowledge newly acquired at the irrigation sites to irrigation staffs of NIRC, district officers, and private sectors. In the original plan, National Irrigation Research and Training Centre (NIRTC) was planned to be constructed in Dakawa Village, Mvomero District, Morogoro. The use of the proposed site is agreed with the local government.

The JICA Project Team inspected the proposed site in March 2017 to evaluate the original plan. In August 2017, NIRC proposed a new plan for the NIRTC due to the change of circumstances surrounding NIRC. In consequence of this change, the JICA Project Team re-evaluated the NIRTC plan based on the new plan.

(2) Comparison of Original and New Plans

Table 5.9.1 compares the new plan with the old plans.

Table 5.9.1 Comparison Table of the Old and New Site Plans

	Original Plan	New Plan
Location	Dakawa Village, 7 km from the Morogoro-Dodoma national road	Njedengwa Investment Area in Dodoma
Building Plan	Administration Block Dispensary Conference Hall Class rooms/Lecture Theatre Staff Quarters Rest House Cafeteria Gens Dormitories Ladies Dormitories Workshop	Administration Block 300 m^2 Library 150 m^2 Hostel/Research Flat 50 persons Experimental/Modelling Workshop 150 m^2 Lecture Theatre 100 persons Multi-purpose Room 100 persons Cafeteria 50 persons
Laboratory	i) Hydrology & Water Resources ii) Soil Mechanics iii) Irrigation & Water Management iv) Material Testing (Strength of materials) v) Remote Sensing & GIS vi) Technology Transfer	i) Water Resources 150 m^2 ii) Soil Mechanics 150 m^2 iii) Geo – Technical 150 m^2
Demonstration Allotment	Four (4) demonstration plots Detailed plan is not described in the planning report.	Four (4) demonstration plots Centre pivot irrigation model Sprinkler system irrigation model Drip irrigation system model Channel/canal irrigation system model
Project Cost Estimate	USD 13.94 Million (Fund Requirement; USD 13.64 million)	USD 13.94 Million (Fund Requirement; USD 13.64 million)

Remarks: NIRC has submitted JICA two times of the applications of Japanese ODA for the original plan.
Source: NIRC

Judging from the building plan of the new plan, it seems to narrow down the functions of the NIRTC. The number of laboratories was reduced to half of the old plan. In addition, there would be a possibility to reduce or remove the function for lodging because of the advantageous location that it is in, the Dodoma capital area.

(3) Comparison of Soft Components

The centre aims to compile the domestic and international research results, conduct research in collaboration with domestic and international research institutions as necessary, and conduct trainings to disseminate the appropriate technology obtained as a result.

For this purpose, in the original plan, nine (9) thematic areas were selected. Basically, this component would not be changed between the original and new plans as shown in Table 5.9.2.

Table 5.9.2 Nine Thematic Areas in Irrigation Research

Thematic Areas	
i) Agricultural Land and Water Resources Development	ii) Improvement of Water Productivity and Irrigation Water Use Efficiency
iii) Development and Utilisation of Appropriate Irrigation Technologies	iv) Effective and Efficient Farmers Organisations
v) Appropriate Irrigation Methods	vi) Appropriate Irrigation Lining Materials
vii) Suitable Environmental Management	viii) Socio-Economic and Cultural Management
ix) Improvement of Irrigated Soils Fertility	

Source: Proposal for Establishment of National Irrigation Research and Training Centre, NIRC

(4) Evaluation of New NIRTC Plan

(a) Evaluation of the Location

In the original plan, the NIRTC was planned to be constructed in a rather isolated area which was about 40 km away from Morogoro town. In the new plan, it will be constructed within the NIRC's plot, which is close to the Dodoma city area.

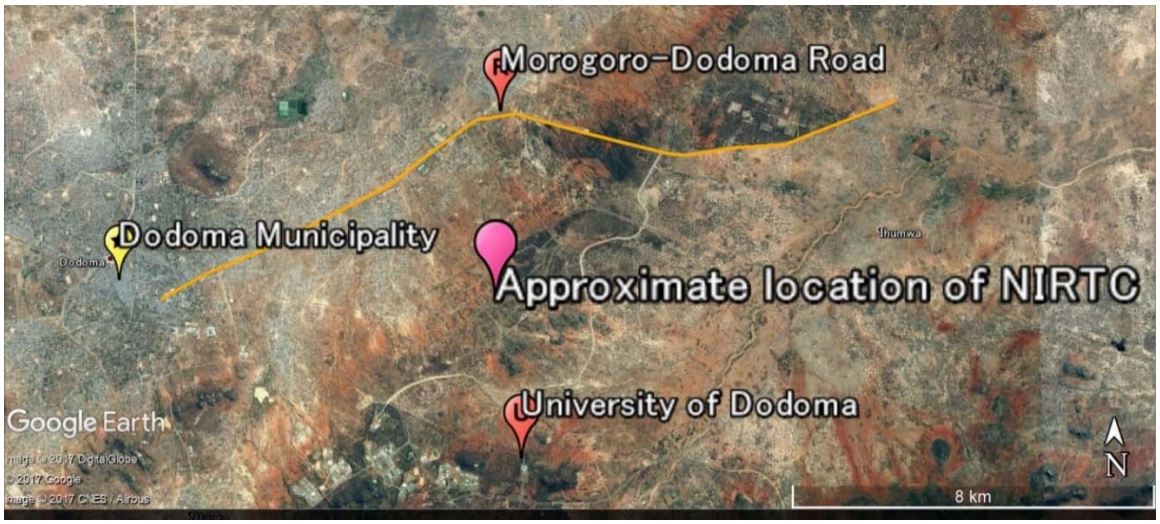
Since the proposed site is located within the NIRC's plot, it is expected that the knowledge of the experienced NIRC staff would be utilised for trainings.

As for lodging and restaurant facilities, there is a possibility to utilize neighbouring facilities.

(b) Evaluation of Water Source

Regarding water supply, water will be supplied from tanks shared with other agencies. There would be no original water source. The total area of the NIRC plot is about 7.9 ha, of which the area of the exhibition farm plots would be approximately 1.6 ha consisting of four farm blocks. In these exhibition farm plots, 1) sprinkler irrigation, 2) drip irrigation, 3) centre pivot irrigation, 4) surface water irrigation would be practiced. Judging from the irrigation methods, crops with low water consumption would be cultivated. The required water volume for irrigation would be about 60 tons per day (0.68 litters/second) in total at the peak time of water consumption. There would be a possibility that water would be able to be secured by measures such as reducing the required water volume by rotational irrigating within four farm plots, reducing the cultivation area according to the amount of water supplied, and installation of a water tank. In the future, however NIRC shall negotiate with the Water Supply and Sanitation

Authorities (WSSAs) in Dodoma to allocate sufficient water to NIRTC day and night times.



Source: Google Earth image@2017 Digital Globe, @2017 google, image@2017 CNES/Airbus (Map), NIRC for Location

Figure 5.9.1 Location Map of Proposed NIRTC

(c) Evaluation of Research Plan

Irrigation in Tanzania has various problems, for example, low irrigation efficiency, poor water management, and serious sedimentation in canals and reservoirs.

It is important to develop and disseminate the appropriate technologies suitable for each region in consideration of soil, geological and weather conditions, rather than applying technologies of foreign countries as they are.

The proposed research plan covers the necessary area of irrigation technology (see Table 5.9.2).

(d) Collaboration with Other Institutions

The NIRTC would not conduct research by themselves independently. Necessary technical documents and information would be collected, and researches would be conducted as necessary in collaboration with national and international institutions.

This NIRTCs plan is realistic and a possible way to improve irrigation technology in Tanzania.

(e) Overall Evaluation

Development and dissemination of technologies suitable for regions is essential for future irrigation development in Tanzania. The NIRTC has a role as a research and training institution capable of acquiring practical skills while NIRC and district staffs are in office. For districts and regions which are operated by limited number of irrigation staffs, it would be a good opportunity to effectively acquire skills avoiding long-term absence of staff.

It may be difficult for many irrigation staffs to master water saving technologies such as drips, sprinklers, central-pivots which are still not yet popular in Tanzania only by classroom lectures. Therefore, an experimental farm equipped with such facilities is required to develop their capacity for the mechanical appliances, installation and O&M. Also, a computer laboratory associated with GIS and CAD for design standardisation, a material laboratory equipped with testing apparatus for quality control of soil and

concrete are equally important for NIRC.

Problems such as employment of many of the management and technical staffs and securing of water in the original plan would be highly expected to be improved by the new plan. As a conclusion, the JICA Project Team judges that the new plan is worth considering for realisation.

5.10 Donors' Support in Irrigation Sector

5.10.1 Japanese ODA in Irrigation Sector

(1) Small-Scale Irrigation Development Project

The SSIDP is a Japanese official development assistance (ODA) Loan Project, which started in July 2013 with the selection of consulting company, having the objective to improve the productivity of crops (especially rice) through construction and rehabilitation of irrigation facilities and provision of related equipment, thereby contributing to increasing income of farm households and poverty reduction. As of July 2017, the total disbursed amount has come to JPY 3,017 million against the total loan amount of JPY 3,443 million.

Table 5.10.1 Loan Allocation (L/A No. TA-P12)

Category	Loan Amount (JPY in Mil.)
(a) Civil Works and Equipment*1	2,941
(b) Consultancy Services*2	221
(c) Interest during Construction*2	1
(d) Contingencies*2	280
Total	3,443

Note: Terms of the loan, 6 years from 16th July 2013
*Payment method, *1= Advance Procedure, *2= Transfer Procedure*
Source: SSIDP Consultant (July 2017)

As for the civil works, 119 projects were originally listed up for irrigation development of 52,494 ha, later which was slightly revised to be 51,778 ha as shown in Table 5.10.2

Table 5.10.2 Target Irrigation Development by Zone

Irrigation Zone	Original Plan			
	No. of Projects	Irrigation Area (ha)		
		Existing	Extension	Total
Dodoma	13	1,780	1,660	3,440
Kilimanjaro	19	5,837	1,970	7,807
Mbeya	31	10,975	8,694	19,669
Morogoro	15	2,281	2,627	4,908
Mtwara	19	3,721	3,965	7,686
Mwanza	10	581	420	450
Tabora	12	4,552	1,475	6,027
Total	119	29,727	22,767	52,494

*Note: *= Batch-1 is nearly completed, Batch 2 is under construction and Batch-3 is under sub-project selection.*
It is planned that No. of Projects will be 119, and No. of contract lots will be 131. The reason why No. of contracts are increased is due to division of contract and/or phasing works in the same Batch and serious works of 1st and 2nd Batches.
Source: NIRC, 2017, Distribution material at SSIDP tripartite meeting held on 21st July 2017 (No. 29)

It is noted that, since the beginning of SSIDP's operation, a tripartite meeting chaired by NIRC has been conducted inviting JICA and the project consultants monthly to discuss problems and solutions

encountered during the project operation.

Table 5.10.3 summarises the points to give feedback to future similar type of irrigation projects based on the SSIDP's operation so far.

Table 5.10.3 Feedback from the SSIDP's Operation

Dimension	Feedback from SSIDP
Technical Aspect	・ The CGL is a general guideline for implementation of small scale irrigation projects in Tanzania. Meanwhile a national standard design criteria/manual for irrigation is not available yet in Tanzania, designers often use a draft design manual prepared by Gibb Africa in 1999 or whatever they have. ← *A standard design criteria/manual needs to be prepared.* ・ It has been agreed that SSIDP targets the small-scale irrigation projects having irrigation area less than 500 ha. In reality, however, SSIDP often includes the projects that would be a part of medium and/or large-scale projects. ← *Definition of the target projects needs to be confirmed.* ・ The average budget available for SSIDP sub-projects is say TZS 300,000,000, which is less than half of ASDP budget ceiling of TZS 800,000,000. ← *Proper cost estimate will be required for full development.*
Financial Management Aspect	・ After 2013/14 when new contributions to the ASDP basket fund substantially ended, the Government fund allocation to ZIOs and LGAs (DAICO offices) has been suffering from serious shortage. The divergence between the budget allocation and the delay in disbursement are in a normal state, and in the year 2015/16 the allocation of budget was almost zero due to the result of the election which was going on. At present, the funds are secured only for some projects supported by donors including SSIDP projects and DP's projects. Many of the LGAs are facing serious fund shortage in daily operation. ← *It might happen in the future. So, not only construction budget but also special provision for operation fund for ZIO and LGA like as SSIDP needs to be considered in case of loan projects.* ・ There was a big gap between the physical and financial progress. This was mainly caused by i) time spent for preparation of payment statement by contractors, ii) delay in approval process by LGAs (DED), and iii) in some cases a temporary fund diversion for other purposes. ← *ZIO shall be involved in the routing monitoring process of the project implementation.*
Institution Aspect	・ NIRC is always facing chronic shortage of professional staffs, office space, capacity of administration and accounting units. ← *A low ratio of approved budget execution is a bottle neck to improve overall situation.*
Irrigation Development Aspect	・ Water storage facilities such as small dams and ponds will be quite useful especially in semi-dry zone and rainfed paddy areas to secure supplemental irrigation in wet seasons. According to the dam list of MoWI, there are more than 600 dams in Tanzania, most of which are small (H < 10 m and Q < 1.0 MCM). A charco dam; a kind of RWH pond, could be seen in many places in semi-dry zones of Tanzania. ← *A RWH pond including small dams shall be considered as a climate change adaptation measures.* ・ Mtwara is recently coming up for industry development; natural gas and cement production. Also, the road connection to Dar es Salaam has been drastically improved with the completion of the Mkapa bridge. Mtwara is a rice import region because it has been left behind irrigation development for a long time. ← *The above needs to be considered in process of development priority ranking.*

Source: JICA Project Team based on interview to SSIDP Consultant (July 2017)

(2) Project for Capacity Development for the Promotion of Irrigation Scheme Development under the District Agriculture Development Plans (DADPs) Phase 2: TANCAID2

(a) Objectives of TANCAID2

TANCAID has been implementing various activities since August 2015 as a four-year project. The project objectives are:

- Capacity building of the district staff in irrigation project through enhancement of project management ability from "project planning to implementation" to "operation and maintenance" of NIRC and through trainings by NIRC,
- Dissemination of CGL, which is prepared for appropriate implementation of irrigation

development and operation and maintenance, as a national standard, and

- Strengthening of organisation to improve the management system for irrigation development and to promote irrigation development.

(b) Outline of Activities

1) Target Area

A total of seven (7) schemes in three zones, namely, Dodoma, Tabora, and Mwanza, are selected as demonstration schemes. In addition, TANCAID2 provides guidance on project monitoring to 62 schemes of SSIDP batch 2 which did not utilise CGL. Moreover, several staff trainings are given to 40 schemes selected among 62 by NIRC.

2) Beneficiaries

Direct beneficiaries of trainings and guidance are zonal engineers of all zones and irrigation staffs of district in target schemes. Indirect beneficiaries are irrigators' organisations, which receive guidance by district irrigation staffs.

3) Activities

In order to improve the efficiency of management in the irrigation development and to make the procedure of scheme management to work homogeneously at an adequate level, the following activities are conducted.

i) Revisions of CGL as necessary
ii) Preparation of supporting technical manuals and standard designs
iii) CGL trainings to zones and districts staff
iv) Improvement of project monitoring sheets, and monitoring of projects
v) Establishment of monitoring and reporting system of NIRC for efficient operation

(c) CGL

CGL was prepared in 2010 by JICA experts based on the guideline published in 2004 by NIMP2002. During the project implementation period of TANCAID1, promotion of CGL was carried out nationwide. In June 2016, revised CGL was published incorporating experiences in demonstration schemes.
The revised CGL covers the four (4) fields.

- Volume 1: Formulation
- Volume 2: Implementation
- Volume 3: Operation and Maintenance
- Volume 4: Training

Among these four volumes, CGLs for "Formulation", "Implementation", and "Operation and Maintenance" are given legal status in the National Irrigation Act 2013.

(d) Lessons learned through the Activities

1) In adequate Budget Arrangement

In many development schemes, budgets are not adequately allocated. As a result, expected effects have

not been demonstrated in many cases. Approved budget for irrigation development by the central government is not always disbursed fully and timely to the NIRC or local governments.

2) Lack of Consciousness to Observe the Law

Staffs at both national and local levels lack consciousness to observe rules and laws. Therefore, unified management work of irrigation schemes becomes difficult.

3) Insufficient Staff and Management organisation

The number of irrigation staff at the national and the district levels are insufficient, and organisational management systems have not been established.

4) Poor Ability of Contractor

Contractors, who are engaged in small scale irrigation construction works, lack experience, with none or very few irrigation technical staff. In addition, they lack consciousness of quality control of construction works. As a result, many faults are observed especially in concrete works.

(3) TANRICE2

(a) General

The technical cooperation projects supported by Japan originated in the 1970s, Kilimanjaro Region Agricultural Development Project. After that, five projects (Kilimanjaro Agricultural Development Centre (KADC) Project, The Kilimanjaro Agricultural Development Project (KADP), Kilimanjaro Agricultural Training Centre Project (KATC), KATC Phase II Project, and Technical Cooperation in Supporting Service Delivery Systems of Irrigated Agriculture (TANRICE)) had been consecutively implemented until 2012 by JICA. From the KATC project, irrigated rice was targeted across the country and upland rice was added as a target crop in TANRICE.

TANRICE2 is an abbreviation of “the Project for Supporting Rice Industry Development in Tanzania”. The ongoing six-year technical cooperation project started in November 2012 and will end in November 2018, covering the Tanzania mainland as well as Zanzibar. Overall goal of the project is set as “rice production is increased in the rice production areas across the county.” and its project purpose is defined as “rice farming technologies are adopted by farmers in the priority rice production areas.”

The project deals with not only irrigated rice but also upland and rain-fed lowland rice. It means that the crops covered by TANRICE2 are beyond irrigated land territory. Since 2012, numerous training courses on various rice farming technologies has been provided in many irrigation schemes, which in turn has contributed to improvement of cultivation methods and unit yield. The data summarised by TANRICE indicated that average rice unit yield level of 30 irrigation schemes improved by 42%, from 2.6 ton/ha to 3.7 ton/ha. This indicated that the training courses were so effective that the farmers trained could increase their harvest per unit area.

In principle, irrigation itself matters how to convey water, which is indispensable for crop growth, from water sources to crop land in a sustainable, efficient and economical manner. But when farming and water control technologies at crop land are relatively low, irrigation water cannot be used effectively,

which in turn may cause waste of irrigation water. On the other hand, irrigation water availability is considered to be an essential prerequisite for some of the farming technologies such as unification of improved variety for planting and field water and fertilizer control. Without irrigation water, these technologies cannot be practiced on crop land, which makes impossible to achieve high productivity.

Taking the above into account, irrigation development and farming technology improvement/extension at the field level such as TANRICE2 are considered to be inseparable and/or reciprocal. In other words, irrigation development is regarded as a kind of infrastructure development while farming technology improvement/extension at the field level is considered as software and/or capacity development. Both subjects are closely interrelated and complementary.

(b) Lessons Learned through TANRICE and TANRICE2

Through the experience of TANRICE and TANRICE2, the following are derived as lessons:

In some irrigation schemes, it was observed that irrigation facilities were not well operated or maintained after completion of irrigation facilities construction. Proper operation and maintenance of the irrigation facilities by district officers and beneficiaries is important. In particular, the beneficiaries should be aware of that in case irrigation facilities were broken, district officers could still receive monthly salary, but other farmers will experience trouble because they could not cultivate paddy without irrigation water. That is why farmers should organise proper operation and maintenance (O&M) system for irrigation facilities by themselves.
At district level, proper institutional framework should be set up to facilitate effective irrigation facilities management because the ZIO is busy with planning, designing and supervising new irrigation schemes. In addition, with budget constraints at the central government, it seems to be impossible to manage individual irrigation schemes by the central government officers (ZIO). Hence district officers should fill the role of day-to-day O&M at each irrigation scheme, and ZIO and/or NIRC should take responsibilities in case of engineering matters such as facility repair works are necessary.
For Tanzania, irrigation agriculture is rather new; therefore, technologies and capacity development is indispensable for proper O&M of irrigation facilities. After the training, long term irrigation water provision will be possible, which in turn leads to long term function of irrigation facilities. Therefore, local capacity development for proper O&M is essential. Without the capable staff at the local level, any good-looking irrigation facilities will eventually lose their functions.

Source: JICA Project Team based on interview to TANRICE2 project

Considering the importance of proper and sustainable O&M for irrigation facilities to be constructed in the future, it is quite significant for the Project to formulate the NIMP2018 which fully takes account of capacity development of central/local government staff as well as institutional framework for facility O&M.

(c) Possibility of Cooperation with TANRICE2

TANRICE2 has provided many training courses for stakeholders of various irrigation schemes where facilities had been constructed to some extent. Lower Moshi area is one of good examples. After completion of the NIMP2018, irrigation facility development is supposed to start according to an action plan of the NIMP2018. Coincident with irrigation facility development, timely training courses for farming technology improvement should be provided to the farmers concerned to achieve synergistic effects of both activities from the beginning.

(4) ATC

Originally established as Technical College of Arusha in 1978, Arusha Technical College (ATC) was established in 2007. JICA has continuously supported its effort for civil and irrigation engineering program through dispatch of experts and AIHRD-Project (2014-). In 2016/17 academic year, ATC

operates BSc. in Civil and Irrigation Engineering and OD in Civil and Irrigation Engineering with annual intake capacity of 66 and 75 students, respectively.

ATC can contribute to the achievement of NIMP2018 especially in the following areas:

- Provision of irrigation human resources: As NIMP2018 requires more irrigation engineers and technicians, ATC continues to be an indispensable source of human resource provision.
- Provision of short training courses: With the support of JICA, the college is equipped with demo plots of irrigation farming, open channel apparatus. Using these equipment and facilities, ATC can provide various training programs tailored to irrigation engineers, technicians, and irrigators.
- Research and development: Located in semi-arid area, ATC is suitable for research on water-saving irrigation. Thus, NIRC can commission ATC to conduct a research on water-efficient irrigation techniques.

5.10.2 Other Support in Irrigation Development by Development Partners

As already discussed, Development Partners (DPs) are putting more emphasis on agriculture value chain development from production and processing to marketing involving private sector who are considered as a key driver for agricultural transformation. Amid such circumstances, USAID and the World Bank (WB) are continuously supporting the irrigation infrastructure development with attention to soft components including but not limited to capacity building of IOs in planning and doing of agriculture business and water management.as shown in Table 5.10.4.

Table 5.10.4 Irrigation Development Projects supported by Other Development Partners

DP	Name of Project	Project Description
USAID	Irrigation and Rural Roads Infrastructure Project under Feed the Future (FTF) Initiatives (2011-2016)	The project has completed comprehensive feasibility studies (FS) to evaluate the development of four potential irrigation schemes (Kisegese, Udagaji, Mgugwe, and Mpanga-Ngalimila) in Kilombero Valley. Besides carrying out feasibility studies in Kilombero valley, the project decided to improve the Dakawa (pump) existing irrigation scheme of 2,000 ha. The work of the Dakawa irrigation scheme is under way while there is no further development of the schemes which have received feasibility studies.
WB	Japan Policy and Human Resources Development (PHRD) (2012-2016)	PHRD, which is granted by Japan, is implementing through WB's operation to support ASDP1 to (a) strengthen access to improved technologies, (b) improve access to markets and value addition/processing, (c) build capacity for irrigation development. Among others, PHRD puts emphasis on irrigated rice cultivation involving KATC and Ministry of Agriculture Training Institutions (MATI).
WB	Expanding Rice Production Project (ERPP) (2014-2017)	The project development objective is to increase the productivity and production of rice in targeted areas of Morogoro and Zanzibar. The project will expand and/or rehabilitate irrigation infrastructure at five irrigation schemes on the mainland, and eight irrigation schemes in Zanzibar. On the mainland, 325 ha of irrigated area will be rehabilitated and 315 ha will be expanded. In Zanzibar, 58 ha will be rehabilitated and 72.5 hectares will be expanded. The project will support the design of the irrigation infrastructure, the construction of the infrastructure, and the strengthening the irrigators' organisations to assure sustainable operation and maintenance of the irrigation works.
WB	Resilient Natural Resources Management for Tourism and Growth (REGROW) (2018-2024)	The project development objective is to improve management of natural resources and tourism assets in priority areas of southern Tanzania, and to increase access to alternative livelihood activities for targeted communities. REGROW will implement priority actions of the IWRMDP for the Great Ruaha Sub-basin, in collaboration with the Rufiji Basin Water Board (RBWB) and MoWI. Some of the activities will include investments in some identified irrigation schemes in order to improve their irrigation efficiencies so as to allow more water to flow downstream to meet other uses in the Mikumi National Park.

DP	Name of Project	Project Description
KF	Irrigation Development Project in Luiche Valley in Kigoma Region. (Envisaged to start in 2018)	The Luiche Delta is supplied with flood coming from Luiche River, which originates from Kasulu District. The river eventually enters Lake Tanganyika, creating behind it an enormous fertile land which is estimated to have about 3,000 ha of arable land suitable for conducting small and large scale modern irrigated agriculture. A dam is planned to be constructed in the upstream of the project area in order to impound water for irrigation as well as to control floods in the farm land.
AfDB	Songwe River Basin Development Programme (SRBDP) (2003-2014)	The SRBDP is a bilateral initiative between Malawi and Tanzania on the transboundary Songwe River. It was initiated in order to stabilise the meandering course of the River, as it forms the border between the two countries. The Lower Songwe River Tanzania (LSRT) irrigation scheme is on the left bank of the Songwe River in Kyela District and situated between the Songwe River and the Kiwira River. Its upper boundary is near the town of Kasumulu just downstream of the Kasumulu Bridge and the lower boundary a few km upstream of Lake Nyasa/Malawi. A feasibility level design for LSRT has been prepared. The net irrigation area is 3,005 ha with a cropping intensity of 200%. The major crop to be grown is rice which will take up over 150% of the cropping pattern. A business plan have been prepared with an aim of providing a clear direction on the business of the Songwe River Basin Commission, an institution mandated to co-ordinate the implementation of various projects over the ten-year period, 2015 to 2025.
AfDB	Kikonge Multipurpose Dam for Hydropower and Irrigation project (Planned from 2016)	The project is for construction of a dam for development of a hydropower scheme and an irrigation project on the Ruhuhu River in the south-west part of the country. The envisaged project infrastructures comprise i) an irrigation scheme of 4,000 ha including a diversion weir, the main canal, the downstream command areas, a mini hydropower plant and water supply systems to the local communities and ii) a hydropower scheme including a 120 m high dam, a storage reservoir of 6 billion m^3 capacity and 60 km long and a 300 MW power plant and the various appurtenant infrastructures. The project is currently under feasibility stage.
AfDB	Rice and Edible Oil Value Chain Development Project (ROVCD) (Planned from 2016)	The project will improve farm incomes, rural livelihoods, food security and contribute to poverty reduction through interventions along the whole value chain of rice and edible oil paying special focus on unemployed youth and women in the lake, central, northern, eastern and southern highland zones. AfDB will support the preparatory activities including feasibility study, detailed design, environmental and social management framework, potential markets and market access in 2017. The project implementation is planned to start in 2018, but approval of Tanzania's government for budget for preparatory survey is delaying.

Note: WB loan to the Catalysing the Future Agri-food Systems of Tanzania (CFAST) was finally cancelled.
Source: NIRC

Recently, a Memorandum of Understanding (MoU) was signed between Korea Rural Community Corporation (KRC) of South Korea and the Southern Agriculture Growth Corridor of Tanzania (SAGCOT) to support modern irrigation water schemes for rural farmers in Tanzania (17th August 2017). And also, China through Shanghai Municipal Agricultural Commission had agreed to bankroll the Agricultural Park at Kimamba in Kilosa District, including construction of irrigation infrastructure and dam in 2,400 ha farm (10th June 2017).

5.10.3 Issues for Future Irrigation Development

Table 5.10.5 summarises the issues for future irrigation development in Tanzania based on an interview with the development partners by the JICA Project Team. These issues shall be addressed in the formulation of NIMP2018.

