ルワンダ共和国
農業動物資源省

ルワンダ国
東部県ンゴマ郡灌漑開発基礎情報収集調査
ファイナルレポート

（データ集）

平成 24 年 7 月
（2012 年）

独立行政法人
国際協力機構(JICA)

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<u>　資　料　</u>

資料-1．ルワンダ国における農業開発に関する質問票

Questionnaire on the MINAGRI's policy regarding irrigation development

Co-manager of JICA survey team on Ngoma-22 scheme

Haruo Hiki (12th of April, 2012)

[Interlocutor; Mr. Jean Claude, a member of Irrigation and Mechanization Task Force]

1. Total plan for irrigation development

Please let us know the total plan for irrigation development scheme by scheme, and also their concepts and number of projects.

Scheme	Concept	Number of projects in plan	Number of projects under studying or construction
LWH project	・Land husbandry ・Water harvesting ・Hillside irrigation	About 10 projects	About 4 projects
RSSP project	・Paddy field developments on marshlands	Phase-3 (20 projects, 7,000ha)	Phase-2 (7 projects, 3.100 ha) Phase-1; Infrastructure
Pumping Project	Pumping up irrigation water from a lake	In plan, 5,000 ha Procurement; 1,700 ha Others; 1,000 ha	On going; 2 projects, 1,000 ha

2. LWH project

(1) Land Husbandry

・ Definition of Land Husbandry

We have been understanding that Land Husbandry is the countermeasure against erosion, that is to say, the method to prevent the top soil from being eroded by rain water, and is classified into three categories composed of the ditch along the counter line, the progressive terracing and the radical terracing. But nowadays, it seems that the economical effectiveness of the radical terracing is emphasized and the word 'Land Husbandry' means the radical terracing.

① Is this recognition correct? Does MINAGRI intend to extend the radical terracing to the whole farmlands on the hill slopes nationwide?

No, not correct. The radical terracing is only a part of the land husbandry.

MINAGRI intends to extend the land husbandry nationwide not the radical terracing.

② Is there a formal paper that indicates the change of definition of Land Husbandry?

No.

③ If there is a study result in terms of the economical effectiveness of the radical terracing, please provide us with that result.

I have ever seen such papers, but I don't have here. Please ask Mr. Dan.

・ Construction works of the radical terracing

① Is construction works of the radical terracing carried out based on design drawings?

Yes.

② Is the designing of radical terracing carried out under consideration of land features and land owner ships? To which is the priority given?

Yes, it is and the priority is given to land features.

③ In the radical terracing works, the plow layer (cultivated soil) must be scraped off and dumped temporally before the land shaping is started. Is this process considered in the construction works of radical terracing? (As far as our inquiry survey on the radical terracing in Ngoma District where the construction works was done by prisoners or non-experienced workers regardless of this process, most of the farmers' assessments to the radical terracing were negative.)

There are examples constructed poorly but in many areas the land husbandries have been constructed successfully and have brought productivity improvement and large benefit.

④ Please introduce us the area where the perfect radical terracing works were constructed.
In Byumba, land husbandries have been constructed successfully since 20 years ago. And in Karongi the plantation of Irish potatoes on the terraced farmlands has gained a big success.

(2) Hillside irrigation

・ Inequality in opportunities to the benefits brought by irrigation
In LWH projects, the scale of command area is some one hundred hectares, which is at most only several percent of the farmlands on the surrounding hill slopes. This means that the farmers who can receive the benefits of irrigation are limited to be several percent of the neighboring farmers. We are afraid that our project brings up economical inequality that might cause discords and conflicts among villagers. Does MINAGRI have any idea to avoid such a situation?
Nationwide, the area to which the priority of the project implementation is given is decided based on the necessity the concerned area has to that project. At the project site, the project affects not only the direct beneficiaries but also common villagers indirectly and contributes to the improvement of livelihood of whole villagers. Moreover, other projects are also implemented in collaboration with the irrigation project. Therefore, the situation mentioned above would not occur.

・ Project cost and the philosophy of MINAGRI
We have already recognized through the results of some feasibility studies that the cost of LWH projects ,US$/ha, is about three to four times higher than the RSSP projects that were/have been constructed with the unit cost of some thousand US$ per hectare. Whereas, MINAGRI is going to push forward the hillside irrigation projects. What are the reasons and the philosophy of MINAGRI challenging the hillside irrigation?
The conditions are different between the RSSP projects and the LWH projects. In RSSP projects, dams are low, command areas are large, and earthen canals are enough for water conveyance systems. On the other hand in LWH projects, dams are high, command areas are small, and sometimes pipe line systems are needed for the water conveyance.
If the hillside irrigation becomes too costly, we might adopt a choice that the land husbandry only shall be applied and the hillside irrigation shall be given up considering the budget conditions. But fundamentally, more than 60% of land is hilly area and 10,000,000 people live on this hilly area in Rwanda, so that we can not abandon the LWH projects because of their low benefit-cost ratio.