Table 5.10.5 Issues to be addressed in Future Irrigation Development

Organisation	Key Issues
JICA*1	・ Water conflict with other sectors ・ Environmental and social consideration

Organisation	Key Issues
	・ Climate change resilience ・ Sedimentation ・ Incompletion of the projects due to fund shortage ・ Scattering of irrigation-related information and data ・ O&M supporting system ・ Shortage of irrigation human resources
EOJ	・ Paradigm shift from subsistence farming to profitable agriculture ・ Capacity building of IOs ・ National food security ・ Employment security for rural youth
WB	・ Climate smart irrigation development (drip and sprinkler, sub-surface dam, etc.) ・ Improvement of market access ・ Agriculture business planning by IOs
IFAD	・ Securing land tenure of smallholders against land grabbing ・ Linkage with agriculture value chain (business plan) on PPP basis ・ Water and land conflict among users (farming vs. livestock keeping) ・ Deregulation in import and export of agriculture commodities ・ Construction of quality irrigation systems
USAID	・ Environmental flow assessment (EFA) ・ Linkage with private sector in agriculture value chain ・ Water saving agriculture in semi-dry zone ・ Deregulation in import and export of political crops ・ Preparation of business plan (crop budget) ・ Improvement of market access roads ・ O&M fee collection
AFDB	・ Coordination with ASDP2 (especially, irrigation development in Lake Zone)
FAO	・ Improvement of productivity and profitability in agriculture ・ Strengthening of IOs in a sustainable manner ・ Agriculture statistics ・ Promotion of climate smart agriculture ・ Youth involvement in agriculture sector
DFID	・ Combination of green water (soil moisture and rainfalls) and blue water (river and lake water)

*Source: JICA Project Team based on interview to the relevant organisations, except *1) JICA Formulation of Detailed Plan for the Project on Revision of National Irrigation Master Plan, February 2016*

5.11 Challenges in Irrigation Sector

Challenges currently being faced in the irrigation sector is derived from the field survey, interviews to and discussions with various stakeholders, literature searching, etc. are summarised in the Table 5.11.1.

Table 5.11.1 Major Challenges in Irrigation Sector

Category	Challenges
Study and Design	・ Improper F/S and D/D available before implementation of sub-projects ・ Small budget available for F/S and D/D including geodetic survey and geological investigation ・ Vulnerability for drought and floods ・ Sedimentation problems ・ Low irrigation efficiency ・ Non-availability of design standards and manuals ・ Low awareness of CGL
Construction Supervision	・ Insufficient staff and daily operation cost ・ No timely reporting of physical and financial progress in construction works ・ Poor quality of works ・ No utilisation of construction management manuals, etc.
Budget and Fund Flow	・ Small development budget and further small disbursement, resulted in partial completion of works ・ Delay in payment to the contractor ・ No transparency in fund management

Category	Challenges
Institution and Human Resources Development	・ Irrigation organisation reform ・ Shortage of capable irrigation engineers and technicians ・ Limited number of new staff recruitment by the government and the private sector ・ Poor coordination with relevant government organisations and institutions
Capacity Building	・ Insufficient technical capacity of irrigation engineers and technicians ・ Inactive IOs and supporting system of IOs ・ Poor monitoring and evaluation system
O&M	・ Constant water shortage ・ No proper planning for O&M ・ No business planning by IOs ・ Poor collection of irrigation service fees

Source: JICA Project Team

Countermeasures for the above challenges will be discussed later in Chapter 8.

Chapter 6 Irrigation Database Update and Irrigation Scheme Mapping

6.1 General

6.1.1 Brief History of Irrigation Database

The irrigation database was initially developed in 2002 as part of the National Irrigation Master Plan 2002 (NIMP2002). In 2009, the irrigation dataset was updated and the interfaces of the database program were renewed. This database is called the "2009 database". The number of data collected by the 2009 database reached to around 2,800. These databases were created by utilising the Microsoft Access program.

Because the 2009 database was managed by one developer, a problem occurred that during that time, access to data by the National Irrigation Commission (NIRC) headquarters and Zonal Irrigation Office (ZIO) staff was difficult. In addition, since the person in charge of development of the database transferred to a section not related to database, it became more difficult to use the irrigation database.

Under such circumstances, NIRC requested the Japan International Cooperation Agency (JICA) to support the development of a new irrigation database which is user friendly and easy to use. In response to the request, JICA dispatched a database expert as a Capacity Development for the Promotion of Irrigation of Scheme Development under the District Agricultural Development Plan 2 (TANCAID2) short term expert in 2016.

The Information Communication Technology (ICT) unit of NIRC and the JICA expert of TANCAID2 developed a database called the "Model Database".

6.1.2 Model Database

The Model Database is a Microsoft Excel based database targeting selected six districts. Interface of the database, which is a collection of Excel sheets, is created utilising the Visual Basic for Application (VBA). Data collected by the district irrigation staff is stored in an excel sheet.

In the system design of the Model Database, the data collected in each district will be sent to a database officer in a zonal office by an e-mail, the officer will consolidate them. Data consolidated in a zone will be sent to the ICT unit by e-mail and will be consolidated again. The consolidated data sent from each zone will be the National Irrigation Database.

Moreover, the model database includes the irrigation scheme mappings by use of the GPS pointing survey.

6.1.3 TOR

The JICA Project Team is requested in the TOR of National Irrigation Master Plan 2018 (NIMP2018) to update the model database. The components of updating work are as follows:

i) Develop databases for zonal and NIRC HQs staff if necessary
ii) Collect irrigation data for nation-wide database

iii) Create irrigation scheme map
iv) Develop data sharing method (through e-mail, website, etc.)
v) Collect data on newly planned irrigation schemes
vi) Train database officers

6.2 Method and Procedure

6.2.1 Development of Database for Zonal and NIRC Headquarters Staffs

Updating of database work consists of two parts. They are:

- Updating irrigation schemes data
- Updating of interface for input, output and data storage

(1) Updating Irrigation Schemes Data

Updating data work was carried out by requesting the district irrigation staff to modify the list of the irrigation schemes' data after examining it. JICA Project Team prepared the scheme list by collecting available data. Table 6.2.1 summarises the data sources and their data numbers.

Table 6.2.1 List of Irrigation Scheme Data Collected

Data Source	Number of Data in Each Source
2002 NIMP2002	1,427
2009 Database	2,826
2015 Irrigation data kept by NIRC	2,415
2016 List of schemes on each zonal office	Total of 2,339

Source: JICA Project Team

(a) GPS Pointing Survey:

In order to confirm the existing irrigation schemes, a GPS pointing survey in the field was carried out by each district irrigation staff on the basis of the 2016 scheme list. Details of the GPS survey work are presented in section 6.3.2.

(b) Questionnaire Survey:

In the initial plan, data collection was planned for approximately 1,300 schemes selected based on 2009 database. However, during the data collection period, the JICA Project Team found many discrepancies in contents among the data sources. Therefore, the JICA Project Team decided to conduct scheme data survey for all schemes where a GPS survey was carried out after limiting the data items. For this purpose, questionnaire was prepared for district staffs. Details of this survey work is presented in section 6.3.2.

6.2.2 Irrigation Scheme Mapping of Selected Schemes

In the creation of the scheme map, at first, the JICA Project Team collected layout maps, sketches and other materials that are likely to be helpful. And then, by referring to the collected layout maps, sketches and GPS data, the JICA Project Team drew the scheme boundary, canals, etc., on Google Earth. Details are shown in the section 6.4.

6.2.3 Revision of Interface

The basic concept of the Excel based interface, which is applied in the Model Database, is not changed.

The Zonal and NIRC HQs interfaces are upgraded adding operation buttons for the data consolidation function and data processing. The details are discussed in Section 6.3

6.2.4 Website Development

In Tanzania, the e-Government Agency (eGA) under the Public Service Management of President's Office is managing the development of the website and is responsible for maintaining it. In connection to this, the project team consulted with eGA concerning the proposed NIRC website, and collected the necessary information such as guidelines. The details are described in section 6.5.

6.3 Update of Irrigation Database

Before starting data collection, the JICA Project Team took advantage of the opportunities of TANCAID training and conducted training for zone officers who are expected to become trainers for district officials.

6.3.1 Training for Update Database

Training was conducted for five days from 7th to 11th November 2016 in collaboration with TANCAID2 in Morogoro. The main objectives are to give training to the Zonal database officers, who will be in turn, trainers to the district staffs. The training program consisted of three sub programs. They are:

- New function of Zonal interface (Explanation of consolidation function as a draft basis)
- Creation of Scheme Layout (Method and procedure using GPS)
- Presentations by Database Officers (Simulation of training for district officers)

In day one and first half of day two, the training for database took place.

In the second half of day two, day three and day four, training for scheme mapping was conducted including a sample site visit to the Kiroka scheme, which is one of the Small-Scale Irrigation Development Project (SSIDP) project, in day three.

In the last day of day five, seven database officers presented their achievement. All of them performed well, and performances of some of them were very impressive.

In addition to the seven Zonal database officers, the technical working group members of TANCAID2 including four TANCAID2 experts also participated in this training. Therefore, the total number of participants reached to 37.

Table 6.3.1 Update Database Training Program

Date	Venue	Subject	Number of Participants
7th November 2016	VETA conference room in Morogoro	・ Update database	37
8th November 2016	VETA conference room in Morogoro	・ Update database ・ Creation of Scheme Map	37
9th November 2016	Kiroka Irrigation Scheme	・ Sample site survey	37
10th November 2016	VETA conference room in Morogoro	・ Creation of Scheme Map	37
11th November 2017	VETA conference room in Morogoro	・ Presentations by Zonal database officers	37

Source: JICA Project Team

6.3.2 GPS Pointing Survey

Aiming at measuring coordinates of all irrigation and dam schemes for GIS analysis and irrigation database, the GPS pointing survey was conducted from the end of January 2017 to the end of April 2017 but it was extended until August 2017 due to rains and other reasons. In this survey, two locations such as intake point and start point of irrigated farms were measured.

(1) Methodology

The GPS pointing survey has been conducted in the following manner:

- Collection of the irrigation database prepared by each ZIO. (December 2016)
- Arranging a plan to distribute GPS devices to each ZIO based on the numbers of schemes listed on the zonal database.
- Distribution of GPS devices and survey forms to each ZIO.
- Following up explanation in the workshop for creation of Scheme Maps.
- The list of schemes was revised by each district staff in the workshop.
- GPS pointing surveys by district staff at irrigation schemes.
- Collection of surveyed data directly from district staff or through the zonal database officer.

(2) Result of GPS Survey

The number of irrigation schemes submitted by each ZIO was 2,339 at the end of 2016, and then the revised number by the efforts of district staffs is 2,916. Moreover, the number of GPS pointing survey results submitted by the district staffs was 2,453 as of the end of August 2017. For the purpose of the GPS survey, the JICA Project Team distributed a total of 54 GPS devices to districts through the ZIOs.

The survey period was originally two months from the end of January 2017 to the end of March 2017, which was finally extended to August 2017. Unfortunately, there were reports from district irrigation staffs that survey works were not able to be conducted in several schemes because of poor access to sites due to rain. Consequently, the irrigation schemes, which exist but not surveyed, are excluded from the scheme list.

Table 6.3.2 Number of Irrigation Schemes

Name of Zone	Zonal Database (End of 2016)	Revised Number by LGA (April 2017)	GPS Data (August 2017)
Dodoma	309	319	289
Kilimanjaro	912	1,156	988
Mbeya	494	527	403
Morogoro	225	288	236
Mtwara	166	218	158
Mwanza	182	308	267
Tabora	51	100	112
Total	2,339	2,916	2,453

Source: JICA Project Team

At the final stage of discussion with NIRC made from February to March 2018, the number of irrigation schemes has increased to 2,947 because additional irrigation schemes submitted by NIRC and LGAs.

6.3.3 Data Collection by Questionnaire Survey

The project team distributed questionnaires with regard to basic irrigation scheme and dam information. Items tried to collect information by questionnaire are shown in Table 6.3.3.

Table 6.3.3 Items Tried to Collect Information by Questionnaire

Questionnaire items for irrigation scheme	・ Location (Village name) ・ Priority for development ・ Reasons for requiring the scheme development ・ Water source ・ Existing category of irrigation scheme ・ Intake method ・ Irrigation method	・ Present status ・ Required type of work ・ Utilization of CGL ・ Irrigation area (potential, designed, developed, irrigated wet, irrigated dry) ・ Scheme history (start year, completion year, improved, etc.) ・ Ownership ・ Beneficiaries/IO members
Questionnaire items for dam	・ Location ・ Type of dam ・ Purpose of dam ・ Dam dimensions ・ Present status ・ Required type of work	・ Commanding irrigation schemes ・ Irrigation area ・ History of dam ・ Beneficiaries

Source: JICA Project Team

Questionnaires were distributed to 162 district staffs through NIRC HQs and Zonal offices. The number of answers received is tabulated in Table 6.3.4.

Table 6.3.4 Number of Schemes: Questionnaire Survey

Name of Zone	Irrigation Schemes	Dam
Dodoma	193	30
Kilimanjaro	903	15
Mbeya	211	4
Morogoro	334	9
Mtwara	189	6
Mwanza	218	32
Tabora	134	35
Total	2,182	131

Source: JICA Project Team

6.3.4 Data Collection on New Schemes

In parallel with the data collection by questionnaire survey, NIRC summarised the following list of the well-prepared irrigation schemes which Pre-F/S or F/S were conducted by NIRC in the past.

Table 6.3.5 Summary of Earmarked Projects for Future Development/Improvement

S/No	Project	Type	Potential Area (ha)	District	Region	Zone
1	Bukirilo – Gwanupu Irrigation Project	Water saving Technology	50	Kibondo	Kigoma	Katavi
2	Participatory Dams Development Program in Semi-Arid Areas of Tanzania	Exisisting dams (30 Numbers)	13,444		Manyara, Dodoma, Singida, Mara, Tabora	Dodoma, Tabora, Mwanza
		Proposed new dams (128 Numbers)	97,648		Singida, Manyara, Mwanza, Mara, Geita, Shinyanga, kigoma, Tabora	Dodoma, Tabora, Mwanza
3	Euga Irrigation Scheme		400	Ulanga	Morogoro	Morogoro
4	Karema Irrigation		1,000	Mpanda	Katavi	Katavi

S/No	Project	Type	Potential Area (ha)	District	Region	Zone
	Scheme					
5	Kibaoni Irrigation scheme	Water saving Technology	50	Mpanda	Katavi	Katavi
6	Kitengule Irrigation Scheme	Water saving Technology	50	Karagwe	Kagera	Mwanza
7	Luiche Irrigation Project	Dam	3,000	Kigoma Municipal	Kigoma	Katavi
8	Lukuledi Irrigation Project		4,680	Lindi	Lindi	Mtwara
9	Madibira Phase II Project		3,600	Mbarali	Mbeya	Mbeya
10	Maleza Irrigation Project		7,500	Sumbawamga	Rukwa	Katavi
11	Promotion of Micro Irrigation System for Improved Crop Production for Smallholder Farmers in Tanzania	Water saving Technology	16,710	18 District Councils and 1 Municipality		
12	Muhongo Iriigation Project		1,500	Ngara	Kagera	Mwanza
13	Mwamapuli Irrigation Project	Dam	10,900	Mlele	Katavi	Katavi
14	Nanjembo irrigation Project		1,750	Chunya	Mbeya	Mbeya
15	Pawaga Irrigation Project		3,170	Iringa	Iringa	Mbeya
16	Ngongwa Irrigation Project	Water saving Technology	130	Maswa	Simiyu	Tabora
17	Songwe River Basin Development Project	Dam	3,005	Kyela	Mbeya	Mbeya
18	Yongoma Dam for supporting Ndungu Irrigation Scheme		1,600	Same	Kilimanjaro	Kilimanjaro
19	Luhanga Consolidated Rice Project	Dam	4,000	Mbarai	Mbeya	Mbeya
20	Ruhuhu Irrigation Project	Dam (Kikonge)	3,200	Nyasa/Ludewa	Ruvuma/Njombe	Mtwara/ Mbeya
Total Potential Area (ha)			177,387			

Source: NIRC

Irrigation schemes on the Table 6.3.5 are included in the database. These irrigation schemes are compiled by irrigation type in section 8.6.

6.3.5 Customization of Interface

(1) Re-naming of Terminology for the National Irrigation Database System

The concept of the Model Database, a collection of databases held in district offices, zonal offices, and NIRC headquarters, is defined as a national irrigation database. In this concept, a database of a district may be misunderstood as the National Irrigation Database (NID). In order to avoid such confusion, the project team defines the data set only consolidated and possessed by the NIRC's ICT unit as the National Irrigation Database.

Table 6.3.6 Comparison Table for Database Terminology

TANCAID2, Model Database	Project Team Definition
-	NID for user
Headquarters Database	NID
Zonal Database	Zonal interface Zonal data set for NID
District Database	District interface District data set for NID
-	Interface: A collection of Excel sheets for operation
-	Data set: An Excel sheet where the collected data is stored.

Note: For utilisation of database, interface, and database (or data set at zonal and district levels) are necessary.
Source: JICA Project Team

(2) Required Functions of Interfaces

In this project, four versions of interfaces will be prepared.

The ICT unit of NIRC headquarters is responsible for management and maintenance of the National Irrigation Database system. The ICT unit will have an interface with all functions.

Database officers in zonal and district offices will have authority to input the collected data and compile the stored data as an administrator. Therefore, they need to use an interface having data input and data compiling functions.

In addition, the Zonal staff requires a data consolidation function to compile data sent from districts offices.

User excluding administrators will require a data import function from website and a function of data output. As for irrigation scheme map, a function to use google earth based map will be added considering rather good condition of internet connection.

Differences among interfaces are summarised below.

Table 6.3.7 Comparison Table for Difference in Functions among Interface Versions

Function / Interface	Data Input/Modificatio	Output	Library	Map		Data Search	Data Storage	Data Import	Data Export	Data Consolidation	Data Compiling
				Map on Google Earth	Excel based Map						
ICT unit ver.	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Zonal Office ver.	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	—
District Office ver.	✔	✔	✔	✔	✔	✔	✔	✔	✔	—	—
User ver.	—	✔	✔	✔	—	✔	✔	✔	—	—	—
Model Database	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	—

Note: ✔: function is equipped, : function is not equipped.
Data items stored in each office is the same as the National Irrigation Database.
Source: JICA Project Team

(3) Development of Data Sharing Method

(a) Irrigation Scheme Data Transmission

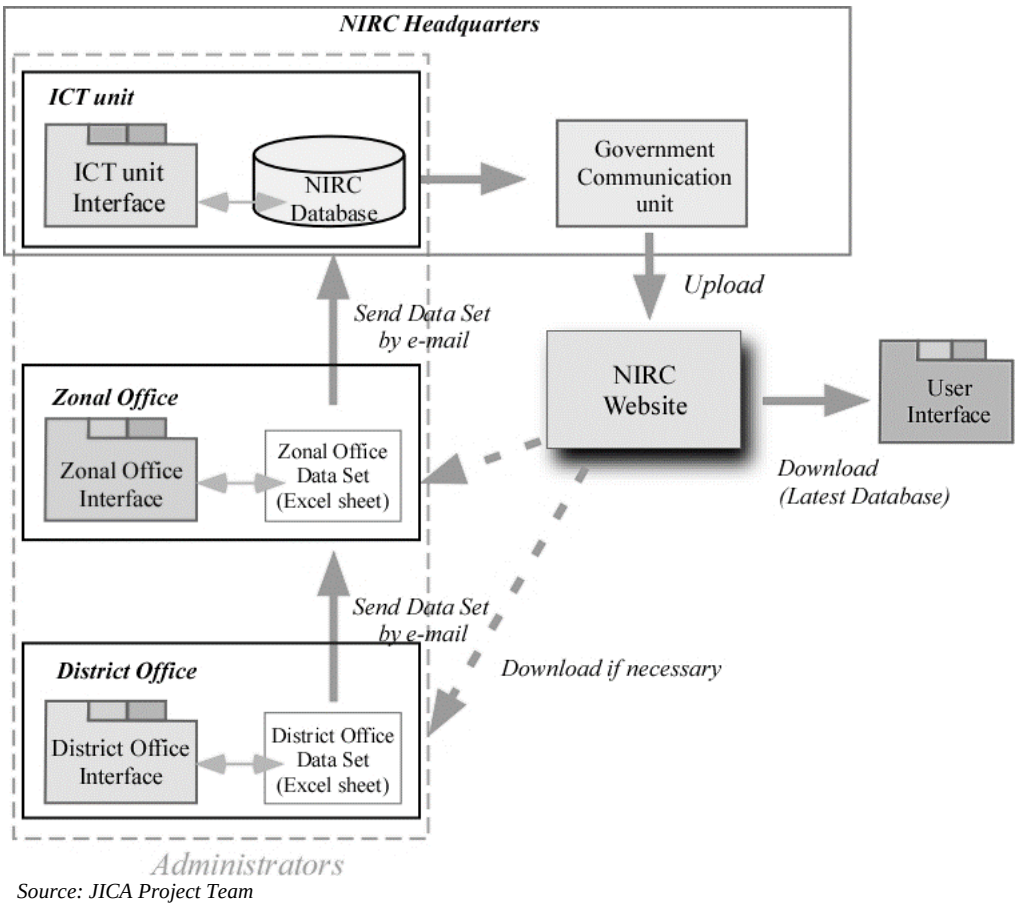
Expected size of one data set, which will be sent by district or zonal offices, would be less than one hundred kilo bites. Considering the communication situation of the Internet, data transmission by e-mail is considered to be the most realistic.

(b) Use of the National Irrigation Database

Currently, the easiest way to share the latest version of the database would be to utilise the expected NIRC website. The management section for the expected NIRC website will be the Government Communication (GC) unit to be established in NIRC. The latest version of database and interfaces would be uploaded by the ICT unit after getting approval from GC unit.

Users will be able to download the latest version of the database and interface from the NIRC website for their use in the future.

Figure 6.3.1 shows the proposed data sharing and NIRC website utilisation methods.



Source: JICA Project Team

Figure 6.3.1 Proposed Data Sharing and Website Utilisation Method

6.4 Irrigation Scheme Mapping of Selected Schemes

6.4.1 Background

At the same period when the model database was created, a method to make a scheme map was developed by the joint efforts of the NIRC ICT unit and TANCAID2 expert to fulfil the following necessity:

(1) Conformity with National Irrigation Act 2013

In the "National Irrigation Act 2013 PART III, Declaration of Irrigation Area and Land Classification, Clause 16 sub-section (3)", the "(a) map or plan showing the boundaries and extent of the lands proposed to be comprised in the area" is requested.

However, the topographical maps which are currently available are old ones created in the 1970s and are very difficult to obtain. For the preparation of a new map, a lot of time and budget will be required to conduct topography survey works.

From the legal point of view, a scheme map, which shows a scheme boundary with low cost, is required.

(2) Necessity of Scheme Monitoring

In a village resources map that is required to be created by CGL, it is difficult to confirm the boundary of the scheme. Moreover, since the map has no scale, it is impossible to manage the scheme in terms of quantity such as the irrigation area and the canal length.

As a tool, a scheme map with enough accuracy for scheme management is required.

(3) Necessity of Scheme Management and Planning

In a district office, the design drawings and design reports are not kept in most cases. Therefore, it is almost impossible to confirm the scheme area where the development is requested for the newly appointed irrigation staff in particular.

There is a high demand of a scheme map, which can measure the area easily with a certain accuracy, from the district staff.

6.4.2 GPS Mapping Workshop

In order to transfer the GPS mapping creation method, after the joint national workshop with TANCAID2 at Morogoro, training workshops for district officers were held in each NIRC zone with the schedule as shown below. Each workshop had three days program which included one day field work during the middle of the day. The database officer in each zonal office was the main lecturer with support from ICT unit of NIRC headquarters.

Table 6.4.1 Subject of GPS Workshop

Date	Zone	Venue		Number of Participants
		Workshop	Field work	
6th February – 8th February, 2017	Morogoro	Edema Conference Centre & Hotel in Morogoro	Irrigation scheme near Wami Dakawa S 6.455337 E 37.560483	18
15th February – 17th February, 2017	Kilimanjaro	Umoja Lutheran Hostel in Moshi	Irrigation scheme near Uchira S 3.4231717 E37.4612094	23

Date	Zone	Venue		Number of Participants
		Workshop	Field work	
20th February – 22nd February, 2017	Dodoma	VETA meeting room in Dodoma	Irrigation scheme near Kisalalo Bulu River S 5.886959 E 35.294088	23
1st March – 3rd March, 2017	Tabora	Moravian Church Hostel in Tabora	Inara irrigation scheme S 5.116765 E 32.934665	14
6th March – 8th March, 2017	Mwanza	Victoria Palace Hotel, La Kairo Hotel in Mwanza	Irrigation scheme near Magu S 2.616408 E 33.457895	36
20th March – 23rd March, 2017	Mtwara	Evengalical Lutheran Church in Mtwara	Kitele irrigation scheme S 10.353154 E 39.705285	18
27th March – 29th March, 2017	Mbeya	Mtenda Sunset Hotel in Mbeya	Mshewe Irrigation Scheme S 8.8485556 E 33.2816914	28

Source: JICA Project Team

6.4.3 Procedure to Making Irrigation Scheme Layout Map

The JICA Project Team is making an irrigation scheme layout map with the following procedures:

i) Collect existing irrigation scheme layout information
ii) Conduct training for zonal officers on how to draw irrigation scheme layout maps
iii) Conduct training for district officers on how to draw irrigation scheme layout maps
iv) Draft scheme layout maps by the JICA Project Team
v) Modify layouts by district officers
vi) Upload to NIRC websites

The following documents were collected as the basic information for drawing scheme layout maps:

- Design layout that was prepared by NIRC
- Scheme layouts in several reports
- Hand written sketch from IO, District offices,
- GPS coordinates from field visit

Example of the data is shown in Figure 6.4.1.

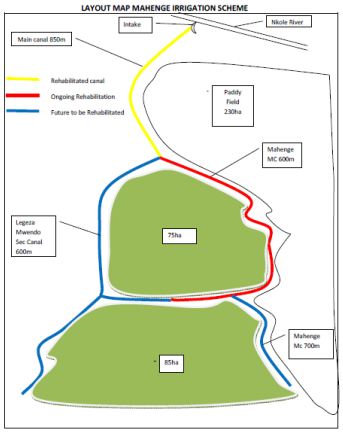
Based on the collected information, layouts were drawn with Google Earth Pro reference with satellite image, and saved in KML format. Prepared KML files will be integrated to National Irrigation Database System. The number of layout maps prepared by the Project is shown in Table 6.4.2.

Table 6.4.2 Number of Prepared Scheme Layout Maps

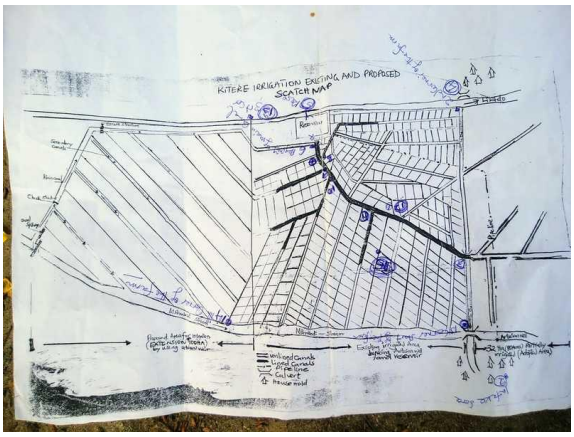
Zones	Number
Dodoma	44
Kilimanjaro	108
Morogoro	106
Mtwara	93
Mbeya	136
Tabora	49
Mwanza	66

Source: JICA Project Team

(a) Existing irrigation scheme map

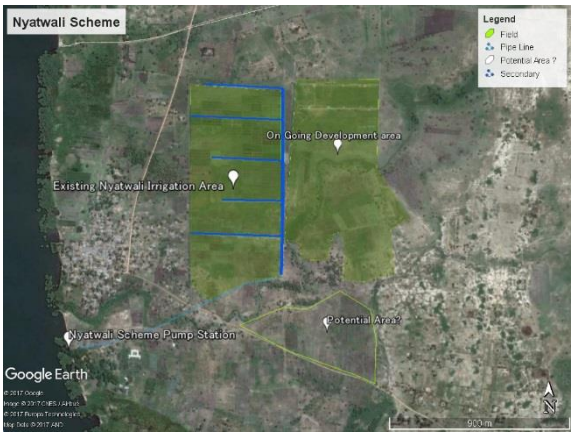


(b) Irrigation scheme map in several reports



(c) Hand written irrigation scheme map in a district office

(d) GPS coordinates map measured during a filed survey



(e) Nyatwali irrigation scheme map

(f) Inala irrigation scheme map

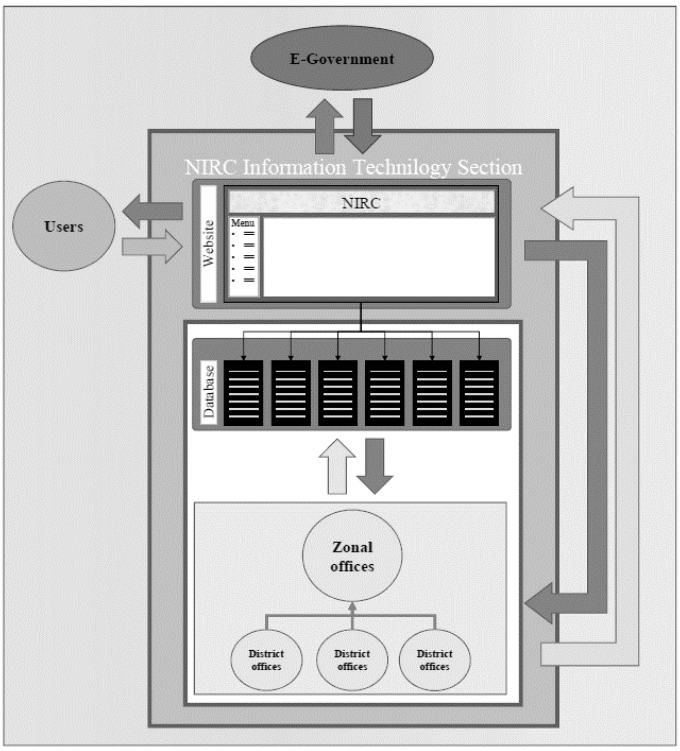
Source: JICA Project Team

Figure 6.4.1 Example of Irrigation Scheme Maps

6.5 Website Development

6.5.1 Website Guidelines

Figure 6.5.1 shows the flow chart of the website development as well as the database interaction among district offices, zonal offices, and NIRC. More details about database interaction and updating process is explained in Section 6.3. This section will focus on the NIRC website development process.



Source: JICA Project Team

Figure 6.5.1 Website Development Flow Chart

The NIRC as a governmental organisation is advised to develop and operate a website to give information and services provision to the public. The eGA is taking care of developing and maintaining the government websites in Tanzania. The websites, however, should be designed in accordance to the guidelines, and standards defined by the eGA and issued in technical guidelines. An important guideline: "Technical Standards and Guidelines for Governmental Websites" contains detailed information about the following:

- Website development process
- Website design
- Website content management
- Website hosting
- Web information security

Therefore, there are specific requirements that the NIRC should follow to develop a website. These are listed in Table 6.5.1

Table 6.5.1 Terms and Conditions of Government Website

Registering a domain name	The domain name should be unique and does not conflict with other domain names.
Uniform resource locator (URL) standards and naming conversion	Standards and naming conversion: a URL goes into more details than a domain name, which identifies specific web page, file, or document on the internet. It should be also unique and follow specific standards which are detailed in the technical manual.
Navigation elements and branding requirements	The navigation term refers to the menus and links which allow user to move from one page to another within the website. There are four main types of navigation
Global header navigation	It is used to describe important links which users tend to access very frequently
Top level navigation	It is a graphic image or text title at the top of web page that identifies the website. It is also a place for the government institution logo.
Body element or utility navigation	It includes navigations buttons like home, about us, publications, etc. It contains the main content area of each page.
Footer navigation	It contains navigation buttons like privacy policy statement, terms and conditions, disclaimer, and copyright.

Source: eGA

Whereas, branding pivotal to the government's goal of providing consistent, seamless look and feel of web presence. Branding includes sites architecture, navigation, layouts, graphics, colours, and fonts, minimum page elements, and consistent terminology, usage, and spelling.

For the website design guideline, there are also several points that should be taken into consideration during the design process including usability, discoverability, accessibility, compatibility with browsers, and responsive design.

To smoothen the process of creating the homepage of NIRC, the NIRC requested the eGA to build its website. Thus, an important meeting was conducted between the IT unit of NIRC and the eGA's team to discuss and select the preferred design as well as the contents of each webpage so that the eGA can proceed to create a proper website for NIRC which adheres to the above rules and guidelines. Figure 6.5.2 shows the initial design of NIRC homepage.

The NIRC site map consists of the following information:

Table 6.5.2 Navigation Menu and its Contents of NIRC Website

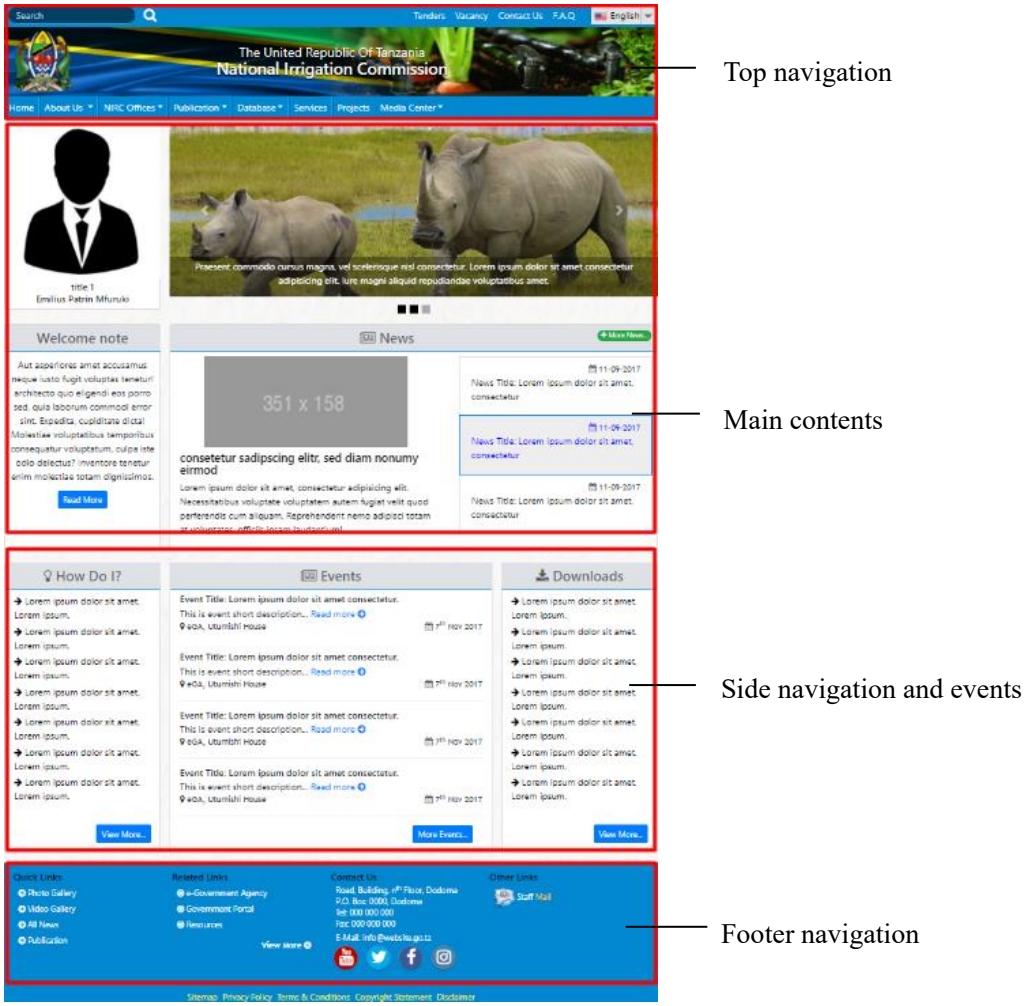
Navigation Menu	Contents
i) HOME	・ General
ii) About NIRC	・ Establishment History ・ Vision and Mission ・ Organisation Structure ・ Board Members ・ Departments ・ Units
iii) Zonal Offices	・ Zonal information
iv) Publications	・ Polices and Acts ・ Reports ・ Articles ・ Guidelines and Manuals
v) Irrigation Maps and Database	・ Irrigation Database ・ Irrigation Maps (GIS Web Map)
vi) Services	・ Services information
vii) Projects	・ Ongoing

Navigation Menu	Contents
	・ Completed
viii) Media Centre	・ Speeches ・ Press Release ・ Photo Gallery ・ Video Gallery

Source: NIRC and eGA

As shown in the menu above, the NIRC website will have database of irrigation schemes. In the contents management system (CMS) (back-end), NIRC will be able to enter Irrigation Data either by uploading the whole sheet or one entry after another. The data will be in Excel (.xls or .xlsx or .csv) formats. The excel template shall be provided by the NIRC.

Under "Irrigation Map & Database" menu, web visitors shall be able to see an Irrigation Data Table. The Data Table shall have a search and filter capability. The information in the Data Table shall be able to be exported (and downloadable) onto Excel or PDF formats. The filtering capability should allow users to see data of their preference.

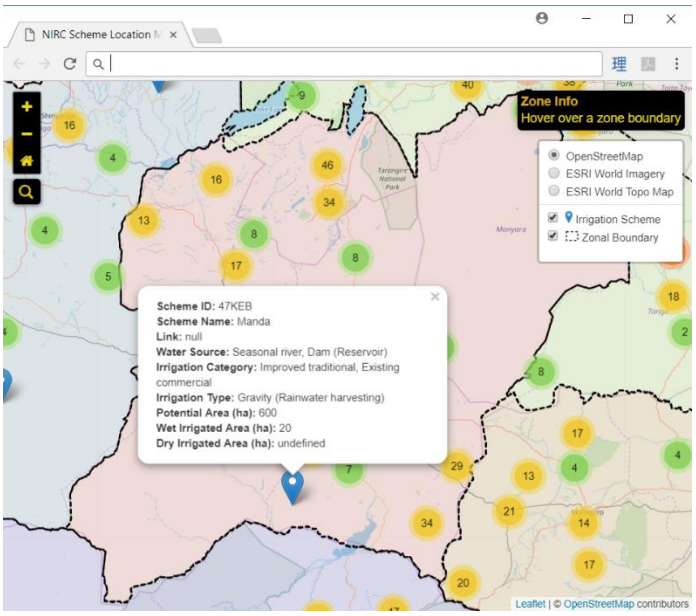


Source: eGA, 2014, Technical Standards and Guidelines for Governmental Websites, accessed to http://www.ega.go.tz/index.php/standards

Figure 6.5.2 Layout of the Navigation Element

The NIRC website will contain also an interactive GIS web map. The web map consists of a web map service (WMS) base maps that cover the entire globe, the NIRC zonal boundaries, and clusters of the

irrigation schemes which have been collected using GPS devices. It also has a search toolbar to search for a specific irrigation by its identification (ID) code which has a similar ID code created in the irrigation scheme database. The web map enables a user to click on any of the zonal boundaries and it will zoom in to the extent of the target zone. There is also a navigation toolbar which consists of zoom in, zoom out, and home to zoom out to the extent of the Tanzania boundary. The irrigation schemes in the web map contain information about the Scheme ID, Scheme Name, Link, Water Source, Irrigation Category, Irrigation Type, Potential Area (ha), Wet Irrigated Area (ha), and Dry Irrigated Area (ha). Figure 6.5.3 shows the distribution of irrigation schemes in one selected zone and an attribute data associated with each irrigation scheme.



Source: JICA Project Team

Figure 6.5.3 A Web Map of Irrigation Scheme Locations

6.5.2 Website Management and Maintenance

The NIRC website will be developed by eGA according to government guidelines, standards and best practices, and eGA will handover it to NIRC[1]. However, since NIRC has its own server, collocation hosting arrangement with eGA will be put in place. This means they will provide room to host not only the software but also the hardware (server) required for the website to operate and enable the sharing of ICT and other resources.

The development cost for the NIRC website is about TZS 9 million, the cost of collation hosting option[2] will be TZS 25,000 and the maintenance of the website will be TZS 50,000 per year but its dependent on the number of users.

In NIRC, the website will be managed by two units: the Government Communication Unit will go through, verify, and approve all information needed to be uploaded to the website (contents updating), and the ICT Unit will deal with technical parts, i.e., software updating, regular maintenance.

[1] NIRC website was publicly opened in June 2018 after taking over from eGA. (http://nirc.go.tz/)
2 A hosting method that eGA manages NIRC's server in their server room.

Chapter 7 Review of Potential Irrigation Development Area

7.1 General

The potential irrigation areas are evaluated based on available water resources for irrigation. Then, a prioritization analysis is made for selecting irrigation schemes to be incorporated into the National Irrigation Master Plan 2018 (NIMP2018) along with the result of land suitability analysis.

7.2 Water Availability for Irrigation

7.2.1 Method and Procedure

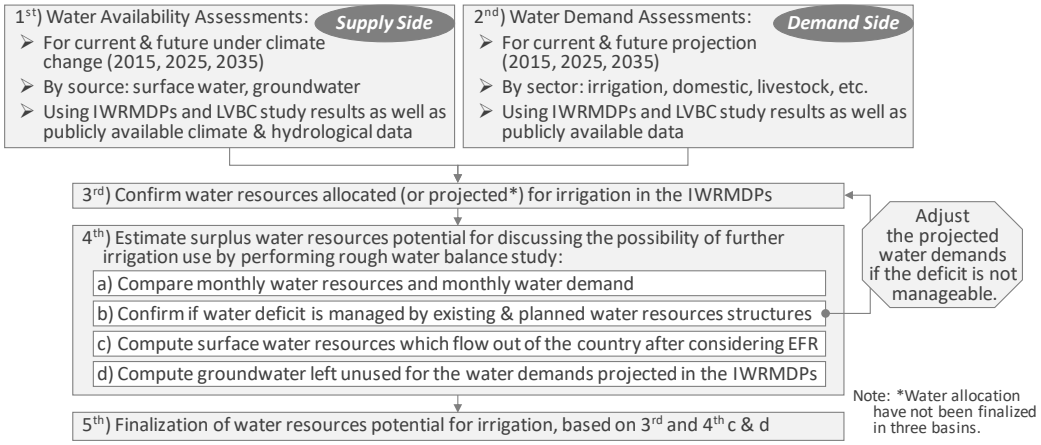
(1) Principle

According to the National Water Policy (NAWAPO), water uses other than basic human needs and environment purposes will be subject to social and economic criteria, which will be reviewed from time to time. Water is a finite and vulnerable resource which is under pressure and growing scarce as a result of increasing multi-sectoral demands due to the rapidly growing population. Under such difficult circumstances, water resources shall be utilized based on the principle of equity, right, and rationality.

The aforementioned Integrated Water Resource Management and Development Plans (IWRMDPs) have been formulated in accordance with NAWAPO including the said principle. From the standpoint of impartial utilization between sectors, even water resources left unused are not freely allocable for a specific sector. Consequently, the balanced IWRMDPs will be fundamental in preparing the NIMP2018. This means that the NIMP2018 has to harmonize with the water allocation determined in the IWRMDPs. On that basis, water resources remained unallocated to any sector is estimated as surplus water for reference in discussing the possibility of further irrigation use.

(2) Procedure

Figure 7.2.1 presents the key procedure of water resources assessment for estimating water available for irrigation purpose.



Source: JICA Project Team

Figure 7.2.1 Procedure of Water Resources Assessment

First of all, in the 1st and 2nd steps of Figure 7.2.1, the IWRMDP reports and the Lake Victoria Basin Commission (LVBC) study report were carefully reviewed for understanding the methodologies applied to the respective basins as well as compiling the study outputs in terms of surface water, groundwater, water demand for each sector and environmental flow, on a monthly and sub-basin basis. These processes are explained in Chapter 3.

After gathering the study outputs as well as confirming the water allocation to be used for the irrigation development plan of NIMP2018 in the 3rd step of Figure 7.2.1, surplus water resources potential was separately estimated for the purpose of discussing the possibility for further irrigation use. The estimation was made by performing a rough water balance study as listed in the 4th step of Figure 7.2.1.

As illustrated in Figure 7.2.1, water resources for irrigation were considered using a two-step process, namely 1) allocated water and 2) potential water, which are explained in the following sub-sections 7.2.2 and 7.2.3, respectively. The allocated water is to be used for the NIMP2018, while the potential water is presented as reference.

7.2.2 Allocated Water for Irrigation

(1) Approach for Determining Water for Irrigation

Water resources allocated for irrigation in the respective IWRMDPs can be considered secured and fully available for irrigation use by 2035. Irrigation areas to be proposed in the NIMP2018 will be elaborated within the water allocations, although some improvement of the irrigation system may be assumed in terms of cropping pattern, irrigation efficiency, etc.

However, the problem is that the IWRMDPs have not yet been formulated in the three basins, namely; Pangani, Wami/Ruvu, and Lake Victoria basins. This means that the projected irrigation water demands have neither been officially allocated nor secured. Therefore, it is necessary to review whether or not the water demands projected in the existing studies are realistically manageable for the three basins.

In addition, the annual water balance calculation made in Subsection 3.7.3 indicated that the projected water demands for 2035 are not met in four sub-basins, which are included in the Pangani, Lake Nyasa and Lake Victoria basins. Therefore, the irrigation demand for the Lake Nyasa basin needs to be additionally reviewed below.

(2) Review of Irrigation Water Demands for the Four Basins

(a) Pangani Basin

The result of the annual water balance calculation by sub-basin is summarized in Table 7.2.1. As seen in the table, the water demand in the Pangani River sub-basin will not be satisfied in 2025 and 2035 if environmental flow requirement (EFR) is deducted from surface water (SW). Even if groundwater (GW) is fully used, the deficit remains.

The deficit in the annual calculation means that any of the water storage facilities are not able to overcome the water shortage within the sub-basin unless water is supplied from the other sub-basins. However, from the topographic viewpoint, the water transfer from the surrounding sub-basins is not

realistic.

Table 7.2.1 Annual Water Balance by Sub-basin for Pangani Basin

Sub-basin Name	Area (km^2)	SW (MCM/yr)			GW (MCM/yr)			Demand (MCM/yr)			EFR (MCM/yr)			SW - EFR - Dem (MCM/yr)		
		2015	2025	2035	2015	2025	2035	2015	2025	2035	2015	2025	2035	2015	2025	2035
Pangani River	43,652	4,832	4,096	3,524	466	466	466	2,685	2,976	3,209	1,511	1,544	1,557	636	**-424**	**-1,242**
Umba	8,205	934	733	611	71	71	71	133	154	190	19	19	19	782	559	401
Msangazi	5,085	687	601	543	31	31	31	12	54	102	1	1	1	674	546	440
Zigi-Mkulumuzi	2,159	510	452	422	18	18	18	33	49	76	91	90	90	387	312	256

Source: Prepared by the JICA Project Team based on the Pangani IWRMDP Study Report

On the other hand, the percentage of EFR to SW in the Pangani River sub-basin for 2035 is 44%. This is quite large compared with the other three sub-basins. However, the EFR of Pangani River sub-basin almost corresponds to the plant discharge required for hydropower generation at the existing New Pangani Falls HPP. Thus, the EFR is hardly able to be reduced.

It is particularly worth noting that one of the key features in the Pangani basin assessment is largely decreasing surface water by 27% from 2015 to 2035 due to climate change. The surface water might be reviewed at the planning stage, however, this is still an unclear factor at present. Even if the irrigation area is not further developed, the projected water demand for 2035 will not be satisfied. The envisaged future water deficit needs to be managed through more effective utilization of water resources in various sectors and/or alternative power generation means. If the deficit is managed only by the irrigation sector, the water resources allocated for irrigation sector in 2035 will be less than 78% of the 2015-based irrigation water demand, according to the monthly calculation made in the following Subsection 7.2.3.

Considering the severe situation of the Pangani River sub-basin, irrigation water use in the sub-basin cannot be increased from 2015 to 2025 and needs to be reduced by 22% from 2015 to 2035 by improving the irrigation system or reducing irrigation area. The NIMP2018 study will adopt the above-adjusted irrigation water in planning irrigation development for 2025 and 2035 for the sub-basin.

(b) Wami/Ruvu Basin

Although the IWRMDP for the Wami/Ruvu basin has not been formulated, a comprehensive water resources management and development plan was prepared in 2013 with the technical assistance of JICA. The Ministry of Water and Irrigation (MoWI) has positioned the plan as an assessment part of IWRMDP because climate change impacts have not been taken into account in the said plan.

The plan also proposed appropriate water resources development measures including new construction of 16 reservoirs and heightening of the existing five dykes, with careful consideration of the reliability of water utilization of 1/10-yr drought.

There is still a possibility of monthly water deficit if climate change impacts are considered. However, from the viewpoint of annual water balance presented in Table 7.2.2, the water deficit will be manageable within the basin. Therefore, the NIMP2018 study will adopt the projected water demands without changes.

Table 7.2.2 Annual Water Balance by Sub-basin for Wami/Ruvu Basin

Sub-basin Name	Area (km^2)	SW (MCM/yr)			GW (MCM/yr)			Demand (MCM/yr)			EFR (MCM/yr)			SW - EFR - Dem (MCM/yr)		
		2015	2025	2035	2015	2025	2035	2015	2025	2035	2015	2025	2035	2015	2025	2035
Kinyasungwe	16,509	289	289	289	129	129	129	118	182	279	0	0	0	171	107	9
Mkondoa	12,964	671	671	671	179	179	179	290	422	502	3	3	3	378	246	166
Wami	14,270	1,408	1,408	1,408	169	169	169	141	209	247	91	91	91	1,176	1,108	1,070
Upper Ruvu	7,623	2,252	2,252	2,252	102	102	102	79	108	127	116	93	93	1,766	1,511	1,121
Ngerengere	2,913	156	156	156	27	27	27	33	50	82	0	0	0			
Lower Ruvu	7,253	54	54	54	283	283	283	62	100	119	70	85	85			
Coast	4,763	35	35	35	250	250	250	353	525	845	17	26	26			

Note: The balance for the Upper Ruvu, Ngerengere, Lower Ruvu and Coast sub-basins are shown together because water demand in the lower sub-basins (Lower Ruvu and Coast) highly depend on the water supply from the upper sub-basins.
Source: Prepared by the JICA Project Team based on the Wami/Ruvu IWRMDP Study Report

(c) Lake Victoria Basin

The annual water balance is calculated in the same manner as the above basins. Out of the 13 sub-basins in the Lake Victoria basin, three sub-basins will have an annual deficit as presented in Table 7.2.3. However, the situation is considered still manageable within the basin by adjusting EFR and/or by water transfer between sub-basins. Since EFR has not been estimated for the Lake Victoria basin, the sanitation water demand using BOD5 is provided instead in the water balance calculation. As a result, the percentages of EFR to SW exceed 90% in some sub-basins. The basin has enough leeway to review the EFR. Therefore, the NIMP2018 study will adopt the projected water demands without changes.

Table 7.2.3 Annual Water Balance for Three Sub-basins in Lake Victoria Basin

Sub-basin Name	Area (km^2)	SW (MCM/yr)			GW (MCM/yr)			Demand (MCM/yr)			EFR (MCM/yr)			SW - EFR - Dem (MCM/yr)		
		2015	2025	2035	2015	2025	2035	2015	2025	2035	2015	2025	2035	2015	2025	2035
L.V. Islands	1,407	124	124	124	28	28	28	15	23	24	116	119	115	**-8**	**-19**	**-15**
Magogo-Moame	5,401	284	284	284	77	77	77	73	122	136	272	271	235	**-61**	**-109**	**-87**
Nyashishi	1,689	41	41	41	26	26	26	43	67	68	41	41	41	**-43**	**-67**	**-68**

Note: Calculation sheet for the remaining 10 sub-basins is presented in Appendix A.
Source: Prepared by the JICA Project Team based on the LVBC Study Report

(d) Lake Nyasa Basin

The annual water balance is calculated in the same manner as the above basins. Out of the ten sub-basins in the Lake Nyasa basin, the Muchuchuma sub-basin will have an annual deficit in 2025 and 2035 as presented in Table 7.2.4. Although the Lake Nyasa IWRMDP report also points out this situation, it does not clearly mention any interventions. According to the inventory survey conducted in the NIMP2018 for the purpose of updating the irrigation database, there is no existing scheme in the sub-basin. Irrigation development is less expected even in the future. Therefore, as with the case of the above Pangani River sub-basin, it is recommended to reduce the irrigation water use for 2025 and 2035 to 96% and 89% of 2015-based irrigation water demand, respectively, based on monthly calculation in the following sub-section 7.2.3.

Table 7.2.4 Annual Water Balance for Muchuchuma Sub-basin in Lake Nyasa Basin

Sub-basin Name	Area (km^2)	SW (MCM/yr)			GW (MCM/yr)			Demand (MCM/yr)			EFR (MCM/yr)			SW - EFR - Dem (MCM/yr)		
		2015	2025	2035	2015	2025	2035	2015	2025	2035	2015	2025	2035	2015	2025	2035
Muchuchuma	670	143	141	141	3	3	3	93	100	107	47	53	59	3	**-12**	**-26**

Note: Calculation sheet for the remaining 9 sub-basins is presented in Appendix A.
Source: Prepared by the JICA Project Team based on the Lake Nyasa IWRMDP Study Rteport

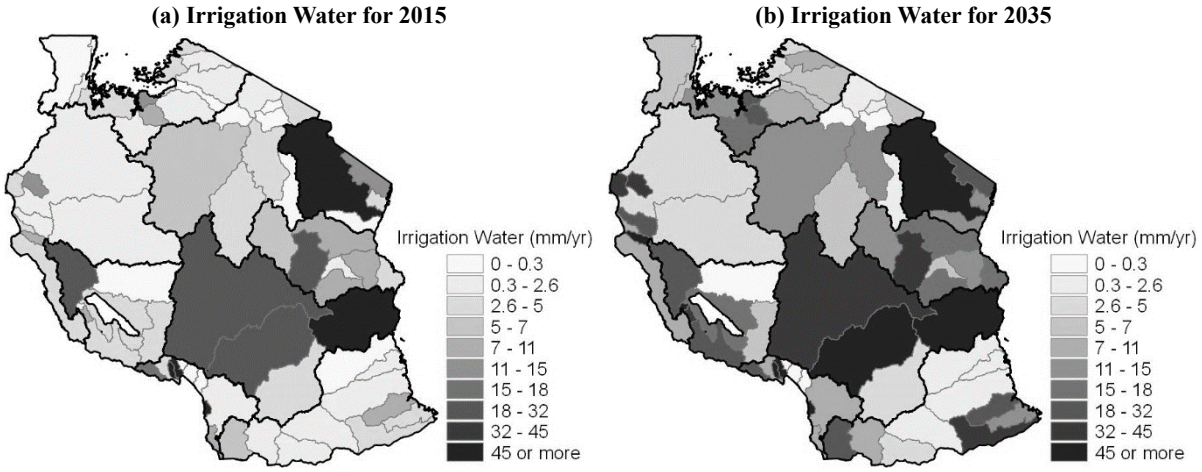
(3) Determined Water Allocation for Irrigation

As a result of the 3rd step process of Figure 7.2.1, monthly water resources for irrigation use by sub-basin have been determined. The allocated irrigation water is summarized in Table 7.2.5 by basin and Figure 7.2.2 by sub-basin. The NIMP2018 will utilize these figures for planning and irrigation development.

Table 7.2.5 Annual Irrigation Water by Basin by Target Year

Basin	Original Irrigation Water Demand (MCM/yr)			Determined Water for Irrigation [To be used for NIMP2018] (MCM/yr)			Remarks
	2015	2025	2035	2015	2025	2035	
Pangani	2,657	2,959	3,110	2,657	**2,724**	**2,234**	Changed from IWRMDP
Wami / Ruvu	656	993	1,268	656	993	1,268	
Rufiji	4,905	5,504	7,619	4,905	5,504	7,619	
Ruvuma	254	568	1,056	254	568	1,056	
Lake Nyasa	309	606	938	309	**595**	**913**	Changed from IWRMDP
Lake Rukwa	532	832	1,164	532	832	1,164	
Lake Tanganyika	273	578	986	273	578	986	
Lake Victoria	163	430	772	163	430	772	
Internal Drainage	561	869	1,177	561	869	1,177	
Total	10,309	13,338	18,091	10,309	**13,092**	**17,190**	

Source: Prepared by the JICA Project Team based on the IWRMDP and LVBC study reports



Source: Prepared by the JICA Project Team based on the IWRMDP and LVBC study reports

Figure 7.2.2 Allocated Water for Irrigation by Sub-basin

The monthly data by sub-basin is presented in Appendix A. The monthly allocation of irrigation water for the Ruvuma and Lake Victoria basins are determined based on cropping patterns proposed by the NIMP2018 because only annual irrigation water is presented in the previous study reports for those basins.