・ Assistance of MINAGRI to the operation and maintenance (O&M) of the main irrigation facilities
In RSSP (Rural Sector Support Program) projects, RSSP staffs supervise O&M works such as the discharge control, estimation of water fee, etc. Does MINAGRI have a plan to establish an organization similar to RSSP?
It's of course, because RSSP belongs to MINAGRI.
Apart from RSSP, we have established WUA (Water User Association) Support Unit that would take care of O & M works to all kinds of water utilization facilities.

3. RSSP project and rice

・ Self-sufficiency of rice

① It is said that the nationwide self-sufficiency of rice has not yet achieved. Does MINAGRI keep challenging toward the accomplishment of self-sufficiency of rice?
Yes.

② If so, how many hectors of paddy fields must be newly developed and does MINAGRI have the development plan already?
No, we don't have.

③ We suppose the development of paddy fields would be done on marshlands; and we have heard that there is an environmental law that forbids the intrusion of agricultural/economical activities into marshlands. How does MINAGRI arrange the situation between the necessity of development and the protection of marshlands?

The law does not forbid the utilization of marshlands. The regulations of the law show the conditions/rules in terms of their utilization.

- Export of rice

  There is a high potential of producing rice for export as quantity of rice production is not enough in many African countries. Does MINAGRI keep challenging to increase the rice production level enough for exporting?

  Yes.

- Upland rice

  We suppose the area between the marshland and the hill foot would be suitable for planting upland rice. Does MINAGRI have a plan of introducing upland rice?

  Please get an answer form RAB.

- Floating rice

  We are now studying the possibility of introducing floating rice that would grow on the water surface of the reservoir. This idea has come up through thinking about how to compensate the farmers whose farmlands are submerged in the reservoir water. How does MINAGRI think of this idea?

  Welcome, personally.

4. Large scale irrigation project

   We have heard that some large scale irrigation projects where irrigation water is pumped up from a lake onto a high point of the hill slope are now under studying or construction.

   ① How many large scale irrigation projects are under studying or construction?

   The answer is already given.

   ② Please give us the information of the representative project in terms of the following items.

- Project name;
- Capacity of the pump; Pump discharge: Lifting height:
- Command area;
- Pump power;
- Construction cost of pumping system;
- On-farm irrigation method;
- Main crops planted;
- Organization in charge of operation and maintenance of the pumping system;

  An adequate person shall be introduced later.

   ③ If a pumping irrigation system is introduced to a LWH project, are engineers who belong to the organization above able to take care of this installed one?

   There are many engineers/technicians in Rwanda who can maintain pumps.

   ④ In these large scale projects, is the radical terracing provided to the command area?

   The land husbandry would be provided; the radical terracing is only a part of land husbandry.

5. Food security and market-oriented agriculture

   The importance of both the food security and the market-oriented agriculture is emphasized at the beginning of every feasibility study report, but actually many of the reports show the cropping program only for cash crops. We would like to give greater importance to the crops such as maize, plantain, etc that have a high market demand and also contribute to the food security. How does MINAGRI think of our fundamental policy on selecting the crops?

   We agree it; but I don’t think F/S reports show the cropping program only for cash crops. RAB has the criterion for the selection of crops where soil conditions, climate conditions, market conditions and the social habits, and of course the food security, are taken into account.

6. Relationship between the promotion of one family one cow policy and LWH projects

   It is said that the average body count of cows per one household is less than 0.5 heads. On the other hand, there is an opinion that there is no room to increase the body count of cows under the condition of feeding cows by grasses growing on the side of roads and paths, and that to increase the body count of cows it is necessary to plant pasture in the farmland. We would like to make it the fundamental policy that the cow's matter shall not be included in our study of the cropping program but shall be left on the hands of farmers in future. Does MINAGRI agree on this fundamental policy?

In Rwanda, grasses for cows grow on openings among other crops under a mixture condition so that it is not necessary to consider the pasture in the cropping program.

7. Infrastructure in rural areas

Does MINAGRI have any developing plan for introducing infrastructures in rural areas?

Yes, we have feeder road projects.

We don't have the projects for electricity, which is belongs to 'Energy, Water and Sanitation Authority'. When this institution carries out a project in rural area, we collaborate since demands are provided to them by us.

In rural area, solar electricity systems are familiar these days. You can see every governmental office has a solar electricity system on its roof.

How about the capacity building plan of O & M staff for these infrastructures?

We don't have any plan. It seems there are enough engineers/technicians in the society.

If MINAGRI does not have and other institutions have, please introduce us the plans of the other institutions.

Sincerely yours, Haruo Hiki

Questionnaire on your development support program to Rwanda

Co-manager of JICA survey team on Ngoma-22 scheme

Haruo Hiki (11th of April, 2012)

[Interlocutor; Mr. MWUMVANEZA Valens, Rural Development Specialist, World Bank – Kigali]

1. Development support programs WB is offering or is going to offer

   Please let us know development support programs WB is offering or is going to offer, and fund scales to them if it is permissible.