7.2.3 Potential Water for Irrigation

(1) Purpose of Estimating Potential Water for Irrigation

The abovementioned allocated water on a monthly and sub-basin basis for the target year of 2035 is to be used in formulating an irrigation development plan in the NIMP2018. On the other hand, the NIMP2018 Project Team is requested to present the potential of further irrigation development under the assumption that surplus water resources are fully used for irrigation. Thus, the purpose of estimating potential water for irrigation is to grasp the irrigation potential areas from the perspective of limitation of water resources.

(2) Handling of Potential Water for Irrigation

The potential water to be estimated in this subsection shall be basically treated as reference in the NIMP2018 for understanding the future potential of further irrigation development that will be incorporated into the plan after 2035. The potential water is defined as the water resources remained unused in the existing water resources plans by 2035. The potential water comprises two forms, namely; i) water exceeding environmental flow requirement among unused surface water flowing into sea or transboundary lakes, and ii) groundwater remained unused. It can be used not only for irrigation but also for the other sectors. Although the potential water is not basically used for irrigation development plan to be proposed in the NIMP2018, it may be partially used if the necessity of additional water use exceeding the allocated water arises.

(3) Approach for Estimating Potential Water for Irrigation

(a) Basic Data to be Used for Calculation

The following data that were compiled and/or estimated based on the IWRMDP and LVBC reports as well as provided by the MoWI are used in water balance calculation. All the data here are 2035 basis.

- Monthly water resources (surface water and groundwater) by sub-basin
- Monthly water demand and monthly environmental flow requirement (EFR) by sub-basin
- Storage capacities of the existing reservoirs and planned reservoirs proposed by IWRMDPs

(b) Key Considerations in Calculating Water Balance

Basic rules of how to supply water to each demand sector are considered as follows:

- The EFR needs to be secured only by surface water. This means that the potential water is not computed from a simple addition and subtraction method by sub-basin such as “surface water + groundwater – water demand – environmental flow”.
- The water demand is divided into “irrigation” demand and “the other” demands in advance. Groundwater is used only for “the other” demands in the calculation. The “irrigation” here indicates the allocated water for irrigation, which was determined in Subsection 7.2.2.
- Although the balance calculation is made basically by sub-basin, the surface water resources generated but unused in the upper sub-basins can be used in the lower sub-basins. Among all the 71 sub-basins, only eight sub-basins have a flow to downstream sub-basins.

Step-wise procedures of calculation considering the above rules are described in Appendix A.

(c) Output to be Yielded from the Calculation

From the above computation, the following water resources are regarded as potential water available for further irrigation development:

- Monthly water exceeding EFR among unused surface water flowing into sea or transboundary lakes; and
- Monthly groundwater remained unused for "the other" demands.

(4) Estimated Potential Water for Irrigation

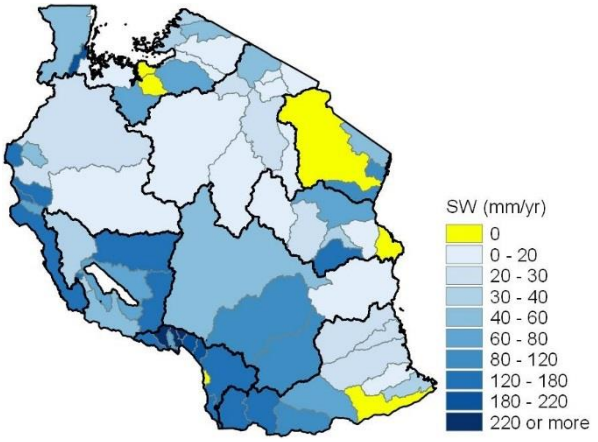
The computation was made on a monthly and sub-basin basis. The result of estimating the potential water for irrigation is summarized into annual data and presented in Table 7.2.6 by basin and Figure 7.2.3 by sub-basin. The monthly data by sub-basin is presented in Appendix A.

Table 7.2.6 Estimated Potential Water for Irrigation by Basin for 2035

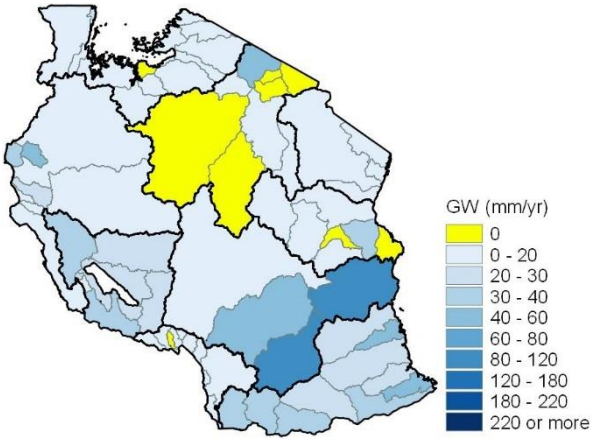
Basin	Catchment Area	Potential Surface Water		Potential Groundwater		Potential SW+GW	
	(km^2)	(MCM/yr)	(mm/yr)	(MCM/yr)	(mm/yr)	(MCM/yr)	(mm/yr)
Pangani	59,102	1,097	19	220	4	1,317	22
Wami / Ruvu	66,295	2,731	41	775	12	3,505	53
Rufiji	183,791	11,485	62	8,548	47	20,032	109
Ruvuma	105,582	5,866	56	3,173	30	9,039	86
Lake Nyasa	27,594	5,957	216	103	4	6,060	220
Lake Rukwa	74,965	7,063	94	2,083	28	9,146	122
Lake Tanganyika	149,500	5,168	35	2,091	14	7,259	49
Lake Victoria	85,630	3,998	47	1,009	12	5,007	58
Internal Drainage	143,100	2,112	15	510	4	2,622	18
Total	895,559	45,477	51	18,511	21	63,988	71

Source: Prepared by the JICA Project Team based on the IWRMDP and LVBC study reports

(a) Potential Surface Water for 2035



(b) Potential Groundwater for 2035



Source: Prepared by the JICA Project Team based on the IWRMDP and LVBC study reports

Figure 7.2.3 Estimated Potential Water for Irrigation by Sub-basin for 2035

(5) Consideration for Utilizing the Potential Water

Due to the limitation of computation accuracy as well as extreme calculation conditions, it must be noted that the potential water estimated in the above clause (4) is not completely utilized for irrigation purposes realistically. Besides, careful attention should be paid particularly to the following matters in

incorporating the potential water into the irrigation development plan.

- Assuming that the water storage facilities proposed in the IWRMDPs can cover only the water demand projected for the year 2035, additional irrigation areas shall be examined based on monthly water resources without storage effect. If favourable dam site for additional water storage is found in the future, the storage effect will be able to be considered.
- Increase in water demand for the sectors other than irrigation after 2035 have not been considered in estimating the above potential water in the above clause (4). If the estimated potential water is used for the irrigation water use planning after 2035, it is necessary to take into account the increase in water demands for the other sectors as well.
- When the potential surface water flows from upper sub-basin to lower sub-basin, the surface water resources can be withdrawn at either sub-basin.
- Groundwater was used only for the sectors other than irrigation in the above computation. On the other hand, the estimated potential groundwater could be fully used for irrigation, in theory. It is necessary to study whether the groundwater use for irrigation purpose is feasible or not.

7.3 Land Suitability for Agriculture

7.3.1 Method and Procedure

Sustainable agricultural development is one of the prime objectives in Tanzania. However, it is a complex process that requires balancing among available land resources, water resources, and target crops. In this section, land suitability (LS) assessment is conducted using GIS-based multi-criteria evaluation analysis to determine the suitability of a specific area for particular agricultural crops considering wide ranges of criteria.

The Analytical Hierarchy Process (AHP) method is one of the multi-criteria decision-making approaches introduced by Saaty (1977) which is commonly used in agricultural land suitability analysis. In the AHP methods, complex problems are structured hierarchically into criteria, sub-criteria, and alternatives from which the choice is to be made (Saaty, 1987). This method allows users to determine the weights of the parameters in the solution of a multi-criteria problem. To evaluate the criteria included in a level compared with other criteria included in the next hierarchy level, a scale ranking is made with the utilization of the preference scale introduced by Saaty (1977), illustrated in Table 7.3.1, that creates a pairwise comparison matrix and relies on the judgements of experts to derive priority scales.

Table 7.3.1 Scale and its Description

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Weak importance of one over another	Experience and judgment slightly favor one activity over another
5	Essential or strong importance	Experience and judgment strongly favor one activity over another
7	Demonstrated importance	An activity is strongly favored and its dominance demonstrated in practice
9	Absolute importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between the two adjacent judgments	When compromise is needed

Intensity of importance	Definition	Explanation
Reciprocals	If activity *i* has one of the above numbers assigned to it when compared with activity *j*, then *j* has the reciprocal value when compared with *i*	

Source: Saaty, 1977, A Scaling Method for Priorities in Hierarchical Structures, Journal of Mathematical Psychology

The AHP provides mathematical measures to determine the consistency of judgment matrix. Based on the properties of the matrix, a consistency ratio (CR) can be calculated. In a matrix, the largest eigenvalue (λ_{max}) is always greater than or equal to the number of rows or columns (n). A consistency index (CI) that measures the consistency of pairwise comparisons can be written as:

$$CI = (\lambda_{max} - n) / (n - 1),$$

where CI is the consistency index, n is the number of elements being compared in the matrix, and λ_{max} is the largest or principal eigenvalue of the matrix. To ensure the consistency of the pairwise comparison matrix, the consistency judgment must be checked for the appropriate value of n using random index (RI) table. The CR coefficients are calculated according to the methodology proposed by Saaty (1994). The CR coefficient should be less than 0.1, indicating a positive evidence for informed judgment. CR can be calculated using the following formula:

$$CR = CI / RI,$$

Where CI is the consistency index, and RI is the random index calculated by Saaty (1994) and defined in Table 7.3.2.

Table 7.3.2 Random Index (RI) Table

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Random Index (RI)	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.58

Source: Saaty, 1994, How to Make a Decision: The Analytic Hierarchy Process, Interfaces

In LS analysis, the sub-criterion was classified into five classes ranging from 1 to 5 based on its suitability for agriculture land. The score of 1 indicates the least suitable while the score of 5 indicates the most suitable. Since the input parameters were collected from different sources, standardization into 1 to 5 was an essential step so that it made it possible to combine various parameters and get meaningful results. LS was calculated using the following formula:

$$LS = \sum_{i=1}^{n} WiXi$$

Where LS is the land suitability, *Wi* denotes the weight of the selected land suitability criteria, *Xi* indicates the assigned sub-criteria score of *i* land suitability criteria, and *n* denotes the total number of LS criteria.

In the NIMP2018, two agricultural crops were considered in LS analysis: paddy field and upland crops. For each of the two crops, three scenarios of LS analysis were evaluated: 1) using land resources only, 2) adding rainfall parameter (rainfed condition), and 3) irrigation priority (irrigation requirement).

There are several criteria that can be taken into consideration in LS for agriculture, however, in NIMP2018, ten criteria were considered for the land resources scenario. For rainfed and irrigation

priority scenarios an additional precipitation criterion was added to become 11 criteria in total as shown in Table 7.3.3. The weightings and rankings of the 10 or 11 criteria were different among each scenario for both paddy field and upland crops which will be detailed in the following sections.

Table 7.3.3 List of Criteria Used in Each Scenario and Their Sources

Criteria	Land Suitability (Land Resource Only) Scenario	Land Suitability (Rainfed) Scenario	Irrigation Priority Scenario	Source
Soil Type	Y	Y	Y	FAO/IIASA/ISRIC/ISSCAS/JRC, 2012. Harmonized World Soil Database (version 1.2). FAO, Rome, Italy and IIASA, Laxenburg, Austria.
Soil Drainage	Y	Y	Y	
Soil Organic Carbon	Y	Y	Y	
Soil pH	Y	Y	Y	
Soil Depth	Y	Y	Y	FAO-UNESCO Soil Map http://ref.data.fao.org/map?entryId=c3bfc940-bdc3-11db-a0f6-000d939bc5d8&tab=about
Elevation	Y	Y	Y	Shuttle Radar Topographic Mission (SRTM) Data
Slope	Y	Y	Y	
Land Use	Y	Y	Y	Global Map-Global Land Cover (GLCNMO version 2)
Topographic Wetness Index (TWI)	Y	Y	Y	JICA Study Steam Based on Shuttle Radar Topographic Mission (SRTM) Data
Temperature	Y	Y	Y	Climate Hazards Group InfraRed Precipitation with Station (CHIRPS) Data Version 2.0. http://chg.geog.ucsb.edu/data/chirps/
Precipitation	N	Y	Y	

Note: Y: Yes, N: No
Source: JICA Project Team

7.3.2 Land Suitability for Paddy

There are three scenarios considered for LS for paddy field as mentioned earlier. In each scenario, the weightings and scorings should be prepared individually. However, since the land characteristics of the paddy field do not change, the values that define the scorings of sub-criteria will be same across all scenarios and only the weighting factors will be updated in each scenario which will be detailed in the following sub-sections. Table 7.3.4 shows the scorings of each sub-criteria used in the LS analysis for paddy field.

Table 7.3.4 List of Criteria, Sub-criteria and Their Scorings Used for Paddy Field

Criteria	Sub-criteria	Scoring	Scoring	Scoring
Soil Type	Cambisols; Luvisols	5	Same Scoring as Scenario (1)	Same Scoring as Scenario (1)
	Fluvisols; Vertisols	4		
	Gleysols; Chernozems	3		
	Phaeozems; Planosols; Nitisols; Andosols; Ferralsols; Acrisols; Histosols; Arenosols; Solonetz	2		
	Lixisols; Leptosols; Regosols; Solonchaks	1		
Slope (°)	0 - 3	5		
	3 - 8	3		
	8 - 15	3		
	15 - 30	1		
	> 30	1		
Elevation (m)	> 2000	1		
	1500 - 2000	2		
	1000 - 1500	3		
	500 - 1000	4		
	≤ 500	5		

Criteria	Sub-criteria	Scoring	Scoring	Scoring
Temperature (°C)	> 25	5		
	20 - 25	3		
	≤ 20	1		
Land Use	Sparse vegetation; Paddy field; Bare area, unconsolidated (sand)	5		
	Shrub; Herbaceous; Herbaceous with sparse tree/shrub	4		
	Cropland; Cropland /other vegetation mosaic	3		
	Bare area, consolidated (gravel, rock)	2		
	Broadleaf evergreen forest; Broadleaf deciduous forest; Needleleaf evergreen forest; Needleleaf deciduous forest; Mixed forest; Tree open; Mangrove; Wetland; Urban; Snow / ice; Water bodies	1		
Soil Depth (cm)	150 – 300	5		
	100 – 150	4		
	50 – 100	3		
	10 – 50	2		
	≤ 10	1		
Soil Organic Carbon (% weight)	> 3.0	1		
	2.0 - 3.0	4		
	1.2 - 2.0	5		
	0.6 – 1.2	3		
	0.2 - 0.6	2		
	≤ 0.2	1		
Soil pH	< 4.5 and > 8.0	1		
	7.5 - 8.0	2		
	4.5 - 5.0 and 7.0 - 7.5	3		
	5.0 - 5.5 and 6.5 -7.0	4		
	5.5 - 6.5	5		
Soil Drainage	Very Poor	5		
	Poor	4		
	Imperfectly; Moderately Well	3		
	Well	2		
	Somewhat Excessive	1		
TWI	> 15.7	5		
	12.2 - 15.7	4		
	8.7 - 12.2	3		
	5.3 - 8.7	2		
	≤ 5.3	1		
Precipitation (mm/year)	> 2000		5	1
	1200 - 2000		4	3
	800 - 1200		3	5
	600 - 800		2	4
	≤ 600		1	2

Scenario (1) Land Suitability (Land Resource Only) | Scenario (2) Land Suitability (Rainfed Condition) | Same Scoring as Scenario (1) | Scenario (3) Irrigation Priority (Irrigation Requirement) | Same Scoring as Scenario (1)

Source: JICA Project Team

(1) Land Resource Scenario for Paddy Field

Table 7.3.5 shows the pairwise comparison matrix of ten criteria of land resource scenario used in LS analysis for the paddy field, the CI, and CR. A pairwise comparison was conducted using the JICA Project Teams' judgment to identify which criterion has more priority than the other. Table 7.3.6 illustrates the final ranking of the criteria weightings.

Table 7.3.5 Weighting Factors for Paddy Field Land Suitability (Land Resource Scenario)

Criteria	ST	S	E	T	LU	SD	SOC	S-pH	SDR	TWI	W	CI	RI	CR
ST	1	1	7	3	5	5	5	5	3	1	0.192	0.112	1.490	0.075
S	1	1	7	3	5	7	7	7	3	1	0.213			
E	1/7	1/7	1	1/3	1	1	1	1	1/3	1/9	0.029			
T	1/5	1/5	1	1	1	3	3	1	1/3	1/5	0.046			
LU	1/5	1/7	1	1	1	3	3	3	1/3	1/7	0.048			
SD	1/5	1/7	1	1/3	1/3	1	1	1	1/3	1/7	0.028			

Criteria	ST	S	E	T	LU	SD	SOC	S-pH	SDR	TWI	W	CI	RI	CR
SOC	1/5	1/7	1	1/3	1/3	1	1	1	1/3	1/7	0.028			
S-pH	1/3	1/3	3	1	1/3	1	1	1	1/5	1/9	0.037			
SDR	1	1	9	3	3	3	3	5	1	1/3	0.136			
TWI	1	1	9	5	7	7	7	9	3	1	0.244			

Note: (ST: Soil Type, S: Slope, E: Elevation, T: Temperature, LU: Land Use, SD: Soil Depth, SOC: Soil Organic Carbon, S-pH: Soil pH, SDR: Soil Drainage, TWI: Topographic Wetness Index, W: Weighting)
Source: JICA Project Team

Table 7.3.6 Priority Ranking of Weightings (Land Resource Scenario)

Criteria	Weighting	Priority Ranking
TWI	0.244	1
Slope	0.213	2
Soil Type	0.192	3
Soil Drainage	0.136	4
Land Use	0.048	5
Temperature	0.046	6
Soil pH	0.037	7
Elevation	0.029	8
Soil Organic Carbon	0.028	9
Soil Depth	0.028	10

Source: JICA Project Team

From Table 7.3.6, it shows the TWI, slope, soil type, and soil drainage have more influence than other criteria in controlling LS for the paddy field. These four criteria comprise 78.5% of the total weight while the remaining six criteria make up only 21.5%.

In general, the values of the output LS analysis are between 1 and 5. These values were normalized to a scale of 0 and 100 percent using the following equation:

$$LS_{\text{norm}} = \frac{x - min(x)}{max(x) - min(x)} \times 100$$

Where LS_{norm} is the normalized LS values between 0 and 100 percent, *x* is the original LS values before normalization, *min(x)* is the minimum value of LS, and *max(x)* is the maximum value of LS. The final LS data were classified into five equal classes: Very low (0 - 20%), Low (21% - 40%), Moderate (41% - 60%), High (61% - 80%), and Very high (81% - 100%).

In this study, the land use/cover map of 2008 was used. It was created using Moderate Resolution Imaging Spectroradiometer (MODIS) satellite data of approximately 500 m spatial resolution - 1 pixel = 500m × 500m - (GLCNMO version 2, 2008). It is composed of eight classes: forest, cropland, other natural vegetation, bare area/sparse vegetation, wetland, urban, water, and protected area as shown in Table 7.3.7. However, among the eight classes of the land use data, four classes were considered in the land suitability analysis: cropland, other natural vegetation, bare area/sparse vegetation, and wetland. These four classes represent the potential agriculture land which make up 255,074 km^2 (25,507,443 ha) and represent 27.2% of the total mainland of Tanzania as shown in Table 7.3.8. The other four land use/cover classes were excluded from the land suitability analysis because agricultural activities are not permitted in these classes.

Table 7.3.7 Acreage of Land Use/Cover in Tanzanian Mainland

Class	Total (km^2)	Total (ha)	Total (%)
Forest	302,396	30,239,605	32.3
Other natural vegetation	164,557	16,455,683	17.6
Cropland	84,707	8,470,708	9.0
Wetland	5,240	523,987	0.6
Bare area/ Sparse vegetation	571	57,065	0.1
Urban	151	15,142	0.02
Water	60,846	6,084,583	6.5
Protected Area	319,093	31,909,306	34.0
Total	**937,561**	**93,756,079**	**100.0**

Source: JICA Project Team

Table 7.3.8 Acreage of Potential Agriculture Area in Tanzania Mainland

Class	Total (km^2)	Total (ha)	Total (%)
Other natural vegetation	164,557	16,455,683	17.6
Cropland	84,707	8,470,708	9.0
Wetland	5,240	523,987	0.6
Bare area/ Sparse vegetation	571	57,065	0.1
Potential Agriculture Land	**255,074**	**25,507,443**	**27.2**

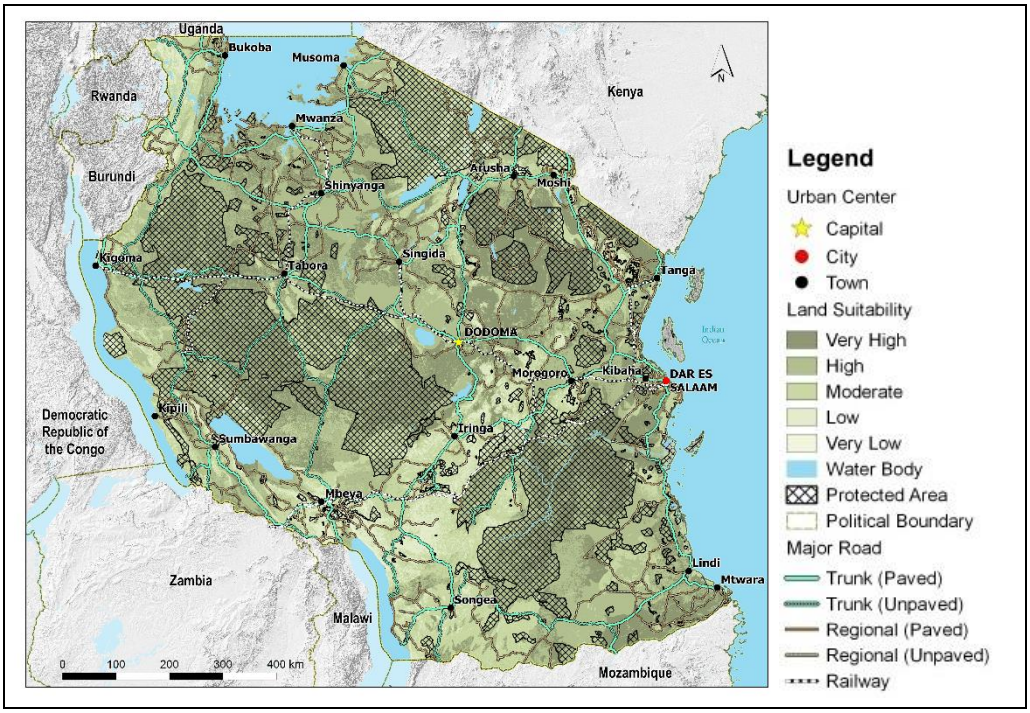
Source: JICA Project Team

The resultant LS for paddy field within the potential agriculture land based on the above criteria shows that the total area of very high and high suitability classes is 196,765 km^2 (19,676,514 ha) which represents 77% of potential agriculture land area as illustrated in Table 7.3.9 and constitutes 21% of the total mainland area of Tanzania. On the other hand, there are 58,309 km^2 (5,830,929 ha) located in moderate, low, and very low suitability that represent 23% of the potential agriculture land and 6.2% of the Tanzanian mainland. Figure 7.3.1 shows the land suitability for paddy field (land resource scenario).

Table 7.3.9 Acreage of Land Suitability of Paddy Field (Land Resources) within Potential Agriculture Land in Tanzania Mainland

Class	Very Low (ha)	Low (ha)	Moderate (ha)	High (ha)	Very High (ha)	Total (ha)
Other natural vegetation	2,112	517,145	2,799,859	6,865,860	6,270,707	16,455,683
Cropland	3,102	478,336	1,875,036	3,065,557	3,048,677	8,470,708
Wetland	2,853	42,280	101,270	322,992	54,592	523,987
Bare area/ Sparse vegetation	293	228	8,415	24,347	23,782	57,065
Potential Agriculture Area	**8,360**	**1,037,989**	**4,784,580**	**10,278,756**	**9,397,758**	**25,507,443**

Source: JICA Project Team



Note: Political Boundary means National Boundary
Source: JICA Project Team

Figure 7.3.1 Land Suitability Map for Paddy Field (Land Resource Scenario)

(2) Land Suitability Rainfed Scenario for Paddy Field

LS was assessed by adding the rainfall criteria (rainfed condition) to check the regions that are highly suitable for paddy field. Since the number of factors considered for rainfed scenario is different – 11 parameters in this scenario - compared with land resource scenario, the weightings should be recalculated to consider the precipitation criteria. Table 7.3.10 and Table 7.3.11 show the calculated weighting factors and the priority ranking of each criterion, respectively.

Table 7.3.10 Weighting Factors for Paddy Field Suitability (Rainfed and Irrigation Scenarios)

Criteria	ST	S	E	P	T	LU	SD	SOC	S-pH	SDR	TWI	W	CI	RI	CR
ST	1	1	7	1	3	5	5	5	5	3	1	0.165	0.072	1.480	0.049
S	1	1	7	1	3	5	7	7	7	3	1	0.181			
E	1/7	1/7	1	1/5	1/3	1	1	1	1	1/3	1/9	0.026			
P	1	1	5	1	3	5	7	7	7	5	3	0.203			
T	1/3	1/3	3	1/3	1	1	3	3	1	1/3	1/5	0.049			
LU	1/5	1/5	1	1/5	1	1	3	3	3	1/3	1/7	0.042			
SD	1/5	1/7	1	1/7	1/3	1/3	1	1	1/3	1/3	1/7	0.021			
SOC	1/5	1/7	1	1/7	1/3	1/3	1	1	1/3	1/3	1/7	0.021			
S-pH	1/5	1/7	1	1/7	1	1/3	3	3	1	1/5	1/9	0.030			
SDR	1/3	1/3	3	1/5	3	3	3	3	5	1	1/3	0.077			
TWI	1	1	9	1/3	5	7	7	7	9	3	1	0.185			

Note: (ST: Soil Type, S: Slope, E: Elevation, P: Precipitation, T: Temperature, LU: Land Use, SD: Soil Depth, SOC: Soil Organic Carbon, S-pH: Soil pH, SDR: Soil Drainage, TWI: Topographic Wetness Index, W: Weighting)
Source: JICA Project Team

Table 7.3.11 Priority Ranking (Rainfed and Irrigation Scenarios)

Criteria	Weighting	Priority Ranking
Precipitation	0.203	1
TWI	0.185	2
Slope	0.181	3

Criteria	Weighting	Priority Ranking
Soil Type	0.165	4
Soil Drainage	0.077	5
Temperature	0.049	6
Land Use	0.042	7
Elevation	0.026	8
Soil pH	0.030	9
Soil Depth	0.021	10
Soil Organic Carbon	0.021	11

Source: JICA Project Team

In rainfed scenario, precipitation has the most important factor with the highest priority that comprises about 20% among other priority factors as shown in Table 7.3.11.

As explained earlier, there is no change in sub-criteria scorings used for both rainfed and land resource scenarios except for the precipitation parameter which was added in the rainfed case. The precipitation parameter was given a high scoring of 5 for rainfall amount of more than 2,000 mm/year and a scoring of 1 for rainfall amount of less than 600 mm/year as shown in Table 7.3.4 (Scenario 2).

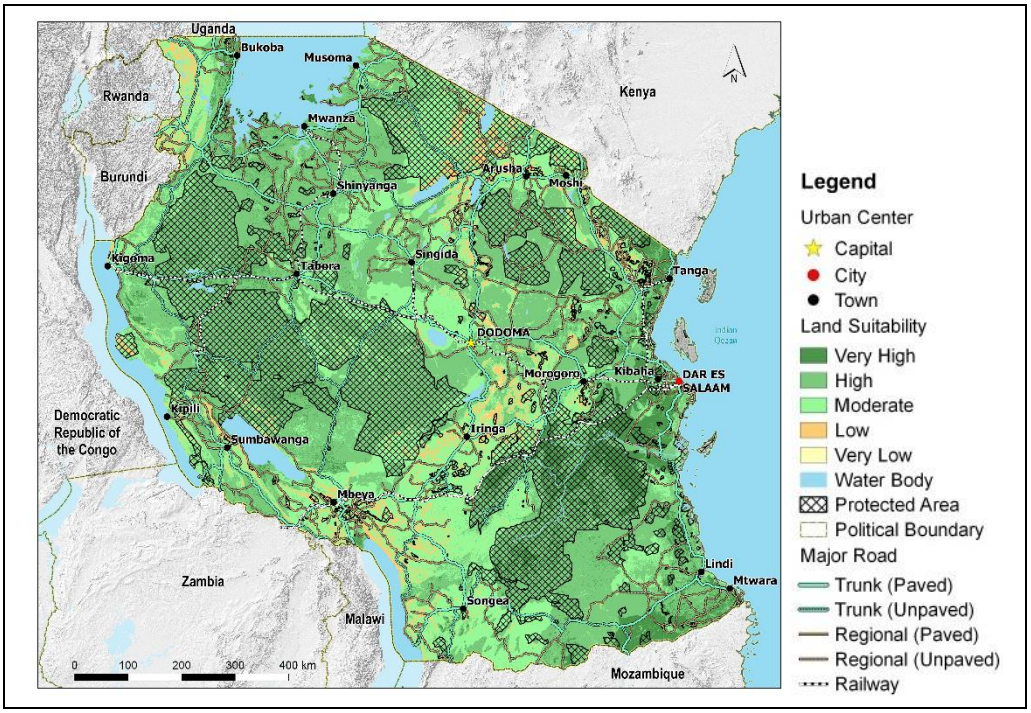
Similar to land resource scenario, this scenario focuses on land suitability within the potential agriculture land. It is worth noting that the total area of potential agriculture land does not change which represents 25,507,443 ha. However, the acreage of land suitability classes within potential agriculture land does change. The results, as shown in Table 7.3.12 and Figure 7.3.2, indicate that very high and high suitability within a potential agriculture land represent 165,095 km^2 (16,509,471 ha) that make up 64.7% of the total area of potential agriculture land suitable for paddy field in rainfed condition and 17.6% of the total area of the mainland of Tanzania. On the other hand, moderate, low, and very low classes represent 35.3% of the total area of potential agriculture land and 9.6% of total mainland area. In this scenario, the area of very high and high classes of LS within the potential agriculture land was reduced by 3,167,043 ha (12.3%) compared with the land resource scenario when the precipitation parameter was added.

The reduction of 3,167,043 ha is attributed to the precipitation distribution. About 14% of Tanzania mainland receives a rainfall amount of more than 1200 mm/year which is very limited when compared with the 86% of the country that receives rainfall amount of less 1200 mm/year as illustrated in Table 7.3.13.

Table 7.3.12 Acreage of Land Suitability of Paddy Field (Rainfed Condition) within Potential Agriculture Land in Tanzania Mainland

Class	Very Low (ha)	Low (ha)	Moderate (ha)	High (ha)	Very High (ha)	Total (ha)
Other natural vegetation	4,304	499,156	5,279,579	9,237,783	1,434,861	16,455,683
Cropland	4,143	363,965	2,467,954	4,483,148	1,151,498	8,470,708
Wetland	5,779	52,029	291,787	172,558	1,834	523,987
Bare area/ Sparse vegetation	0	1,962	27,314	24,303	3,486	57,065
Potential Agriculture Area	**14,226**	**917,112**	**8,066,634**	**13,917,792**	**2,591,679**	**25,507,443**

Source: JICA Project Team



Note: Political Boundary means National Boundary
Source: JICA Project Team

Figure 7.3.2 Land Suitability Map for Paddy Field (Rainfed Scenario)

Table 7.3.13 Rainfall Distribution Used in Land Suitability

Rainfall Amount (mm/year)	Area (ha)	Area (%)
≤ 600	6,975,032	7.4
600 - 800	17,147,698	18.3
800 - 1200	56,505,069	60.1
1200 - 2000	13,223,398	14.1
> 2000	92,150	0.1
Total	93,943,346	100.0

Source: JICA Project Team

(3) Irrigation Priority Scenario for Paddy Field

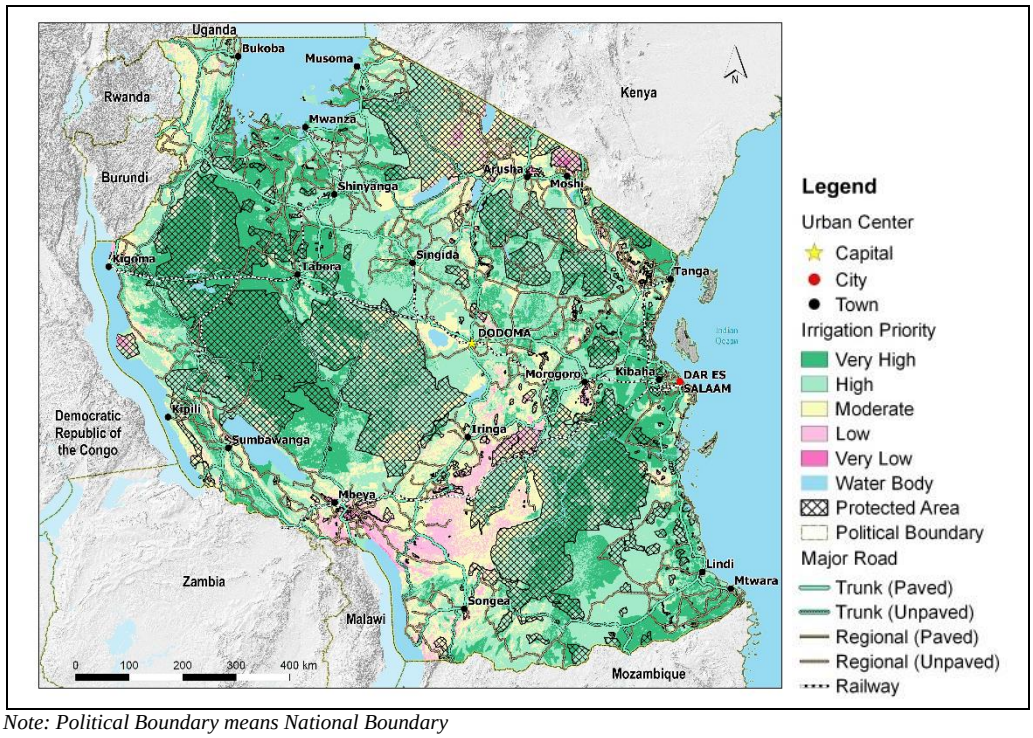
The number of criteria as well as the weighting factors used in the irrigation priority are same as that used in rainfed scenario as shown in Table 7.3.10. The only difference between the two scenarios is the evaluation of the precipitation parameter. In the case of irrigation priority, it is assumed that the land which receives an amount of rainfall of more than 2,000 mm/year does not require additional water as irrigation. While the land that receives an amount of rainfall between 800 mm/year and 1,200 mm/year needs additional water amount as irrigation but that needed water amount is less than that in land with a rainfall between 600 mm/year and 800 mm/year and less than 600 mm/year, respectively. On the other hand, the land that receives rainfall amount between 1,200 mm/year and 2,000 mm/year may still needs additional water in the form of irrigation when needed, but it is not of high priority. Therefore, a scoring value of 5 was given to the amount of precipitation between 800 mm/year and 1,200 mm/year and a scoring value of 1 was given to the amount of rainfall of more than 2,000 mm/year as shown in Table 7.3.4 (Scenario 3).

Table 7.3.14 shows the acreage of land suitable for irrigation priority for paddy field within the 25,507,443 ha of potential agriculture land. It is found that the total land area located within very high and high irrigation priority is 200,433 km^2 (20,043,339 ha), which represents 78.6% of the potential agriculture land and 21.4% of the country's mainland area. Whereas the total area of land located within moderate, low, and very low irrigation priority was reduced to 54,641 km^2 (5,464,104 ha), compared to both land resource and rainfed scenarios, representing 21.4% of the potential agriculture land and 5.8% of the total mainland area. This gives an indication that there are more potential lands when considering irrigation priority (78.6%) for paddy cultivation compared to rainfed case (64.7%). Therefore, proper and efficient irrigation systems shall be provided. Figure 7.3.3 illustrates the irrigation priority map for paddy fields.

Table 7.3.14 Acreage of Irrigation Priority of Paddy Field within Potential Agriculture Land in Tanzania Mainland

Class	Very Low (ha)	Low (ha)	Moderate (ha)	High (ha)	Very High (ha)	Total (ha)
Other natural vegetation	1,357	299,232	3,039,690	8,389,699	4,725,705	16,455,683
Cropland	1,310	318,959	1,639,646	3,626,538	2,884,255	8,470,708
Wetland	907	33,481	102,148	356,610	30,841	523,987
Bare area/ Sparse vegetation	287	1,148	25,939	22,946	6,745	57,065
Potential Agriculture Area	**3,861**	**652,820**	**4,807,423**	**12,395,793**	**7,647,546**	**25,507,443**

Source: JICA Project Team



Note: Political Boundary means National Boundary
Source: JICA Project Team

Figure 7.3.3 Irrigation Priority Map for Paddy Field

The increase of 3,533,868 ha of very high and high classes, when compared with the rainfed scenario, is attributed to the precipitation distribution. The lands which receive rainfall amounts between 600

mm/year and 1,200 mm/year represent 78.4% of the total mainland, as shown in Table 7.3.13, and the rainfall amounts were given the highest scores of 4 and 5 to give these lands a higher priority than other lands that receive the amount of water of less than 600 mm/year or more than 1200 mm/year.

The irrigation priority scenario proves that supporting rainfall with proper irrigation systems will increase the potential agricultural land when compared with rainfall only as in the case of rainfed scenario. Therefore, providing proper and efficient irrigation systems is highly recommended.

7.3.3 Land Suitability for Upland Crops

There are also three scenarios considered for LS for upland crops. Each scenario differs in weightings but shares the same scores because the land characteristics of upland crop do not change. Since some of the land characteristics are more suitable for upland crops than paddy field, it was necessary to change the scorings of sub-criteria to identify those that are most suitable for upland crops. Table 7.3.15 shows the sub-criteria used in upland crops and their scorings.

Table 7.3.15 List of Criteria, Sub-criteria and Their Scorings Used for Upland Crops

Criteria	Sub-criteria	Scoring	Scoring	Scoring
Soil Type	Cambisols; Luvisols; Vertisols; Chernozems; Phaeozems; Nitisols; Andosols; Ferralsols	5	Scenario (2) Land Suitability (Rainfed Condition)	Scenario (3) Irrigation Priority (Irrigation Requirement)
	Acrisols; Histosols	4		
	Fluvisols; Gleysols; Arenosols	3		
	Planosols; Solonetz	2		
	Lixisols; Leptosols; Regosols; Solonchaks	1		
Slope (°)	0 - 3	5		
	3 - 8	4		
	8 - 15	3		
	15 - 30	2		
	> 30	1		
Elevation (m)	> 2000	1		
	1500 - 2000	2		
	1000 - 1500	3		
	500 - 1000	4		
	≤ 500	5		
Temperature (°C)	> 26	3		
	20 - 26	5		
	15 - 20	4		
	12 - 15	2		
	≤ 12	1		
Land Use	Sparse vegetation; Bare area, unconsolidated (sand); Cropland; Cropland /other vegetation mosaic	5		
	Shrub; Herbaceous; Herbaceous with sparse tree/shrub	4		
	Paddy field	3		
	Bare area consolidated (gravel, rock)	2		
	Broadleaf evergreen forest; Broadleaf deciduous forest; Needleleaf evergreen forest; Needleleaf deciduous forest; Mixed forest; Tree open; Mangrove; Wetland; Urban; Snow / ice; Water bodies	1		
Soil Depth (cm)	150 – 300	5		
	100 – 150	4		
	50 – 100	3		
	10 – 50	2		
	≤10	1		
Soil Organic Carbon (% weight)	> 3.0	1		
	2.0 - 3.0	4		
	1.2 - 2.0	5		
	0.6 – 1.2	3		
	0.2 - 0.6	2		
	≤ 0.2	1		
Soil pH	< 4.5 and > 8.0	1		

Scenario (1) Land Suitability (Land Resource Only)

Same Scoring as Scenario (1)

Same Scoring as Scenario (1)

Criteria	Sub-criteria	Scoring		Scoring		Scoring	
	7.5 - 8.0		2				
	4.5 - 5.0 and 7.0 - 7.5		3				
	5.0 - 5.5 and 6.5 -7.0		4				
	5.5 - 6.5		5				
Soil Drainage	Well		5				
	Moderately Well		4				
	Imperfectly		3				
	Somewhat Excessive		2				
	Very Poor; Poor		1				
TWI	> 15.7		5				
	12.2 - 15.7		4				
	8.7 - 12.2		3				
	5.3 - 8.7		2				
	≤ 5.3		1				
Precipitation (mm/year)	> 2000				5		1
	1200 - 2000				4		3
	800 - 1200				3		5
	600 - 800				2		4
	≤ 600				1		2

Source: JICA Project Team

(1) Land Resource Scenario for Upland Crops

There are ten parameters considered for the land resource scenario similar to paddy field, and the weights of which criterion has more influence than the other was assessed based on the JICA Project Team's judgment. Table 7.3.16 shows the calculated weighting factor for each criterion. As illustrated in Table 7.3.17, TWI, soil drainage, temperature, and soil pH, are the main influencing factors in LS for upland crops comprising 68.3% of the total weight. Whereas slope and elevation have the least influence in LS analysis for upland crop.

Table 7.3.16 Weighting Factors for Upland Crop Suitability (Land Resource Scenario)

Criteria	ST	S	E	T	LU	SD	SOC	S-pH	SDR	TWI	W	CI	RI	CR
ST	1	3	3	1/3	1	1	1	1	1/3	1/5	0.066	0.072	1.490	0.048
S	1/3	1	1	1/7	1/3	1/3	1/3	1/3	1/5	1/7	0.026			
E	1/3	1	1	1/7	1/3	1/3	1/3	1/3	1/5	1/7	0.026			
T	1	3	3	1	3	3	3	1	1	1/3	0.121			
LU	1	3	3	1/3	1	3	3	1	1/3	1/3	0.087			
SD	1	3	3	1/3	1/3	1	1	1/3	1/3	1/3	0.056			
SOC	1	3	3	1/3	1/3	1	1	1/3	1/3	1/3	0.056			
S-pH	3	5	5	1	1	3	3	1	1/3	1/3	0.120			
SDR	5	7	7	1	3	3	3	3	1	1	0.209			
TWI	5	7	7	3	3	3	3	3	1	1	0.234			

Note: (ST: Soil Type, S: Slope, E: Elevation, T: Temperature, LU: Land Use, SD: Soil Depth, SOC: Soil Organic Carbon, S-pH: Soil pH, SDR: Soil Drainage, TWI: Topographic Wetness Index, W: Weighting)
Source: JICA Project Team

Table 7.3.17 Ranking Priority for Upland Crops (Land Resource Scenario)

Criteria Layer	Weighting	Priority Ranking
TWI	0.234	1
Soil Drainage	0.209	2
Temperature	0.121	3
Soil pH	0.120	4
Land Use	0.087	5
Soil Type	0.066	6
Soil Depth	0.056	7
Soil Organic Carbon	0.056	8
Slope	0.026	9

Criteria Layer	Weighting	Priority Ranking
Elevation	0.026	10

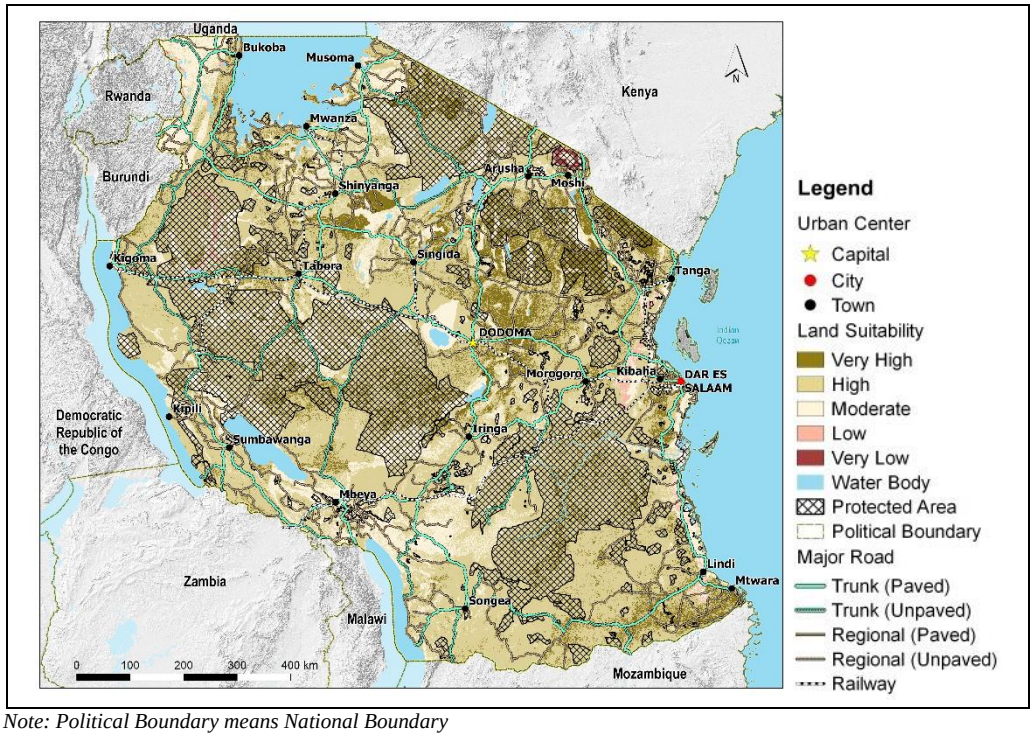
Source: JICA Project Team

Similar to land suitability for paddy field, the land use/cover data are the base for analysis. Out of eight land use/cover classes, four classes were excluded from the land suitability analysis: forest, urban, water, and protected area because the agricultural activities are not allowed in these classes. Thus, the land suitability for upland crops was assessed only on four land use/cover classes: cropland, other natural vegetation, bare area/Sparse vegetation, and Wetland. These four classes were grouped into one class named potential agriculture land. The results, as illustrated in Table 7.3.18 and Figure 7.3.4, show that the total area of very high and high LS classes located within potential agriculture land is 225,105 km^2 (22,510,486 ha) representing 88.3% of the potential agriculture land and 24.0% of the total mainland area which is higher than the percentage of LS of the same class for paddy field. The LS of 24.0% represents almost quarter the area of the country's mainland that is very suitable for upland crops, which indicates plenty of lands suitable for upland crops.

Table 7.3.18 Acreage of Upland Crop Suitability (Land Resource) within the Potential Agriculture Land in Tanzania Mainland

Class	Very Low (ha)	Low (ha)	Moderate (ha)	High (ha)	Very High (ha)	Total (ha)
Other natural vegetation	426	66,353	2,227,292	10,395,236	3,766,376	16,455,683
Cropland	63	27,161	574,618	4,384,596	3,484,270	8,470,708
Wetland	295	2,808	85,599	428,889	6,396	523,987
Bare area/ Sparse vegetation	3	1,391	10,948	30,943	13,780	57,065
Potential Agriculture Area	**787**	**97,713**	**2,898,457**	**15,239,664**	**7,270,822**	**25,507,443**

Source: JICA Project Team



Note: Political Boundary means National Boundary
Source: JICA Project Team

Figure 7.3.4 Land Suitability Map for Upland Crops (Land Resource Scenario)

(2) Land Suitability Rainfed Scenario for Upland Crops

The weighting factors for the rainfed scenario were recalculated since the number of criteria was increased from 10 to 11 when the precipitation criterion was added. Table 7.3.19 and Table 7.3.20 show the weighting calculations and the priority ranking for each criterion, respectively. Precipitation, TWI, temperature, and soil drainage have the highest weightings making up together 69.3% of the total weightings for the rainfed scenario.

Table 7.3.19 Weightings Calculated for Upland Crops Land Suitability (Rainfed and Irrigation Scenarios)

Criteria	ST	S	E	P	T	LU	SD	SOC	S-pH	SDR	TWI	W	CI	RI	CR
ST	1	3	3	1/5	1/3	1	1	1	1	1/3	1/5	0.050	0.080	1.480	0.054
S	1/3	1	1	1/7	1/7	1/3	1/3	1/3	1/3	1/5	1/7	0.021			
E	1/3	1	1	1/5	1/7	1/3	1/3	1/3	1/3	1/5	1/7	0.021			
P	5	7	5	1	1	3	5	5	5	5	3	0.236			
T	3	7	7	1	1	3	3	3	1	1	1/3	0.129			
LU	1	3	3	1/3	1/3	1	3	3	1	1/3	1/5	0.064			
SD	1	3	3	1/5	1/3	1/3	1	1	1/3	1/3	1/5	0.041			
SOC	1	3	3	1/5	1/3	1/3	1	1	1/3	1/3	1/5	0.041			
S-pH	1	3	3	1/5	1	1	3	3	1	1/3	1/5	0.068			
SDR	3	5	5	1/5	1	3	3	3	3	1	1	0.128			
TWI	5	7	7	1/3	3	5	5	5	5	1	1	0.199			

Note: (ST: Soil Type, S: Slope, E: Elevation, P: Precipitation, T: Temperature, LU: Land Use, SD: Soil Depth, SOC: Soil Organic Carbon, S-pH: Soil pH, SDR: Soil Drainage, TWI: Topographic Wetness Index, W: Weighting)
Source: JICA Project Team

Table 7.3.20 Ranking Priority for Upland Crops (Rainfed and Irrigation Scenarios)

Criteria	Weighting	Priority Ranking
Precipitation	0.236	1
TWI	0.199	2
Temperature	0.129	3
Soil Drainage	0.128	4
Soil pH	0.068	5
Land Use	0.064	6
Soil Type	0.050	7
Soil Depth	0.041	8
Soil Organic Carbon	0.041	9
Elevation	0.021	10
Slope	0.021	11

Source: JICA Project Team

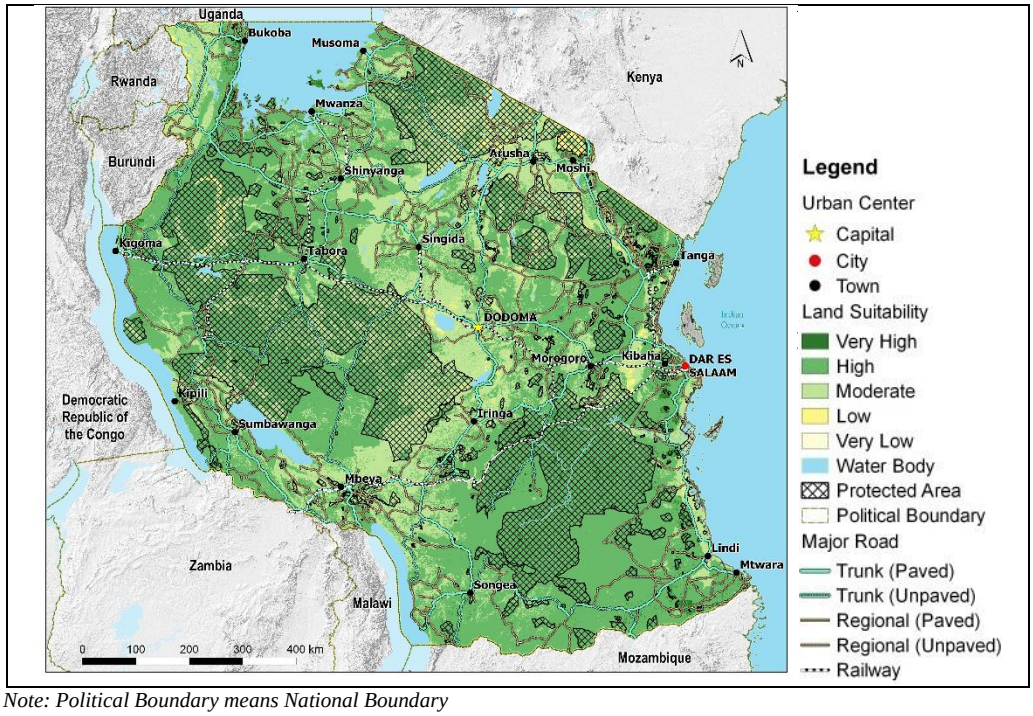
The result of the LS analysis of the rainfed scenario shows that out of 25,507,443 ha of potential agriculture land there are 183,405 km^2 (18,340,483 ha) located within very high and high classes, which represent 71.9% of the total potential agriculture land area, as shown in Table 7.3.21Table 7.3.21, and 19.6% of the total mainland area. Figure 7.3.5 shows the output LS map of the rainfed scenario.

When comparing rainfed scenario with land resource scenario, it is found that the rainfall can limit the potential agriculture land to only areas with high rainfall amounts of more than 1,200 mm/year, which represents 14% of the total mainland area as shown in Table 7.3.13, leaving the majority of the Tanzanian mainland less suitable.

Table 7.3.21 Acreage of Upland Crops Land Suitability (Rainfed Condition) within the Potential Agriculture Land in Tanzania Mainland

Class	Very Low (ha)	Low (ha)	Moderate (ha)	High (ha)	Very High (ha)	Total (ha)
Other natural vegetation	426	66,353	2,227,292	10,395,236	3,766,376	16,455,683
Cropland	63	27,161	574,618	4,384,596	3,484,270	8,470,708
Wetland	295	2,808	85,599	428,889	6,396	523,987
Bare area/ Sparse vegetation	3	1,391	10,948	30,943	13,780	57,065
Potential Agriculture Area	**787**	**97,713**	**2,898,457**	**15,239,664**	**7,270,822**	**25,507,443**

Source: JICA Project Team



Note: Political Boundary means National Boundary
Source: JICA Project Team

Figure 7.3.5 Land Suitability Map for Upland Crops (Rainfed Scenario)

(3) Irrigation Priority Scenario for Upland Crops (Irrigation Requirement)

Similar to the irrigation priority scenario of paddy field, precipitation amount ranging between 800 mm/year and 1,200 mm/year was given the highest ranking of 5 and precipitation amount of less than 600 mm/year received the lowest ranking of 1 as illustrated in Table 7.3.15.

The results show that the total area of very high and high irrigation priority classes is 239,054 km^2 (23,905,362 ha) which represents 93.7% of the potential agriculture land, as shown in Table 7.3.22 and Figure 7.3.6, and 25.5% of the total mainland area.

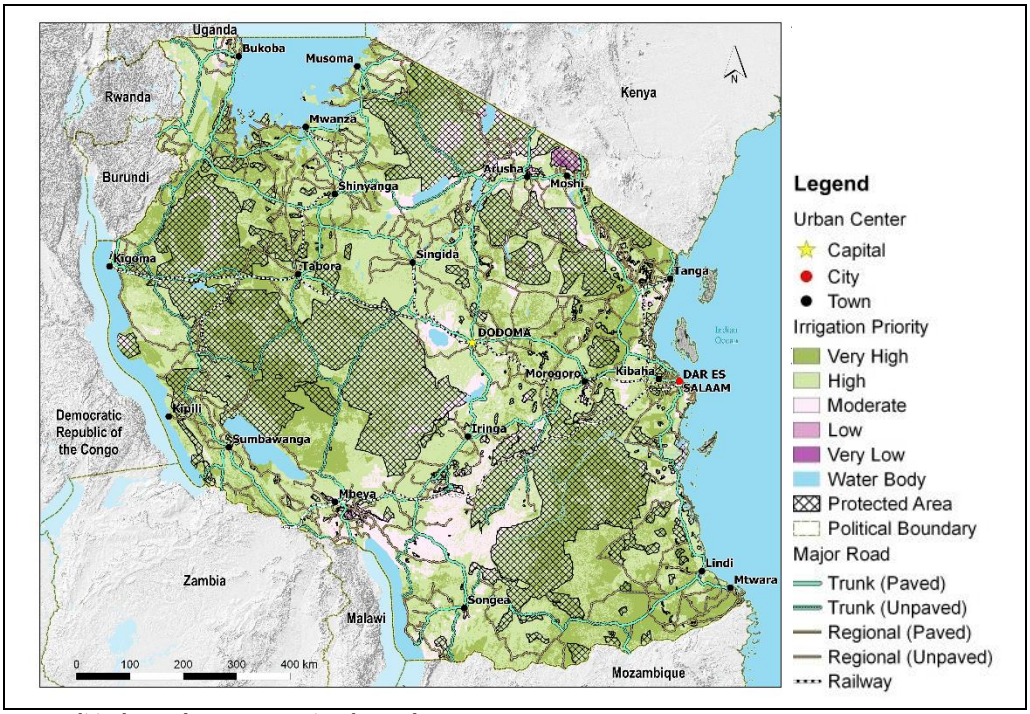
The increase of 5,564,879 ha of very high and high LS classes in irrigation priority scenario (23,905,362 ha) compared with the rainfed condition scenario (18,340,483 ha) is related to the higher scorings of 4 and 5 to the lands with rainfall amounts between 600 mm/year and 1200 mm/year, as shown in Table 7.3.13, which represent 78.4% of the total mainland of Tanzania. This indicates that the irrigation priority scenario increases the land suitability to agriculture when supporting rainfall distribution with

appropriate irrigation system.

Table 7.3.22 The Acreage of Upland Crops Irrigation Priority within Potential Agriculture Land in Tanzania Mainland

Class	Very Low (ha)	Low (ha)	Moderate (ha)	High (ha)	Very High (ha)	Total (ha)
Other natural vegetation	0	8,873	1,176,398	9,775,509	5,494,903	16,455,683
Cropland	0	1,937	338,922	3,681,607	4,448,242	8,470,708
Wetland	0	1,147	50,566	455,456	16,818	523,987
Bare area/ Sparse vegetation	0	1,212	23,026	28,831	3,996	57,065
Potential Agriculture Area	**0**	**13,169**	**1,588,912**	**13,941,403**	**9,963,959**	**25,507,443**

Source: JICA Project Team



Note: Political Boundary means National Boundary
Source: JICA Project Team

Figure 7.3.6 Irrigation Priority Map for Upland Crops

7.3.4 Summary and Conclusion

The LS analysis using the AHP method is very important to assess the suitability of land for agriculture taking into consideration multiple criteria. Figure 7.3.7 shows a comparison among the three scenarios of land suitability for paddy field and upland crops within the potential agriculture land, respectively. The analysis shows that the Tanzania mainland in general is highly suitable for agriculture. Looking at scenario 1, which is land resource scenario, it illustrates that there are more than 19,000,000 ha highly suitable for paddy field and more than 22,000,000 ha highly suitable for upland crops. However, the suitability decreases for both paddy field (~16,500,000 ha) and upland crops (~18,000,000 ha) when considering only rainfall as a source of water as in scenario 2 (rainfed condition). On the other hand, the land suitability increases for both paddy field (~20,000,000 ha) and upland crops (~24,000,000 ha) when supporting rainfall with irrigation as illustrated in scenario 3 (irrigation priority).

Also, Figure 7.3.7 shows that there are more potential lands when considering upland crops compared with paddy field. This is because the physical characteristics of the land (soil characteristics and topography) are more suitable for upland crops compared with paddy field. As shown above, the suitability increases by 4,000,000 ha in the irrigation priority scenario and 1,500,000 ha in the rainfed scenario when selecting upland crops.

Generally, there are plenty of lands suitable for agriculture in Tanzania whether the chosen crops are paddy fields or upland crops. However, the main controlling factor of land suitability to agriculture is not the availability of lands, but actually the availability of water resources for irrigation. Thus, providing efficient irrigation equipment that improve the agriculture in Tanzania is very important.

Note: VH: Very High, H: High, M: Moderate, L: Low, and VL: Very Low
Source: JICA Project Team

Figure 7.3.7 Comparison among the Three Scenarios of Land Suitability for (a) Paddy Field and (b) Upland Crops Within Potential Agriculture Land

7.4 Irrigation Development Potential Area

7.4.1 Method and Procedure

As explained in Subsection 7.2.2(1), the irrigation sector should follow the water allocation plan which will limit the potential irrigable area for irrigation development, in principle.

(1) Literature Review

In order to evaluate irrigable area estimated in the existing studies, the JICA Project Team reviewed the reports. As a result, the team realised the differences in methodology and values of parameters used among the studies. Especially, differences of irrigation efficiency and unit water requirement affect the irrigable area significantly. In this connection, the team re-estimates the potential irrigable area applying the unified parameters and methodology.

(2) Procedure to Estimate the Potential Irrigable Area

The potential irrigable area is estimated by dividing the allocated water volume by the unit water requirement. The unit water requirements of crops are estimated by the conventional method of Food and Agriculture Organization (FAO) which is introduced in the Irrigation and Drainage Paper No. 24[2]. Necessary data for calculation such as rainfall, potential evapotranspiration and crops concerning data

[2] FAO Irrigation and Drainage Paper No.24can be downloaded from the following website.
（http://www.fao.org/publications/card/en/c/6bae3071-5d7b-5206-af5c-c9bfa1d9d1fe/）

are collected. Data on cropping pattern is summarized in the next Section 7.4.3. As for the allocated water volume in each sub-basin on a monthly basis, this review uses the study results made in Section 7.2.2.

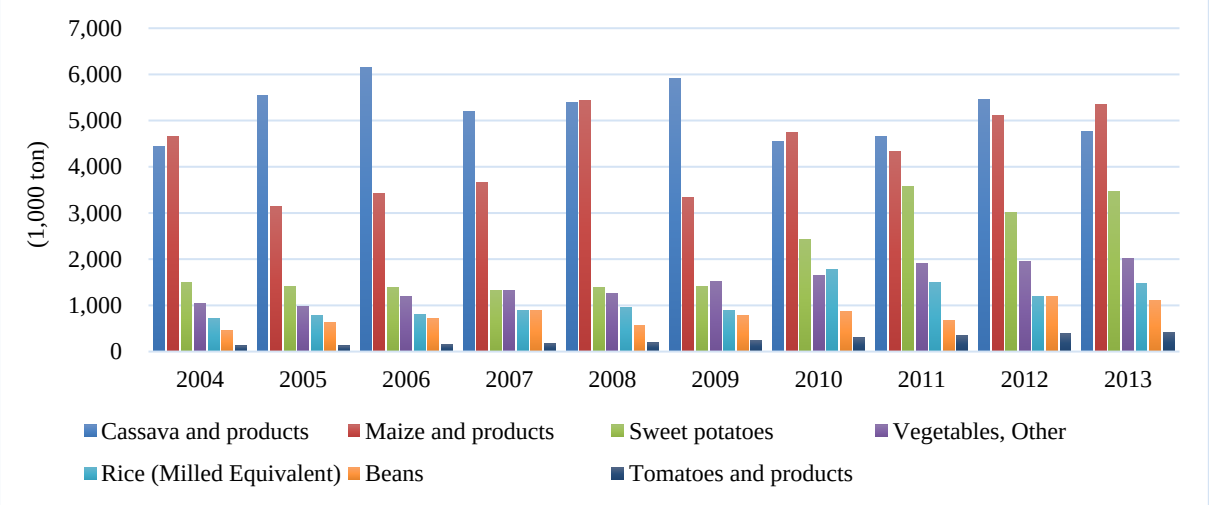
7.4.2 Target Crops for Irrigation

For the selection of target crops for irrigation agriculture, the following issues are taken into account:

i) Changes of production and/or supply of the major crops over time: Because the statistical data clearly indicates that the demand by crop are not available, chronological production and/or supply changes of major crops are considered as the responses based on the demand changes.
ii) Demand changes of agricultural processing industry: In addition to the food demand, agricultural processing is regarded as one of the major end users of crop production, hence, supply changes of major agricultural materials are analyzed.
iii) Trend of export and import of major crops: Trade surplus and deficit amounts of major agricultural products are analyzed to examine possible import substitute and export-oriented crops for irrigation.
iv) Consistency with other governmental policies/strategies

(1) Change of Production and/or Supply of the Major Crops

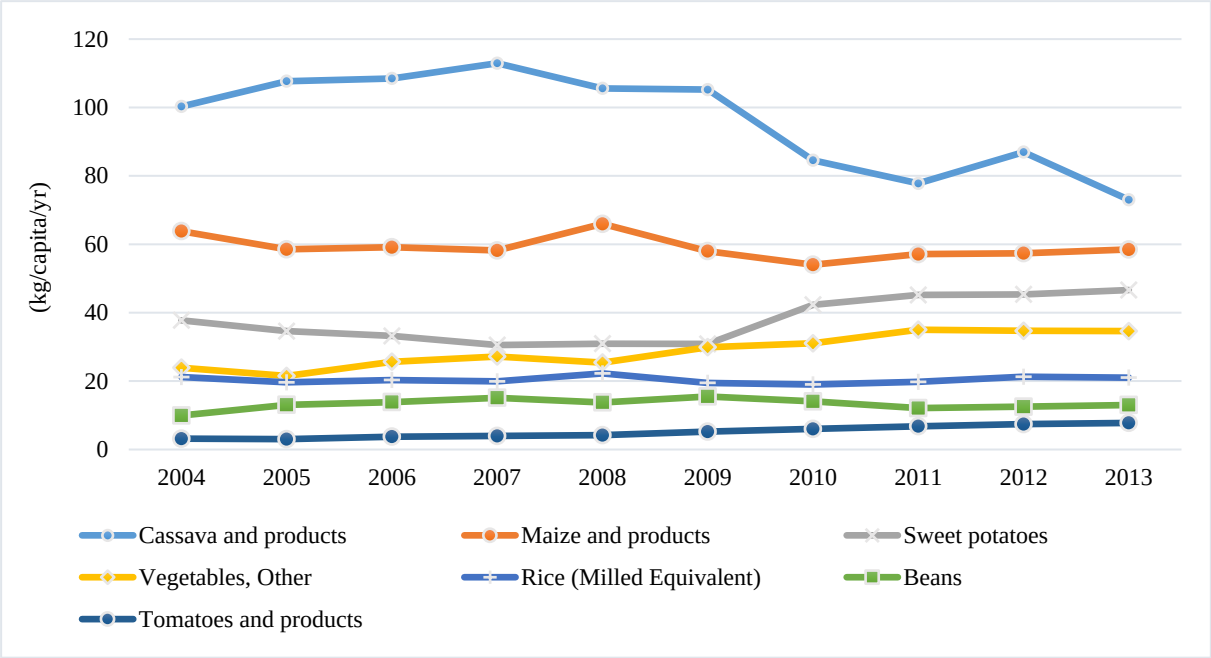
Based on the FAOSTAT statistics, which provide various time series data, production amount changes of the seven major crops are shown below. Cassava and maize are ranked at the first and second places in crop production amount over time. Production amounts of sweet potatoes and vegetables (other) are recently increasing and it is assumed that the demands of these crops are growing.



Source FAOSTAT website, http://www.fao.org/faostat/en/#data

Figure 7.4.1 Production Amount Changes of the Major Crops (2004-2013)

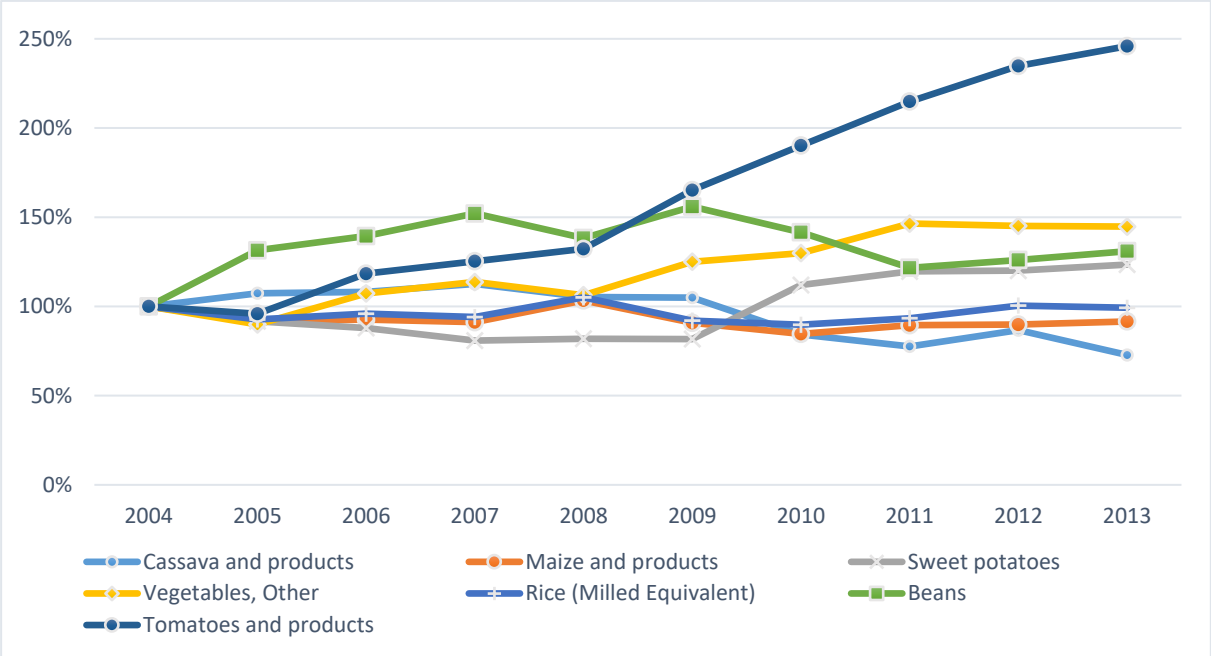
Since the data above does not take into account a factor of population, the per capita food supply quantity data are analysed for seven major crops and is shown in Figure 7.4.2



Source FAOSTAT website, http://www.fao.org/faostat/en/#data

Figure 7.4.2 Per Capita Food Supply Quantity of Major Crops (2004-2013)

While the per capita food supply of cassava gradually decreased, the data of sweet potatoes, vegetables and tomatoes continuously increased. The per capita food supply of rice remained stable as compared with other crops, although its domestic production gradually increased as indicated above. This may imply that annual supply growth of rice is only enough for the volume of the increased population. To see the trends more clearly, the increase rates (2004=100%) are shown in Figure 7.4.3.



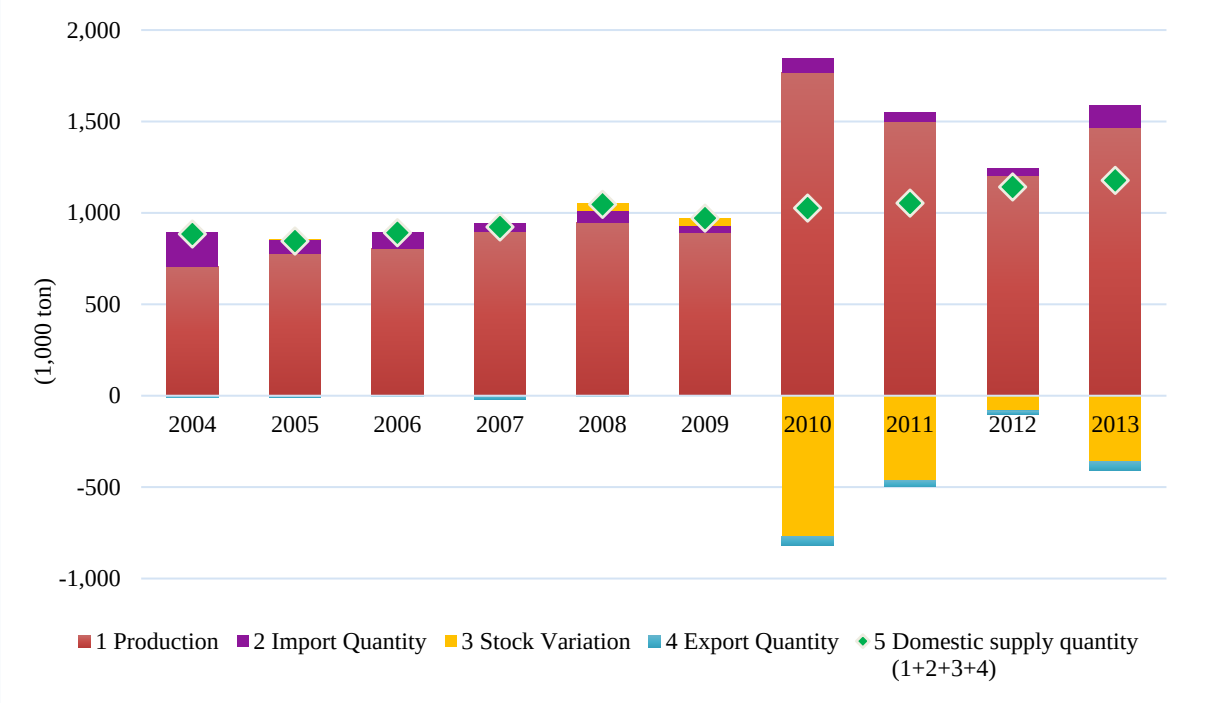
Source FAOSTAT website, http://www.fao.org/faostat/en/#data

Figure 7.4.3 Per Capita Food Supply Quantity of Major Crops (2004=100)

Actual figures are relatively small but the increase rate of tomato is outstanding, nearly 150% increase

in the 10-year period. The second highest increase (45% increase during the decade) was observed in vegetables. Sharp increase of per capita food supply quantity for these vegetables may reflect change of dietary habits in Tanzania as well as population concentration in urban areas. Considering the current population growth rate (2.7%) and the ongoing rapid urbanization in Tanzania, it is predictable that the demand for vegetables further expands in the future.

Here, the domestic supply trend for milled equivalent rice, which normally needs a lot of water during its cultivation period except for upland rice, is analysed from 2004 to 2013 as Figure 7.4.4.



Source FAOSTAT website, http://www.fao.org/faostat/en/#data

Figure 7.4.4 Change of Milled Rice Supply (2004-2013)

The domestic supply quantity has been gradually increasing mainly due to the increase of production quantity, particularly since 2010. During the decade, the production doubled. Also, a certain amount of rice has been imported. This may imply that the domestic supply is still not sufficient as a whole.

Stock variation recorded negative figures and its amount was quite large after 2010. It was not clear why they are such large negative figures but one possible cause was informal border trade[3]. Due to the high quality of Tanzanian rice, it is very popular and has high demand at the markets in neighbouring countries (Uganda, Rwanda, Kenya and Burundi) with a 15% price premium.

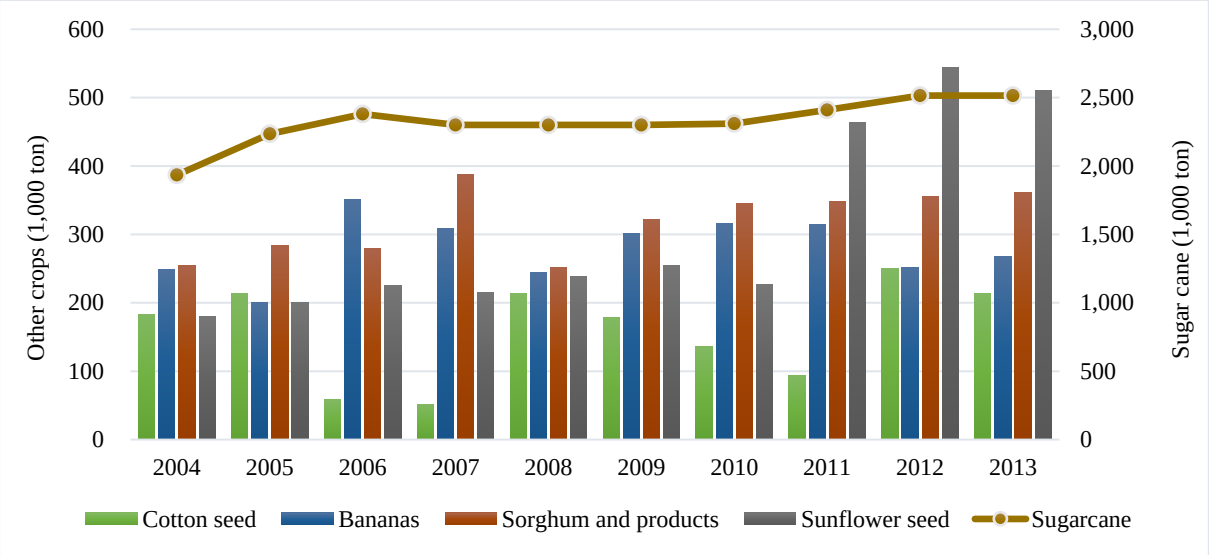
(2) Demand Changes of Agricultural Processing Industry

As mentioned in Chapter 4, agricultural processing is one of the biggest subsectors in manufacturing in terms of contribution to production and employment. However, more than one-third is occupied by sugar, and together with the other top 4 (tobacco products; soft drinks and mineral waters; grain mil products; and cocoa, chocolate and sugar confectionary), those five activities represent nearly two-thirds (62%)

[3] FAO (R. Trevor Wilson and I. Lewis), 2015, The Rice Value Chain in Tanzania - A Report from the Southern Highlands Food Systems Programme (p22)

of the employment in manufacturing.

The recent trend of material supply for five major agricultural processing activities is shown in Figure 7.4.5.



Source FAOSTAT website, http://www.fao.org/faostat/en/#data

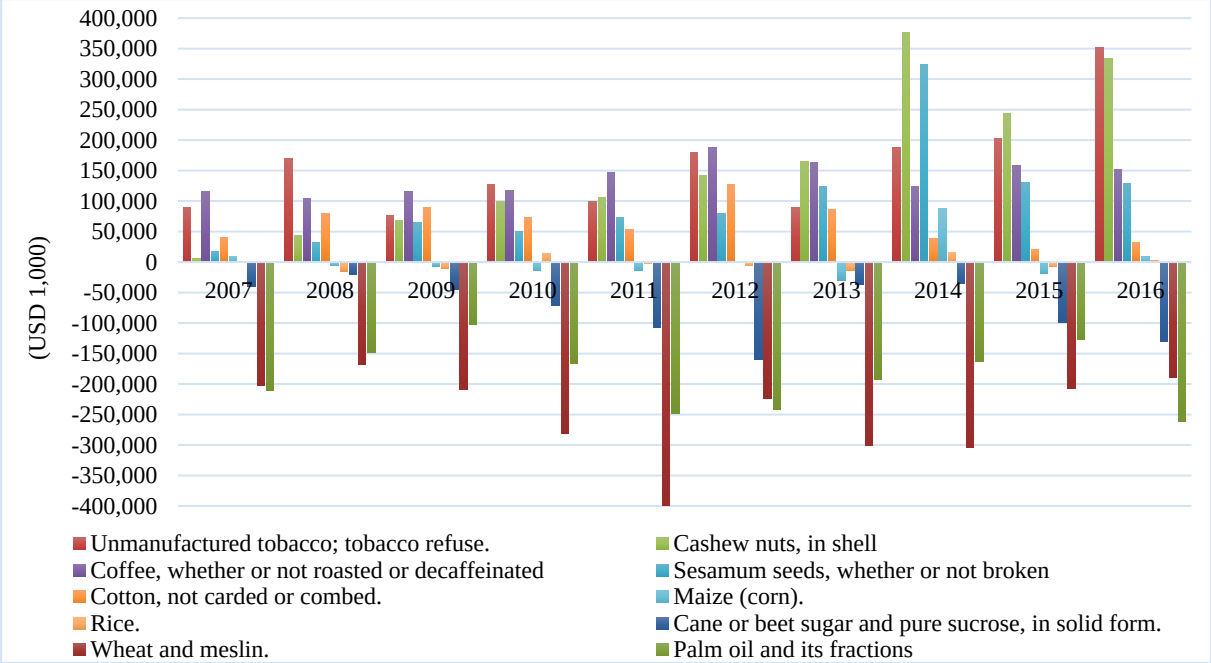
Figure 7.4.5 Material Supply for Agricultural Processing (2004-2013)

The sugarcane supply volume is so large that its axis is indicated on the right hand. Sunflower and sorghum are ranked at the second and third place but their volumes are far fewer than sugarcane. Banana and cotton seeds are ranked at the fourth and fifth. Millet and products, coconuts (including copra), plantains, barley and products and sesame seed are following these top 5 agricultural processing materials.

Except for sugarcane, the material demand for agricultural processing subsector is not so large as compared with the production level. In addition, all these crops for materials are extensively cultivated on rainfed crop land except for commercial sugarcane plantations so it is assumed that there are no material crops that urgently need irrigation water.

(3) Trend of Export and Import of Major Crops

Export and import data of major commodities are compared for the recent ten years, 2007-2016. Because export and import values are considered to be more important than their volumes from the viewpoints of the national economy and import substitution, values are used for comparison. In the UNComtrade trade statistics, both export and import values (USD 1,000) are included by commodity. With these data, trade surplus/deficit figures (export value minus import value) are calculated by commodity and those major surplus and deficit commodities in the last ten years are shown in Figure 7.4.6.



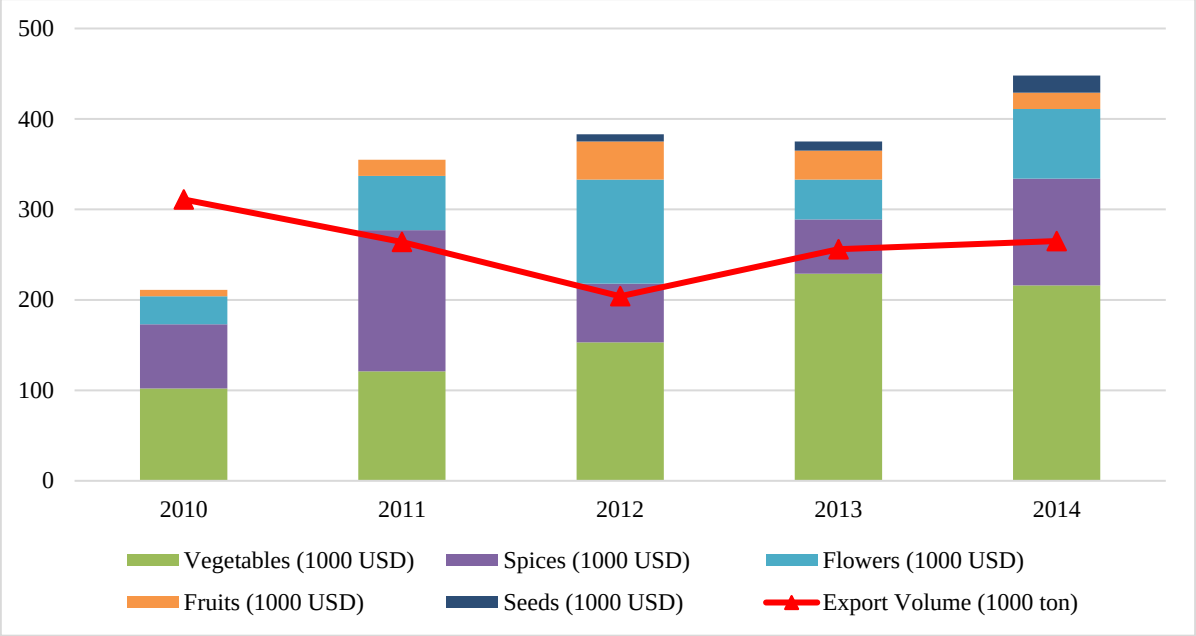
Source UNComtrade website, http //comtrade.un.org/data

Figure 7.4.6 Trade Surplus and Deficit Data of Major Agricultural Commodities (2004-2013)

Major commodities with trade surplus are traditional cash crops such as tobacco, cashew nuts, and coffee. Sesame was once a minor export commodity but its surplus has rapidly increased and its trade surplus ranked second in 2014. In general, these exported cash crops are cultivated on a large scale under rainfed conditions, hence irrigation seems to be less important for production of these crops.

As for the trade deficit, wheat recorded the largest deficit in 2011 with nearly USD 400 million, and still did USD 300 million in 2013 and 2014. Considering the Tanzanian climate conditions, wheat cannot be widely cultivated so it is taken for granted that wheat supply mainly depends on import. Palm oil also has recorded a large amount of trade deficit next to wheat, and its deficit amount exceeded that of wheat in 2016. The trade deficit of sugar ranged from USD 20 million to 160 million for a decade. In 2014 and 2016 a small amount of trade surplus was recorded for maize and rice, but the trade balance was negative in most years and it sometimes reached USD 15-30 million. Among these trade deficit commodities, irrigation is crucial for cultivation of paddy, sugarcane and maize.

Upland crops export value is currently expanding as given below. Between 2010 and 2014, export earnings from upland crops have more than doubled although its amount is still smaller than the traditional cash crops above. The breakdown data indicates that vegetables contribute the most among the five commodities and their export is rapidly boosting and is shown in Figure 7.4.7



Source: Cambridge Economic Policy Associates Ltd., October 2016, Global Agricultural and Food Security Program (GAFSP) Private Sector Window

Figure 7.4.7 Export Data of Upland Crops (2011-2014)

(4) Consistency with Other Governmental Policies/Strategies

For the revision of NIMP, the recent policies and strategies by the central government are also taken into account to select target crops as well as the above information (past trends of production, supply, export, import and processing industry demands). The descriptions in the policies/strategies related to the target crops for irrigation are summarized in Table 7.4.1.

Table 7.4.1 Policies and Strategies Related to the Target Crops for Irrigation

National Agriculture Policy, (NAP, October 2013)
3.6 Irrigation Development 3.6.3 Policy Statements v) Irrigation schemes with special focus on high value crops (vegetable, fruits, and flowers) along with such traditional crops as paddy shall be promoted. (NAP, p15)
Agricultural Sector Development Strategy-II 2015/15-2025/26, (ASDS2, September 2015)
d) Further promote recently increasing export of fish and horticulture. In addition, promote strategically export of maize and rice whose production has been increasing in recent years and the demand from neighbouring countries are continuously high. (ASDS2, p29) Milestone Indicators Showing Progress Towards Objectives: Cropping intensity for irrigated crops (rice, horticulture) (ASDS2, p68)
Agricultural Sector Development Programme 2, (ASDP2, Mar 2017)
61. Sustainability and diversification. ASDS2 emphasizes the need to diversify crop and livestock production to increase farm incomes and to reduce risks in light of both production and price fluctuations. The expansion in irrigated agriculture opens up an opportunity for crop intensification, one of which could be diversification into high value crops, such as horticulture. (ASDP2, p28) Irrigation development towards double cropping, mainly for rice and high value crops (horticulture) (ASDP2, p86) RICE: Tanzania achieves self-sufficiency in rice production (and starts to export these grains) (potential to become a regular exporter) (ASDP2, p86) i. Increased productivity—efficient use of improved technologies iii. Irrigation infrastructure rehabilitation/extension v. Counter-season irrigated vegetables Horticulture (fruits and vegetables): Production for consumption and export in all peri-urban areas and highlands (ASDP2, p87) ii. Irrigation for counter-season production

National Rice Development Strategy, (NRDS, May 2009)
The vision of NRDS is to transform the existing subsistence-dominated rice subsector progressively into commercially and viable production system. (NRDS, p6)
General objective is to double rice production by 2018 (from 889,000 ton in 2008 to 1,963,000 ton by 2018) (NRDS, p20)
Rainfed lowland: yield will be improved from 1 to 2 tons per ha. (NRDS, p21)
Irrigated: yield will be improved from 2.13 to 3.5 tons per ha. (NRDS, p21)
Total: yield will be improved from 1.3 to 2.8 tons per ha. (NRDS, p21)

(5) Target Crops

In the National Irrigation Master Plan 2002 (NIMP2002), three crops (paddy, maize, and others such as beans and vegetables) were identified as target crops. In addition to the discussions above, other data such as gross income and necessity of irrigation are added and the result is summarized in Table 7.4.2.

Table 7.4.2 Summary of Crop Comparison

Aspect	Paddy	Maize	Beans	Sugarcane	Tomato	Onion
Gross income *1	3	1	2	3	3	2
Domestic market *2	3	2	2	2	3	3
Export market	3	1	1	1	1	1
Demand of agro-processing	1	1	1	3	2	1
Strategic commodity: NAP	1	-	-	-	1	1
Strategic commodity: ASDS2	1	1	-	-	1	1
Strategic commodity: ASDP2	1	1	1	1	1	1
Necessity of Irrigation *3	3	3	1	3	2	2
Overall priority	16	10	8	13	14	12

*Note: *1: It is estimated by multiplying unit yield in 2014/15 (t/ha, calculated from statistical data collected from Statistics Unit, MALF) and unit wholesale price in 2013 to ensure consistency of data. For sugarcane, 43,000 TZS/t is used for unit price.*
**2: Three grades are applied (1: Low, 2: Medium, 3: High).*
**3: Derived from "Climatic, Soil and Water Requirements for Crops (FAO)"*
Source: JICA Project Team

In terms of irrigation agriculture, paddy always comes first because it generally needs a large amount of water for its growth as compared with other upland crops. Although the NRDS released in 2009 is a bit old, it is still the national strategy for rice development. The NRDS envisages to transform the subsistence-dominated rice sub-sector progressively into commercial production system, but in fact the majority of paddy production systems in Tanzania are still small scale (74% of the planted area by smallholders[4]) and rather subsistent except for some large-scale paddy production schemes in Morogoro and Mbeya regions. Regardless of the production scale, irrigation is indispensable for stable paddy production. With the recent climate changes such as erratic rainfall patterns, it is considered that the role of irrigation becomes increasingly important for paddy cultivation.

Moreover, paddy was regarded not only as a food crop but also as a crop for export in the future in ASDS2. Many neighbouring countries such as Kenya, Mozambique, DR Congo, etc., have imported plenty of rice for years, hence, Tanzania could be a rice supply area for those rice-deficit nations in case tariff barriers are solved among the countries concerned. Considering the overall information above, paddy is selected as one of the target crops for NIMP2018.

Upland crops are regarded as high value crops and one of the diversification and intensification options, particularly in dry season. The demand and export have rapidly grown during the last decade as seen

[4] FAO (R. Trevor Wilson and I. Lewis) , 2015, "The Rice Value Chain in Tanzania - A Report from the Southern Highlands Food Systems Programme"

above. They also enable to improve nutritional conditions at a household level. With these advantages and reasons, it is believed that upland crops are targeted for irrigation agriculture in NAP, ASDS2 and ASDP2, hence they are selected as target crops for NIMP2018, too. Because upland crops include various vegetables as well as fruits, tomato and onion are tentatively chosen as representatives for targeted upland crops because these two crops are ranked in the top three in terms of planted area (another one is okra) and being cultivated across the country according to the 2014/15 AASS[5].

Sugarcane production expansion seems to be important to reduce recent large trade deficit (import substitution) and necessity of irrigation is also high. At present sugarcane is mainly cultivated near sugar factories by private farms/estates (for sugarcane cultivation, existence of nearby sugar factories is indispensable.), but its major production areas are unevenly distributed to several regions such as Morogoro, Kilimanjaro, and Kagera. Considering the limited distribution of beneficiaries and farmland, in principle sugarcane is not selected as a target crop for the NIMP2018. However, there are already large-scale commercial projects targeted for sugarcane as shown in Table 8.6.11. Therefore, sugarcane is set as a target crop only for these five large-scale commercial projects.

Although maize was one of the target crops in NIMP2002, paddy is selected as the representative of high water demanding crops for NIMP2018, and maize and sugarcane are regarded as alternative crops. Likewise, tomato and onion are selected as the representative of low water demanding crops for NIMP2018, which include other upland crops, oil crops, beans and fruit crops as tabulated below.

Table 7.4.3 Summary of Target Crops for NIMP2018

Crops Used for Irrigation Planning	Target Crops	Features
High water demanding crops	Paddy, Maize, Sugarcane	(Low Risk, Low Returns) ・ Less production cost ・ Less labour intensive ・ No large fluctuation in price ・ Long storable (except sugarcane) ・ Need for extension services, etc.
Low water demanding crops	Tomato, Onion, Oil Crops (Sunflower, Sesame, Beans), Cotton, Grapes, Banana, Papaya and other crops	(High Risk, High Returns) ・ Higher production cost ・ Labour intensive ・ Large fluctuation in price ・ Perishable (except oil crops) ・ Need for more extension services, etc.

Source: JICA Project Team

Finally, the selected two crops, paddy and upland crops, are consistent with the Catalysing the Future Agri-food Systems of Tanzania (CFAST) Project, proposed by NIRC in collaboration with the World Bank.

The data relevant to these target crops for irrigation, paddy and upland crops (represented by tomato and onion), are used for the analysis of the water balance later in this chapter.

7.4.3 Model Cropping Pattern for Irrigation by Region

Basic data on model cropping patterns of the target crops by region, which are necessary for the analysis of the water balance, were collected from ZIOs. Among the seven ZIOs, the data were available in the

[5] National Bureau of Statistics,URT, Sep. 2016, 2014/15 Annual Agriculturel Sample Survey Report

six ZIOs. In some regions, the cropping patterns of the target crops were not available even at the ZIOs. For those regions where the cropping pattern data were not given by the ZIOs, other data were referred to make model cropping patterns. Table 7.4.4 and Table 7.4.5 below show the model cropping patterns of the two target crops by region. As for paddy, the cropping patterns of modern and traditional irrigation schemes are separately indicated if possible.

Table 7.4.4 Model Cropping Patterns of Paddy by Region

Region	Sep		Oct		Nov		Dec		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Remarks	Source
Dodoma										P	P	P	=	=	=	>	H	H	H						Modern Irri. Sch.	ZIO
Arusha	=	=	=	=	=	>	H	H	H	P	P	P	=	=	=	>	H	H	H	H	P	P	=	=	Modern Irri. Sch.	ZIO
		P	P	P	=	>	H	H	H	P	P	P	P	P	P	=	=	=	>	H	H	H			Trad. Irri. Sch.	ZIO
Kilimanjaro	=	=	=	=	=	>	H	H			P	P	=	=	=	=	=	>	H	H	P	P	=	=	Modern Irri. Sch.	ZIO
				P	P	P	=	=	>	H	H	H	P	P	P	=	=	=	>	H	H	H			Trad. Irri. Sch.	ZIO
Tanga	=	=	>	H	H	H	P	P	P	=	=	=	>	H	H	H				P	P	P	=	=	Modern Irri. Sch.	ZIO
	P	P	P	P	=	>	H	H	H	P	P	P	=	=	=	>	H	H	H	H	H	H			Trad. Irri. Sch.	ZIO
Morogoro													P	P	=	=	=	=	=	>	H	H	H		Modern Irri. Sch.	ZIO
Pwani														P	P	=	=	=	=	=	>	H	H	H	Modern Irri. Sch.	ZIO
Dar es salaam														P	P	=	=	=	=	=	>	H	H	H	Apply Pwani	
Lindi					P	P	P	P	P	=	=	=	=	=	>	H	H	H	H	H					Apply Mtwara	
	P	=	=	=	>	H	H	H	H	H											P	P	P	P		
Mtwara					P	P	P	P	P	=	=	=	=	=	>	H	H	H	H	H					Wet season	IWRM[1]
	P	=	=	=	>	H	H	H	H	H											P	P	P	P	Dry season	IWRM[1]
Ruvuma	>	H	H				P	P	=	=	=	=	=	>	H	H		P	P	=	=	=	=	=	Rice-Rice	SESA[2]
							P	P	=	=	=	=	=	>	H	H									Rice-Other crop	SESA[2]
Iringa								P	P	P	=	=	=	>	H	H	H	H	H						Modern Irri. Sch.	ZIO
									P	P	P	P	P	P	=	=	>	H	H	H	H	H			Trad. Irri. Sch.	ZIO
Mbeya	>	H	H			P	P	=	=	=	=	=	>	H	H			P	P	=	=	=	=	=	Rice-Rice	SESA[2]
						P	P	=	=	=	=	=	>	H	H										Rice-Other crop	SESA[2]
Singida										P	P	P	=	=	=	>	H	H	H						Modern Irri. Sch.	ZIO
Tabora								P	P	P	=	=	=	>	H	H	H	H	H	H					Modern Irri. Sch.	ZIO
								P	P	P	P	=	=	=	>	H	H	H	H	H					Trad. Irri. Sch.	ZIO
Rukwa									P	P	P	=	=	=	>	H	H	H	H						Modern Irri. Sch.	ZIO
									P	P	P	=	=	=	>	H	H	H	H						Trad. Irri. Sch.	ZIO
Kigoma							P	P	P	P	>	H	H	H	H	H	H								Modern Irri. Sch.	ZIO
							P	P	P	=	>	H	H	H	H	H	H								Trad. Irri. Sch.	ZIO
Shinyanga						P	P	=	=	=	=	=	=	=	>	H	H								Modern Irri. Sch.	ZIO
											P	=	=	=	=	=	=	>	H	H	H				Trad. Irri. Sch.	ZIO
Kagera						P	P	=	=	=	=	=	=	=	>	H	H								Modern Irri. Sch.	ZIO
											P	=	=	=	=	=	=	>	H	H	H				Trad. Irri. Sch.	ZIO
Mwanza					P	P	=	=	=	=	=	=	=	>	H	H									Modern Irri. Sch.	ZIO
										P	=	=	=	=	=	=	>	H	H	H					Trad. Irri. Sch.	ZIO
Mara						P	P	=	=	=	=	=	=	=	>	H	H								Modern Irri. Sch.	ZIO
											P	=	=	=	=	=	=	>	H	H	H				Trad. Irri. Sch.	ZIO
Manyara	H	H			P	P	=	=	=	=	>	H	H							P	P	P	=	>	Mod. (Pangani riv.)	ZIO
							P	P	P	=	=	=	=	=	>	H	H	H	H						Mod. (Duduera riv.)	ZIO
Njombe									P	P	P	P	=	=	=	>	H	H	H	H					Wet season	IWRM[3]
	P	P	=	>	H	H	H	H															P	P	Dry season	IWRM[3]
Katavi									P	P	P	P	=	=	=	=	=	>	H	H	H	H			Wet season	IWRM[4]
	=	=	=	=	=	>	H	H															P	P	Dry season	IWRM[4]
Simiyu					P	P	=	=	=	=	=	=	=	>	H	H									Apply Mwanza	
										P	=	=	=	=	=	=	>	H	H	H						
Geita					P	P	=	=	=	=	=	=	=	>	H	H									Apply Mwanza	
										P	=	=	=	=	=	=	>	H	H	H						
Songwe								P	P	P	P	=	=	=	=	=	>	H	H	H	H	H			Modern Irri. Sch.	ZIO
									P	P	P	=	=	=	=	=	>	H	H	H	H				Trad. Irri. Sch.	ZIO

Note: Land preparation is not included. P: Transplanting, H: Harvesting

IWRM1: Ministry of Water, 2013, "Preparation of an Integrated Water Resources Management and Development Plan for the Ruvuma River and Southern Coast Basin, Component 1: Review and Inventory of Water Use and Demand and Water Resources Assessment Volume 3: Water Demand Assessment"
SESA2: Ministry of Agriculture Food Security and Cooperatives, 2011, "Agricultural Sector Development Programme, Irrigation Development Sub-Component, The Strategic Environmental and Social Assessment (SESA) for the National Irrigation Master Plan 2002 (NIMP2002) and the National Irrigation Policy (NIP), Final SESA Report Volume III: Appendices"
IWRM3: Ministry of Water, 2015, "Preparation of an Integrated Water Resources Management and Development Plan for the Lake Nyasa Basin, Irrigation Sector Water Plan"
IWRM4: Ministry of Water, 2015, "Preparation of an Integrated Water Resources Management and Development Plan for the Lake Tanganyika Basin, Irrigation and Drainage Sector Water Use Plan"
Source: Data from ZIOs and others are summarized by the JICA Project Team.

Table 7.4.5 Model Cropping Patterns of Upland Crops by Region

Region	Sep		Oct		Nov		Dec		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Remarks	Source
Dodoma	H	H											S	S	S	S	S	S	>	H	H	H	H	H	Tomato	FAO[5]
Arusha	H	H	H	H	H								S	S	S	S	=	=	=	=	=	>	H	H	Tomato	ZIO
Kilimanjaro	H	H	H	H	H	H	H	H	H	H	H	H	S	S	S	S	=	=	=	=	=	>	H	H	Tomato	ZIO
Tanga	H	H	H	H	H	H							S	S	=	=	=	=	=	=	=	>	H	H	Tomato	ZIO
Morogoro															S	S	=	=	=	>	H	H	H	H	Tomato	FAO[5]
Pwani															S	S	=	=	=	>	H	H	H	H	Tomato	FAO[5]
Dar es salaam															S	S	=	=	=	>	H	H	H	H	Apply Pwani	
Lindi					S	S	S	S	S	=	=	=	>	H	H	H	H	H							Apply Mtwara	
	H	H	H	H													S	S	S	S	S	=	>	H		
Mtwara					S	S	S	S	S	=	=	=	>	H	H	H	H	H							Vegetables (wet)	IWRM[1]
	H	H	H	H													S	S	S	S	S	=	>	H	Vegetables (dry)	IWRM[1]
Ruvuma					S	S	S	S	S	=	=	=	>	H	H	H	H	H							Apply Mtwara	
	H	H	H	H													S	S	S	S	S	=	>	H		
Iringa	=	=	=	=	=	>	H	H	H	H												S	S	S	Tomato	ZIO
Mbeya	H	H	H	H	H	H	H	H	H				S	S	S	S	S	S	S	S/H	S/H	S/H	S/H	S/H	Tomato	FAO[5]
Singida	H	H													S	S	=	=	=	=	=	>	H	H	Onion	ZIO
Tabora			S	S	S	=	=	>	H	H	H	H													Tomato season 1	ZIO
									S	S	S	=	=	>	H	H	H	H							Tomato season 2	ZIO
															S	S	S	=	=	>	H	H	H	H	Tomato season 3	ZIO
	=	>	H	H	H	H															S	S	S	=	Tomato season 4	ZIO
Rukwa	=	>	H	H	H	H												S	S	S	S	=	=	=	Tomato	ZIO
Kigoma			S	S	S	=	=	>	H	H	H	H													Tomato season 1	ZIO
									S	S	S	=	=	>	H	H	H	H							Tomato season 2	ZIO
															S	S	S	=	=	>	H	H	H	H	Tomato season 3	ZIO
	=	>	H	H	H	H															S	S	S	=	Tomato season 4	ZIO
Shinyanga	H	H	H	H	H	H	H	H					S	S	S	S	S	S	S	S/H	S/H	S/H	H	H	Tomato	FAO[5]
Kagera																	S	S	=	=	=	=	>	H	Apply Mwanza	
Mwanza																	S	S	=	=	=	=	>	H	Tomato	FAO[5]
Mara																	S	S	=	=	=	=	>	H	Apply Mwanza	
Manyara	H	H											S	S	S	S	S	S	>	H	H	H	H	H	Tomato	FAO[5]
Njombe	=	>	H	H	H	H	S	S	S	S	=	=	=	=	=	=	=	>	H	H	S	S	=	=	Tomato	ZIO
Katavi													S	S	S	S	=	>	H	H	H	H			Vegetables (wet)	IWRM[4]
	S	S	H	H	H	H																	S	S	Vegetables (dry)	IWRM[4]
Simiyu																	S	S	=	=	=	>	H	H	Apply Mwanza	
Geita																	S	S	=	=	=	>	H	H	Apply Mwanza	
Songwe	H	H	H	H													S	S	S	S	S	S	H	H	Vegetables (dry)	IWRM[6]

Note: S: Seeding, H: Harvesting
FAO5: http://www.fao.org/agriculture/seed/cropcalendar/welcome.do, Accessed on 18 August 2017
IWRM6: Ministry of Water, 2015, "Water Sector Development Program, Lake Rukwa Basin IWRMD Plan: Final Interim Report II, Volume I: Water Demand Projections (2015-2035)"
Source: Data from ZIOs and others are summarized by the JICA Project Team.

7.4.4 Irrigation Water Requirement

The diversion water requirements for paddy and upland crops are estimated by the following equations:

Paddy

NWR = ETo x Kc + SAT + PERC – Re

DWR = NWR / IE

Upland Crop

NWR = ETo x Kc – Re

DWR = NWR / IE

Where, NWR: Net water requirement (mm/month)
DWR: Diversion water requirement (mm/month)
ETo: Reference crop evapotranspiration (mm/month)
Kc: Crop coefficient
SAT: Saturation water requirement (mm/month)
PERC: Percolation and seepage losses (mm/month)
Re: Effective rainfall (mm/month)
IE: Irrigation efficiency (%)

(1) Reference Crop Evapotranspiration (ETo)

FAO recommends to apply the ETo using the most widely used FAO Penman-Montieth (FAO PM) method for water requirement calculation. However, the method requires various reliable meteorological data such as solar radiation, air temperature, relative humidity, and windspeed. Unfortunately, the data can be obtained from very limited number of meteorological stations.

On the website, the "Global Potential Evapo-Transpiration Geospatial Dataset" is available on a global scale for 30 years period. According to the test result conducted by CGIAR-CSI as provider, the error between the dataset and FAO PM is acceptably small. Taking into consideration all the above conditions, the JICA Project Team utilizes this potential data as ETo for the calculation.

(2) Crop Coefficient

Kc is a dimensionless coefficient integrated the effect of both crop transpiration and soil evaporation. In this project, Kc is determined for the four distinct growth stages; i.e., i) initial, ii) development, iii) mid and iv) late stage in reference to the FAO Irrigation and Drainage Paper No. 24. For the sake of irrigation water requirement calculation, rice and tomato as representing upland crops are selected. Kc values and corresponding growing stages of selected crops are summarized in Table 7.4.6.

Table 7.4.6 Kc Values and Corresponding Growing Stages

Crop	Growing Period (days)	Land Preparation	Initial Stage	Crop Development Stage	Mid-season Stage	Late Season Stage
Paddy (Rice)	120	30	20	30	40	30
Kc of Paddy			1.05	1.10	1.20	0.80
Tomato	120		20	30	40	30
Kc of Tomato			0.6	0.8	1.15	0.70

Source: JICA Project Team

(3) Saturation Water Requirement (SAT)

Saturation water requirement (SAT), known as land preparation water requirement in the paddy field,

means the amount of water required to saturate soil for puddling of paddy field. The water requirement for SAT varies depending on soil-water condition. In this project, SAT is assumed to be 200 mm.

(4) Percolation and Seepage Loss (PERC)

Percolation and seepage losses (PERC) in paddy field vary highly depending on soil conditions. In this calculation, PERC is assumed to be 3 mm/day on an average.

(5) Effective Rainfall (Re)

Precipitation received by the field is not always fully utilized for crops. Some amount may be wasted after long rainfall. It may be difficult to evaluate the useful amount of precipitation from monthly data. In this situation, the USDA Soil Conservation Service submitted the following method and is widely accepted. Therefore, the project applies this method for calculation.

When the monthly precipitation is excess to 75 mm:

$Re = 0.8 \times R - 25$

When the monthly precipitation is less than 75 mm:

$Re = 0.6 \times R - 10$

Where, Re: Effective rainfall (mm/month)
R: Monthly rainfall (mm)

As for rainfall data, the project collected the dataset of "Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS ver.2)" from the Climate Hazards Group (CHG). The data covers the whole Tanzania for more than 30 years. Effective rainfall is calculated based on the CHIRPS ver.2 dataset.

(6) Net Water Requirement

Net water requirement calculation begins with assigning crop coefficient in each growing stage to a cropping pattern of the crop calendar prepared for each region. Calculation of the net water requirement is carried out for paddy and upland crop and for wet and dry seasons, separately.

In this stage of calculation, adjusted crop coefficients, which are matching the crop calendar, can be obtained for all 26 regions. Sample calculation sheet of this calculation stage is attached in Attachment-7.4.1 (1/2).

And then, the adjusted crop coefficients are proportionally distributed to sub-basins according to the area ratio of regions within the sub-basins because the water is allocated to each sub-basin. In each sub-basin, a combined crop coefficient of distributed coefficients is used for calculation of the net water requirement. Attachment-7.4.1 (2/2) shows a sample calculation of net water requirement.

(7) Irrigation Efficiency

Irrigation efficiency can be obtained multiplying the main canal, branch canal, distribution canal, tertiary canal and field application efficiencies.

$IE = Em \times Eb \times Ed \times Et \times FA$

Where, IE: Irrigation Efficiency
Em: Efficiency of Main Canal

Eb: Efficiency of Branch Canal

Ed: Efficiency of Distribution Canal

Et: Efficiency of Tertiary Canal

FA: Efficiency of Field Application

Table 7.4.7 and Table 7.4.8 show the common values of aforesaid efficiencies.

Table 7.4.7 Estimated Irrigation Efficiency for Lowland Paddy

Lowland Paddy	Traditional Irrigation (Unlined canal)						Improved/New Irrigation (Lined canal)					
	Em	Eb	Ed	Et	FA	IE	Em	Eb	Ed	Et	FA	IE
Large Scheme	0.70	0.70	0.70	0.70	0.85	0.20	0.90	0.90	0.90	0.80	0.85	0.50
Medium Scheme	0.70	0.70	-	0.70	0.85	0.29	0.90	0.90	-	0.80	0.85	0.55
Small Scheme	0.70	-	-	0.70	0.85	0.42	0.90	-	-	0.80	0.85	0.61

Source: JICA Project Team

Table 7.4.8 Estimated Irrigation Efficiency for Upland Crop

Upland Crop	Traditional Irrigation (Unlined canal)						Improved/New Irrigation (Lined canal)					
	Em	Eb	Ed	Et	FA	IE	Em	Eb	Ed	Et	FA	IE
Large Scheme	0.70	0.70	0.70	0.70	0.70	0.17	0.90	0.90	0.90	0.80	0.70	0.41
Medium Scheme	0.70	0.70	-	0.70	0.70	0.24	0.90	0.90	-	0.80	0.70	0.45
Small Scheme	0.70	-	-	0.70	0.70	0.34	0.90	-	-	0.80	0.70	0.50
Dip Scheme	-	-	-	-	-	-	0.95	-	-	-	0.90	0.86
Sprinkler	-	-	-	-	-	-	0.95	-	-	-	0.80	0.76

Source: JICA Project Team

In this project, irrigation efficiencies of the new/improved and traditional schemes are estimated at 50% and 30%, respectively.

7.4.5 Irrigable Area by Allocated Water

Estimate of irrigable area by allocated water in each sub-basin is carried out by the following equation:

$$IA = AWV / DWR / 1{,}000\ (mm/m) / 10{,}000\ (m^2/ha)$$

Where, IA: Irrigable Area (ha)

AWV: Allocated Water Volume (MCM/month)

DWR: Diversion Water Requirement (mm/month)

As expressed in Section 7.4.1, DWR varies greatly depending on Kc and IE because ETo is constant. If the paddy cultivation area, where Kc value is large and covers a large portion, DWR will increase and consequently, the irrigation area will decrease. If IE is low, DWR will also increase and the irrigation area will be smaller.

(1) Proportion of Paddy Area

For basins, where a proportion of paddy area is described in the existing reports, the described proportion is applied to the calculation. The basins, where proportion is not shown, the proportion is assumed to be 60%.

(2) Irrigation Efficiency

With regard to irrigation efficiency, various values are applied in the existing reports. Some reports use the low efficiency of unlined canal as an overall efficiency, and in some reports, they consider increase of the efficiency by improvement of irrigation facilities and farmers' trainings.

Judging from the distribution by size of irrigation and the increased number of lining canals expected in the future stage, irrigation efficiencies applied in the existing reports may be very conservative estimates.

Table 7.4.9 summarizes the proportions and irrigation efficiencies presented in the existing reports.

Table 7.4.9 Summary Table for Irrigation Efficiency and Proportion to Crop Area

River Basin	Proportion	Irrigation Efficiency
Pangani	Paddy: in the range of 2.6% -100% in nine catchment areas Maize: 0–80%	Year: 2015 — Rice: 25% — Vegetables: 25% Year: 2025 — Rice: 30% — Vegetables: 40% Year: 2035 — Rice: 30% — Vegetables: 40%
Wami/Ruvu	Paddy wet season: 0% -78% in five regions	Year: 2015 — Overall: 25% Year: 2025 — Overall: 30% Year: 2035 — Overall: 30%
Rufiji	No description	No description
Ruvuma	Ruvuma: Rice wet 55%, Rice dry 50% in 2035	Overall: 27%
	Mtwara, Lindi: Rice wet 65%, Rice dry 57% in 2035	Overall: 27%
Lake Nyasa	Rice dry: 30% in 2015, 40% in 2025, 50% in 2035	Overall: 25%
Lake Rukwa	No description	No description
Lake Tanganyika	Rice: 60–80%	Overall: 25%
Lake Victoria	Rice: 67%	Global: 50%
Internal Drainage	No description	Lined canal: 50% Unlined canal: 36%

Source: Existing Study reports

7.4.6 Analysis of Irrigable Area and Water Balance

Table 7.4.10 shows the comparison between the estimated result of irrigable area (NIMP2018) calculation by the JICA Project Team based on the allocated water for irrigation determined in Section 7.2.2 and irrigable area projected by the existing studies (IWRMDP).

Table 7.4.10 Comparison Table on Irrigable Area between the Existing Studies and NIMP2018 Estimate (ha)

Basin	2015		2025		2035	
	IWRMDP	NIMP2018	IWRMDP	NIMP2018	IWRMDP	NIMP2018
Pangani	84,473	116,260	89,483	128,430	94,493	111,800
Wami/Ruvu	29,919	32,250	45,039	50,560	57,522	70,460
Rufiji	209,500	225,920	231,400	257,920	319,100	430,470
Ruvuma	12,952	12,520	22,863	29,170	33,338	57,880
Lake Nyasa	5,580	15,910	10,590	32,700	15,590	49,850
Lake Rukwa	28,944	28,970	45,373	64,350	59,637	99,030
Lake Tanganyika	6,501	12,390	14,099	34,510	21,799	77,000
Lake Victoria	40,761	11,010	131,560	27,460	261,288	45,140
Internal Drainage	69,638	21,000	126,647	46,410	183,655	64,070
Total	488,268	476,230	717,054	671,510	1,046,422	1,016,700

Source: JICA Project T eam

(1) Analysis of Each River Basin

The JICA Project Team compares the results of the calculation with the estimates of the existing studies and are shown as follows:

Table 7.4.11 Results of Irrigable Area Analysis in Each River Basin

River Basin	Result of Water Balance Calculation
Pangani	Since the project calculation followed the area proportion of the existing study, difference of area is small. Decrease in area in 2035 happens due to decrease in the allocated water amount.
Wami/Ruvu	Difference of total area is small. However, in the sub-basin, there are large gaps which may be attributed to the difference of the crop calendar applied. In the Upper Ruvu sub-basin, irrigable area is about 50% of the existing study estimate. This problem is caused by insufficient water allocation in April. If more water would be allocated in April, it will be possible to expand irrigation area.
Rufiji	The sub-basins will receive sufficient water except the Kilombero. If water allocation in December would be adjusted, the area would be expanded.
Ruvuma	It is considered that sufficient water amount is generally reserved except the Upper Middle Ruvu sub-basin.
Lake Nyasa	This basin is considered to have sufficient water.
Lake Rukwa	In the Songwe River sub-basin, the calculated area is only half of the estimated area by the existing study. Unit diversion water requirement of the sub-basin is calculated to be 0.59 l/sec/ha. Judging from the small amount of unit water, there is a possibility that the planned area was an overestimate. Water allocation for other sub-basins is sufficient.
Lake Tanganyika	This basin is considered to have sufficient water.
Lake Victoria	In this basin, allocated water by the existing study is short significantly. Allocated unit water is estimated at 0.28 l/sec/ha. In the next study stage, it is necessary to request sufficient and necessary water for irrigation.
Internal Drainage	The amount of water allocated to this basin is absolutely short. Unit water allocated is estimated at 0.62 l/sec/ha. Probably, in the existing study, they assumed that most of the area was upland crop with high irrigation efficiency system.

Source: JICA Project team

(2) Results of Analysis

(a) Proportion of Crop and Total Irrigable Area

Irrigable area is highly affected by the proportion of cultivation areas between crops with high water requirement and crops with relatively low water requirement. In this study, paddy is selected as a representative crop with high water requirement, and tomato is chosen as a representative upland crop with a relatively low water requirement.

If the proportion of paddy cultivation area is set large, even if farmers would divert crops from low requirement ones to relatively high requirement ones in the future, the possibility of water shortage will be low. On the contrary, if it is set low, there would be a possibility to create a water shortage problem, which might cause conflicts among farmers.

Taking all of the above into consideration, the JICA Project Team sets the cultivation area of paddy at 60% and that of upland crop at 40% for the river basins where the proportion of crop areas is unclearly set in IWRMDP studies.

As a result of the calculation with the condition of crop area proportion, irrigable area would be 1,017,000 ha in 2035, and irrigable area would be 672,000 ha in 2025, respectively. These irrigable areas are almost corresponding to the estimated irrigable area of IWRMDP. Incidentally, if the proportion of paddy area is set at 70%, the irrigable area would be reduced to 850,000 ha.

(b) Construction of Irrigation Ponds (Small Dams)

Locally occurred flash floods are mostly not used in irrigation schemes along seasonal rivers, and unused water finally flows into the Indian Ocean. In order to utilize the water from flash floods, construction of irrigation ponds (small dams) would be useful. They would contribute a stable irrigation water supply, and it would be expected to expand the irrigation area.

At present, NIRC keeps a list of approximately 420 dams including large-scale dams, and a total of the potential irrigation areas reaches about 300,000 ha to 400,000 ha.

In the promotion of dam construction, however, it would be necessary to pay attention to the serious problem of sedimentation. For sustainable water use, development of management mechanism to remove sedimentation from reservoir area is a big issue.

(c) Irrigation Area in Lake Victoria Basin

Since the IWRMDP study has not yet been completed in the Lake Victoria basin, the allocated water amount is provisionally estimated based on the results of the report published by the Lake Victoria Basin Commission. As mentioned in the previous section, the estimated amount of irrigation demand per unit area in that report is extremely low.

When the scheduled IWRMDP study would be conducted, it can be expected that appropriate water for irrigation sector would be allocated. Regarding lake side districts, where current lake water use is not progressing, irrigation directly using lake water would be expected to expand to 28,000 ha or more as presented in Section 8.5.4 of this report.

(d) Improvement of Irrigation Efficiency

As a result of the irrigation area calculation, irrigable area would increase by 10,000 ha, if the irrigation efficiency would be improved by 1%. Therefore, continuous efforts to improve irrigation efficiency through canal linings and water management trainings would be crucial.

(e) Proportion of Improved Scheme Area

Trial calculation shows that as the proportion of improvement of traditional schemes' area increases by 10%, irrigable area also increases by approximately 25,000 ha because of improved irrigation efficiency. In order to increase irrigation area, it is necessary to continue making efforts to improve irrigation facilities.

7.5 Irrigation Schemes Proposed for Development

7.5.1 Stage of District Priority Analysis

As a first process, after scoring each scheme based on the scheme data and priority given by each district and NIRC/ZIOs, priority order within a district is decided. And then, schemes are selected by allocated water by IWRMDP studies. The following items explain these processes:

Process 1: Scoring of Irrigation schemes

In this step, the JICA Project Team scores the items concerning physical features of schemes and items

related to development plan of local governments. The following list itemizes the scored items.

- Priority given by NIRC/Zonal Irrigation Office and District
- Type of water source
- Type of required works for development
- Land suitability for main crops
- Main market
- Maturity of scheme (preparation of scheme documents such as D/D and F/S reports)
- Annual average rainfall amount

Process 2: Selection of Schemes by Limitation of Allocated Water Amount (2025)

Sub-Process 2-1: Convert Allocated Water to Irrigable Area

At first, the water amount in each river basin allocated by IWRMDP study for the year of 2025 is converted to irrigation area in consideration of irrigation water requirement. After this, the irrigation area in each river basin is distributed into the irrigation area of each district depending on the proportion of river basin areas which belong to the district territory.

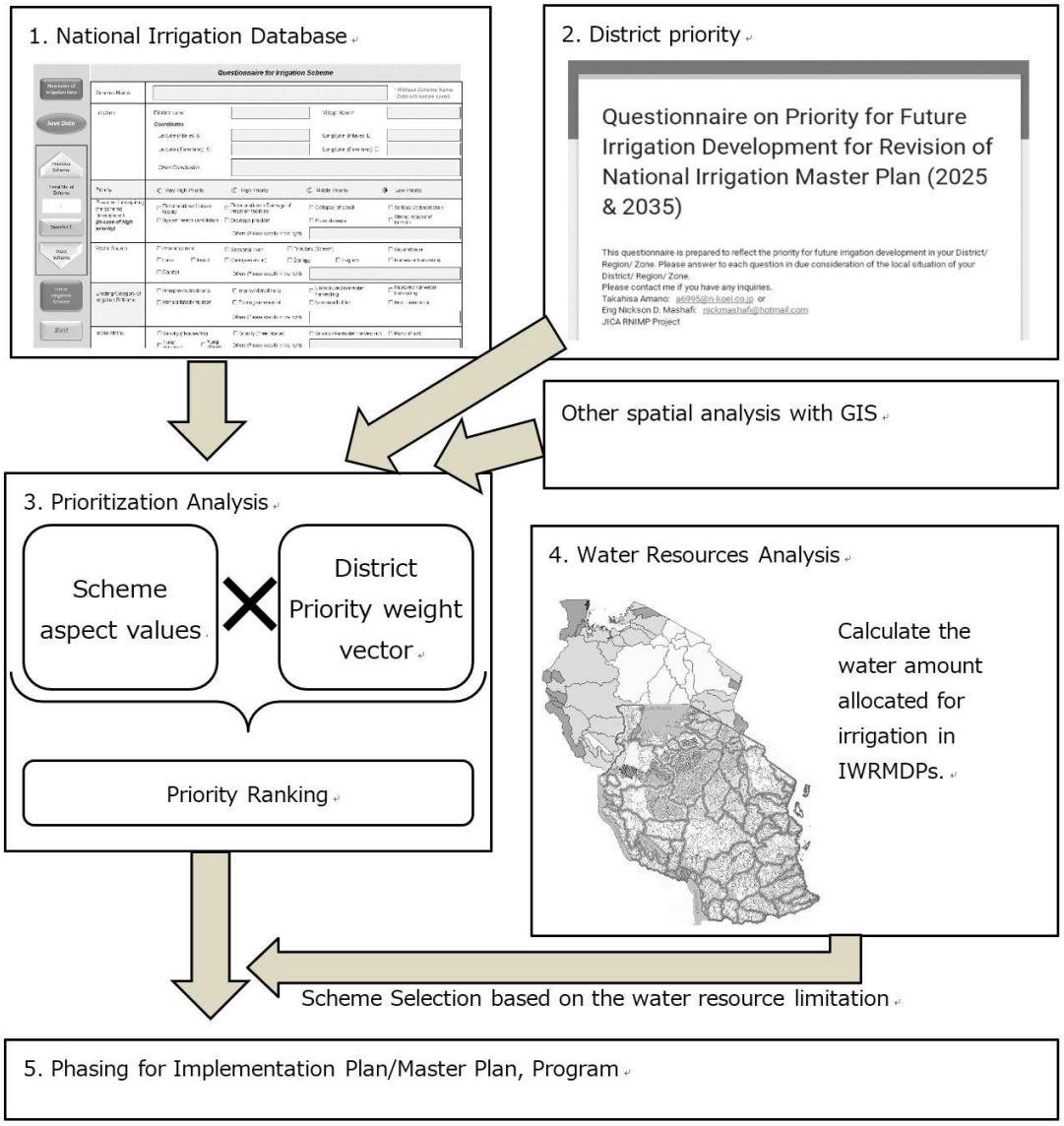
Sub-Process 2-2: Selection of Priority Schemes

In each district, scored irrigation schemes are sorted in descending order of the total scores. The potential irrigation areas of sorted schemes are summed up until reaching the upper limit of the irrigable area distributed to each district. The schemes within the range of upper limit are selected as priority schemes. In this selection process, schemes utilizing ponds (small dams), groundwater, and lake water, which would not depend on allocated water, are selected among the high scored schemes in descending order separately from the aforementioned process.

Process 3: Selection of Schemes by Limitation of Allocated Water Amount (2035)

Phase 2 priority schemes selection uses allocated water for the year of 2035. The selection procedure is the same as Process 2.

Figure 7.5.1 shows the analysis flow of the “District Priority Analysis Stage”.



Source: JICA Project Team

Figure 7.5.1 Analysis Flow Chart for Scheme Selection

7.5.2 Stage of Development Phases

Due to the large number of prioritized irrigation schemes, it is difficult to implement all the irrigation projects at once, therefore, it is better to classify the irrigation schemes development into two phases.

Phase 1 schemes are high priority ones for implementation by 2025. Phase 2 schemes are priority ones to be implemented by 2035. Schemes which require rather long preparation period, are included in Phase 2.

(1) Development Plan of Priority Irrigation Schemes

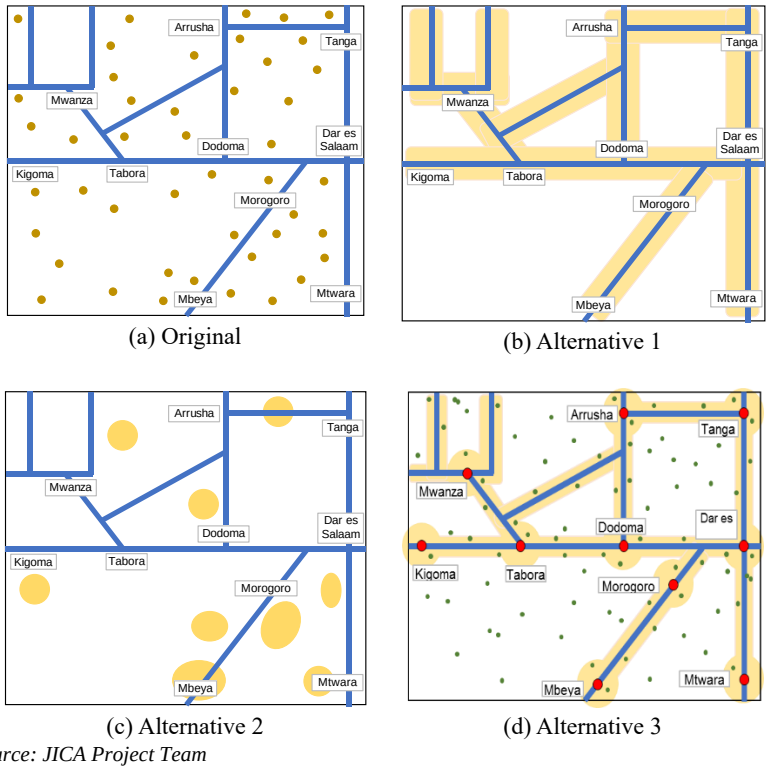
As shown in Table 7.5.1 and Figure 7.5.2, there are four plans to consider which irrigation schemes will be selected in Phase 1 and which of them will be in Phase 2.

Table 7.5.1 Phasing Development Plan of Priority Irrigation Schemes

Plan	Phasing Concept	Merit	Demerit
Original	Focus on irrigation potential:	It is most reasonable from	Low cooperation with

Plan	Phasing Concept	Merit	Demerit
	Irrigation schemes are classified into Phase 1 and Phase 2 according to the development priority order.	the viewpoint of irrigation development potential.	agricultural development.
Alternative 1	Focus on market access: Irrigation schemes along major trunk roads that make up the economic corridor are classified into Phase 1, and others are Phase 2.	High cooperation with the ASDP2, which aims to develop a value chain. It is possible to develop nationwide to some extent.	The priority of the irrigation scheme located at remote places is relatively low.
Alternative 2	Focus on regional cluster: Irrigation scheme is located within the cluster specified in ASDP2, is classified into Phase 1, and others in Phase 2.	High affinity with ASDP2 aiming for cluster agricultural development.	It is regionally concentrated and there is a high possibility that development imbalance between regions will occur.
Alternative 3	Combine distance from major cities and towns, and market access so that irrigation schemes located within specified threshold distance will be conducted in Phase 1 and others in Phase 2	It will focus on irrigation schemes that are close to the major cities and towns as well as major access road for marketing purpose.	It will reduce the potential of selecting irrigation schemes located in villages and within minor roads.

Source: JICA Project Team



(a) Original (b) Alternative 1

(c) Alternative 2 (d) Alternative 3

Source: JICA Project Team

Figure 7.5.2 Conceptual Images of Selecting Irrigation Schemes for Phase 1

(2) Classification of Irrigation Scheme Development

The original plan suggests selecting the top 40% of the highest priority schemes to be implemented in Phase 1 and the remaining priority schemes in Phase 2. The drawback of this plan is that although some of the priority schemes are located within the highest priority, it may be less favourable in terms of agriculture development due to, for example, far access road or due to the lack of support ASDP2 of developing a value chain.

The Alternative 1 Plan suggests selecting within Phase 1 the priority schemes which are located within a specific distance, 30 km distance for example, from the trunk roads, and other irrigation schemes in

Phase 2. Although this plan assists ASDP2, its disadvantage is that it evaluates only one aspect of development by considering transportation as the main influencing factor.

The Alternative 2 Plan proposes to select some specific numbers of priority schemes within the regions as clusters, however, there will be unbalance among the regions for the number of irrigation schemes selected in each region. Big regions will have more irrigation schemes compared with the small regions.

The JICA Project Team suggests implementing Alternative 3 Plan, which is a hybrid plan of alternatives 1 and 2. It considers the distance from major cities and towns and the distance from trunk roads. By identifying a threshold distances from trunk roads as well as cities and towns it will support the idea of the value chain suggested in ASDP2 and helps making an economic corridor that serves not only the domestic markets, but also the international markets.

(3) Selection Procedure of Priority Schemes in Stage of Development Phases

Process 4: Selection of Phase 1 Priority Schemes

In conformity with the ASDP2, schemes are selected applying the Alternative 3 Classification Criteria which is discussed in Section 7.5.2 (2) of this report. In addition to these schemes, high priority schemes in remote areas are also selected from the social aspects.

Process 5: Selection of Phase 2 Priority Schemes

Since the selected schemes in Process 3 includes the Phase 1 priority schemes, Phase 2 priority schemes are further selected by deducting the Phase 1 priority schemes from the selected schemes in Process 3.

7.5.3 Scheme Scoring

In the course of scoring procedure, the JICA Project Team selected items to be evaluated and scored as many as possible as a first step. After verifying whether the result matches the common understanding of the schemes through trial scoring, items were limited to 7.

(1) Scoring of Selected Items

The items finally adopted for scheme scoring are as follows:

Table 7.5.2 Selected Items and Weights for Scheme Scoring

Category		Weight	Items and Score								
Priority	NIRC/ ZIO	0.75	Priority	Very High	High	Medium	Low				
			Score	10.0	7.0	4.0	1.0				
	LGA	0.25	Priority	Very High	High	Medium	Low				
			Score	10.0	7.0	4.0	1.0				
Water Source		1.0	Source	Perennial R.	Seasonal R.	Stream	Groundwater	Lake	Pond	Dam	Spring
			Score	7.75	5.50	5.50	1.00	1.00	10.00	10.00	3.25
Type of Works		1.0	Type	Upgrading	Rehabilitation	Completion	New Dev.				
			Score	(Variable depending on the results of the questionnaire survey. The scores are 10.0, 7.0, 4.0 or 1.0)							
Land Suitability	Paddy	0.7 or 0.3	Rating	Very High	High	Medium	Low				
			Score	10.0	7.0	4.0	1.0				
	Upland Crops	0.7 or 0.3	Rating	Very High	High	Medium	Low				
			Score	10.0	7.0	4.0	1.0				
Main Market		1.0	Location	Local	District	Region	National	Export			
			Score	10.0	(Variable depending on the result of Questionnaire survey. The scores are 7.75, 5.50, 3.25 or 1.0)						

Category	Weight	Items and Score								
Maturity	1.0	Level	D/D study	F/S study	Pre-F/S	Reconnaissance				
		Score	10.0	7.0	4.0	1.0				
Rainfall (mm)	1.0	Amount	< 600	< 800	< 1,200	< 2,000	> 2,000			
		Score	3.25	7.75	10.00	5.50	1.00			

Source: JICA Project Team

Priority

Since the number of engineers or technicians in many districts is insufficient and the experienced ones are also lacking, it seems that the staffs do not always understand well their assigned schemes. With this reason, this study gives higher weight to the priority given by NIRC/ZIOs.

Type of Water Source

As for the type of water source, this study applies the nationwide unified weighted values.

Type of Works

Regarding the type of works, score is calculated comparing the scheme data and the priorities answered to questionnaires by district, region, and zone. When the data of a scheme matches the priorities, the score of the priority type of works is applied.

Main Market

With conformity to the national policy, highest weight is given to the local market. As for other markets, scoring uses the result of questionnaire survey carried out targeting districts and regions. So, the weights vary from district to district.

Land Suitability

Concerning land suitability, the GIS study evaluated the suitability through various data and classified it into four categories for paddy and upland crops, respectively. Score of the land suitability is a summed-up, one for paddy and one for upland crops. If the main crop of the scheme is paddy, the weight will be 0.7 and weight of upland will be 0.3. On the contrary, in the case that main crop is upland crop, weight for upland will be 0.7 and weight for paddy will be 0.3.

Maturity of Scheme (F/S)

For implementation of schemes in the early stage, existence of documents such as detailed design reports an/or feasibility reports is essential. From this viewpoint, the higher score will be given to schemes with necessary documents.

Rainfall

The higher weight is given to the schemes located in the range from 800 mm/year to 1,200 mm/year, where schemes would be able to utilize irrigation water efficiently. The rainfall range from 600 mm/year to 800 mm/year follows. Since the schemes with more than 2,000 mm/year would not require irrigation water supply, this study gives lowest weight of 1 or 0.

(2) Total Score Calculation

If the scheme scores the full mark with all the seven items, it will be 80 points as shown in the table below.

The bottom row of the table below shows the original score converted into 100 points, which can be obtained multiplying original score by 1.25. This study uses the converted full score of 100.

Table 7.5.3 Weight Table for Total Scoring

	Priority		Water Source	Type of Work	Land Suitability	Main Market	Maturity (Study)	Ave. Rainfall	Total
	NIRC/ Zone	LGA							
Score	20		10	10	10	10	10	10	80
	15	5							
Final Score	18.75	6.25	12.5	12.5	12.5	12.5	12.5	12.5	100

Source: JICA Project Team

7.5.4 Result of Scheme Selection

(1) Selected Schemes in Each Selection Process

The following explains the selection process of the priority schemes with the number of selected schemes.

District Priority Stage

Process 1: 2947 Schemes lacking the information were scored low.

Process 2: 918 The total number of schemes was 918, which contained 893 schemes selected by allocated water and 25 schemes with high importance.

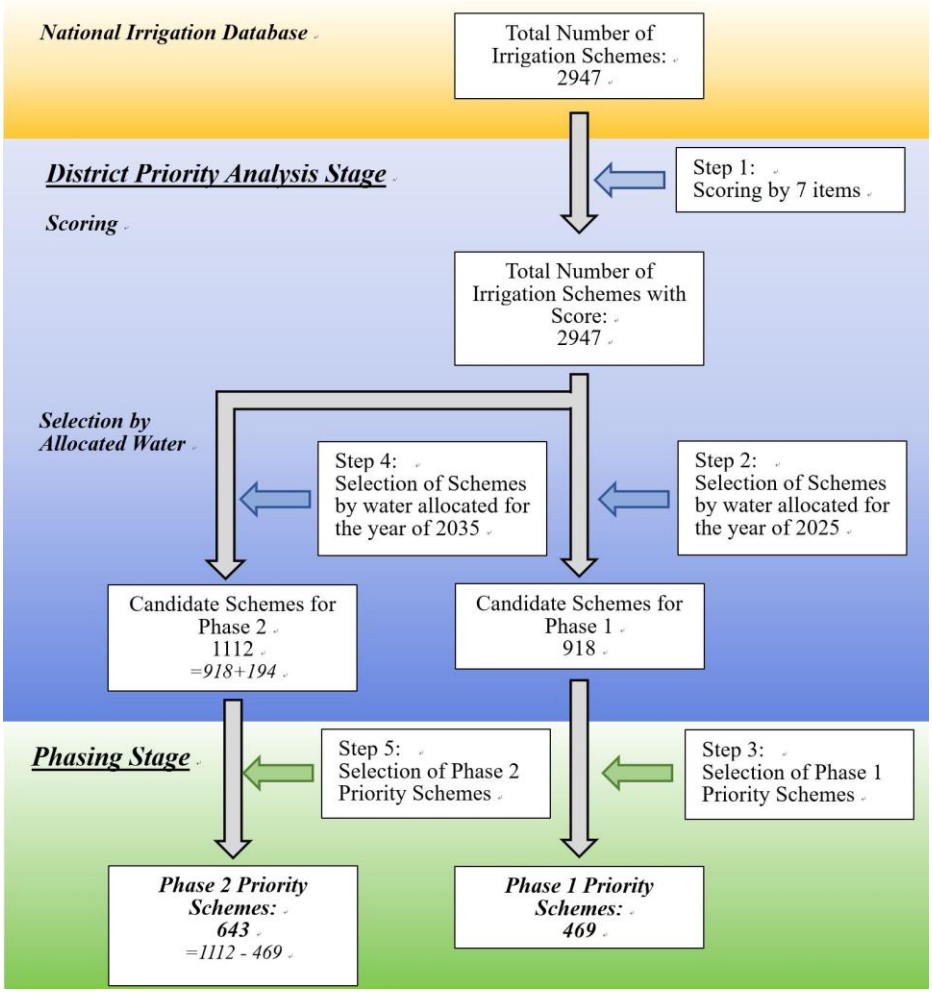
Process 3: 1112 The total number includes Phase 1 priority schemes, schemes which were not selected in Process 2, and new schemes with water allocation for 2035.

Stage of Development Phases

Process 4: 469 As a result of priority scheme selection for Phase 1, 469 schemes with total incremental development area of 248,000 ha were selected.

Process 5: 643 The number is calculated by deducting 469 priority schemes from 1,112 selected schemes in Process 3. Total estimated incremental area of these schemes is 312,000 ha.

The following Figure 7.5.3 visualizes the scheme selection process with selected number of irrigation schemes.



Source: JICA Project Team

Figure 7.5.3 Selection of Priority Irrigation Schemes

The lists of selected Phase 1 priority schemes, Phase 1 related priority dams, and Phase 2 priority schemes are compiled in Attachment-7.5.1.

(2) Selected Irrigation Schemes

New development priority schemes with land reclamation are summarised in Table 7.5.4.

Table 7.5.4 New Development Schemes by Phase and Size

Development Phase	Small Scale		Medium Scale		Large Scale		Total	
	No. of schemes	Irr. Area (ha)	No. of schemes	Irr. Area (ha)	No. of schemes	Irr. Area (ha)	No. of schemes	Irr. Area (ha)
Phase 1	123	15,372	63	43,366	22	78,190	208	136,928
Phase 2	216	34,624	69	49,932	27	85,842	312	170,398
Total	339	49,996	132	93,298	49	164,032	520	307,326

Sources: JICA Project Team

Moreover, priority schemes to improve irrigation efficiency including expansion of irrigation area are tabulated in the following Table 7.5.5.

Table 7.5.5 Priority Improvement Schemes by Phase and Size

Development Phase	Small Scale			Medium Scale			Large Scale			Total		
	No.	Imp area	Exp area	No.	Imp area	Exp area	No.	Imp area	Exp area	No.	Imp area	Exp area
Phase 1	179	27,628	21,114	63	30,127	34,760	19	38,524	55,318	261	96,279	111,192
Phase 2	225	35,680	21,030	87	39,881	44,613	19	17,988	76,069	331	93,549	141,712
Total	404	63,308	42,144	150	70,008	79,373	38	56,512	131,387	592	189,828	252,904

Note: "No." means number of schemes, "Imp area" means improved area (ha), "Exp area" means expansion area (ha)
Sources: JICA Project Team

Table 7.5.6 shows the priority irrigation schemes by water source. In this table, schemes which have several water sources are categorized in one as "multiple water source" because of too many varieties of combinations of water sources.

Table 7.5.6 Priority Irrigation Scheme by Water Source

	Single Water Source							Multiple Water Source	Others	Total
Development Phase	Perennial River	Seasonal River	Dam	Ground water	Lake	Spring	RWH			
Phase 1	253 188,569	41 20,703	31 22,550	9 4,600	14 5,683	15 4,509	10 5,330	83 80,685	13 11,770	469 344,399
Phase 2	311 187,671	88 61,049	42 15,534	10 8,280	4 666	18 11,680	14 13,516	106 64,928	50 42,335	643 405,659
Total	564 376,240	129 81,752	73 38,084	19 12,880	18 6,349	33 16,189	24 18,846	189 145,613	63 54,105	1,112 750,058

Note: the number in the upper row shows the number of schemes and the lower number shows the total irrigation area (ha).
RWH stands for "Rain water harvesting technology".
Sources: JICA Project Team