- WB commits the design quality of LWH Projects by sending the Project Implementation Unit composed of three specialists, Mr. Dan, Dr. Hadush and Mr. Gaspard, of which duty is to manage the conditions from designing to the construction.

Aid scheme	Project name	Fund scale
Agricultural development program	RSSP phase-1 (2001~2008)	45 million US$
	RSSP phase-2 (2008~2012)	35 〃
	RSSP phase-3 (2012~2017)	80 〃
	LWH (2010~2015)	WB; 34 〃
		GAFSP; 50 〃
		USAID; 14〃
		CIDA; 9〃

- The dam height of small dams should be less than or equal to 15m according to the WB procurement standard.
- In case of the dam height being higher than 15m, its design contents shall be examined by the international panel of experts one of which member must be an affiliate of International Commission of Large Dams.
- After that, the project concerned must be approved by the WB headquarters.

2. Policy of supporting hillside irrigation projects

   We have already recognized through the results of some feasibility studies that the cost of hillside irrigation projects ,US$/ha, is about three to four times higher than the RSSP projects that were/have been constructed with the unit cost of some thousand US$ per hectare.

   Based on what policy does WB support hillside irrigation projects with low benefit-cost ratio?

- Topographical conditions are different between RSSP projects and LWH projects. In RSSP, the dam height is 5m or so and the command area is large. On the other hand in LWH, the dam height is around 15m and the command area is small, so that the benefit-cost ratio of LWH projects becomes low.
- The condition that we can not order the construction works of LWH projects to the local contractor also makes the cost high.
- To raise the economical effectiveness of the LWH projects, crops with high profit performance or export orientation should be planted
- We should assess the economical balance totally by including the land husbandry that gives back two or three times of productivity increase.

Questionnaire on your country's development support program to Rwanda

Co-manager of JICA survey team on Ngoma-22 scheme

Haruo Hiki (13th of April, 2012)

[Interlocutor; Mr. Gary Cramer, Senior Agricultural Advisor, USAID/Rwanda]

3. Development support program USAID is offering or is going to offer
   Please let us know the development support program USAID is offering or is going to offer, and fund scales to them if it is permissible.

4. Policy of supporting hillside irrigation projects (If your country is supporting or is going to support hillside irrigation projects, please let us know your policy.)

Aid scheme	Project name	Fund scale
Irrigation development	LWH project	14million US$ (to fund basket)
Socio-economical development	Feeder Road Project	
	Entrepreneur Project	
Others	Water & Sanitation Project	

We have already recognized through the results of some feasibility studies that the cost of hillside irrigation projects ,US$/ha, is about three to four times higher than the RSSP projects that were/have been constructed with the unit cost of some thousand US$ per hectare.
Based on what policy does USAID support hillside irrigation projects with the low benefit-cost ratio?

- The benefit-cast ratio is important but the social effect, such as strengthening the community's solidarity through participating to the land husbandry construction or through establishing/activities of cooperative, should be counted.
- The economical effectiveness should be assessed by the benefit-cost ratio totally that includes the benefit brought after the completion of the project not by the unit cost of construction only.

Sincerely yours, Haruo Hiki

Questionnaire on your country's development support program to Rwanda

Co-manager of JICA survey team on Ngoma-22 scheme

Haruo Hiki (13th of April, 2012)

[Interlocutor; Mr. James Parsons, Chef de Bureau et Chef de la Cooperation]

5. Development support program your country is offering or is going to offer
   Please let us know the development support program your country is offering or is going to offer, and fund scales to them if it is permissible.

6. Policy of supporting hillside irrigation projects (If your country is supporting or is going to support hillside irrigation projects, please let us know your policy.)

Aid scheme	Project name	Fund scale
Irrigation development	LWH project	9 million US$ (to fund basket)
	GAFSP (Global Agriculture Food Security Program)	15 million US$
	Assistance to NGOs	
Socio-economical development		
Others		

We have already recognized through the results of some feasibility studies that the cost of hillside irrigation projects ,US$/ha, is about three to four times higher than the RSSP projects that were/have been constructed with the unit cost of some thousand US$ per hectare.

Based on what policy does your country support hillside irrigation projects with low benefit-cost ratio?

- If the benefit-cost ratio is too low, we can not help abandoning the hillside irrigation as we did not implement it but the land husbandry only in Gatsibo Project and Karongi Project.
- But it is inevitable that the benefit-cast ratio of the LWH project becomes low compared with the one of the RSSP.

Sincerely yours, Haruo Hiki

Questionnaire on Agriculture in Rwanda
Co-manager of JICA survey team on Ngoma-22 scheme
Haruo Hiki (11th of April, 2012)

1. What is the role of RAB?

RAB, the former Rwanda Agriculture Development Authority (RADA), Rwanda Animal Resources Development Authority (RARDA) and Rwanda Agriculture Research Institute (ISAR) has the major roles of;

- Research and,
- Agriculture extension

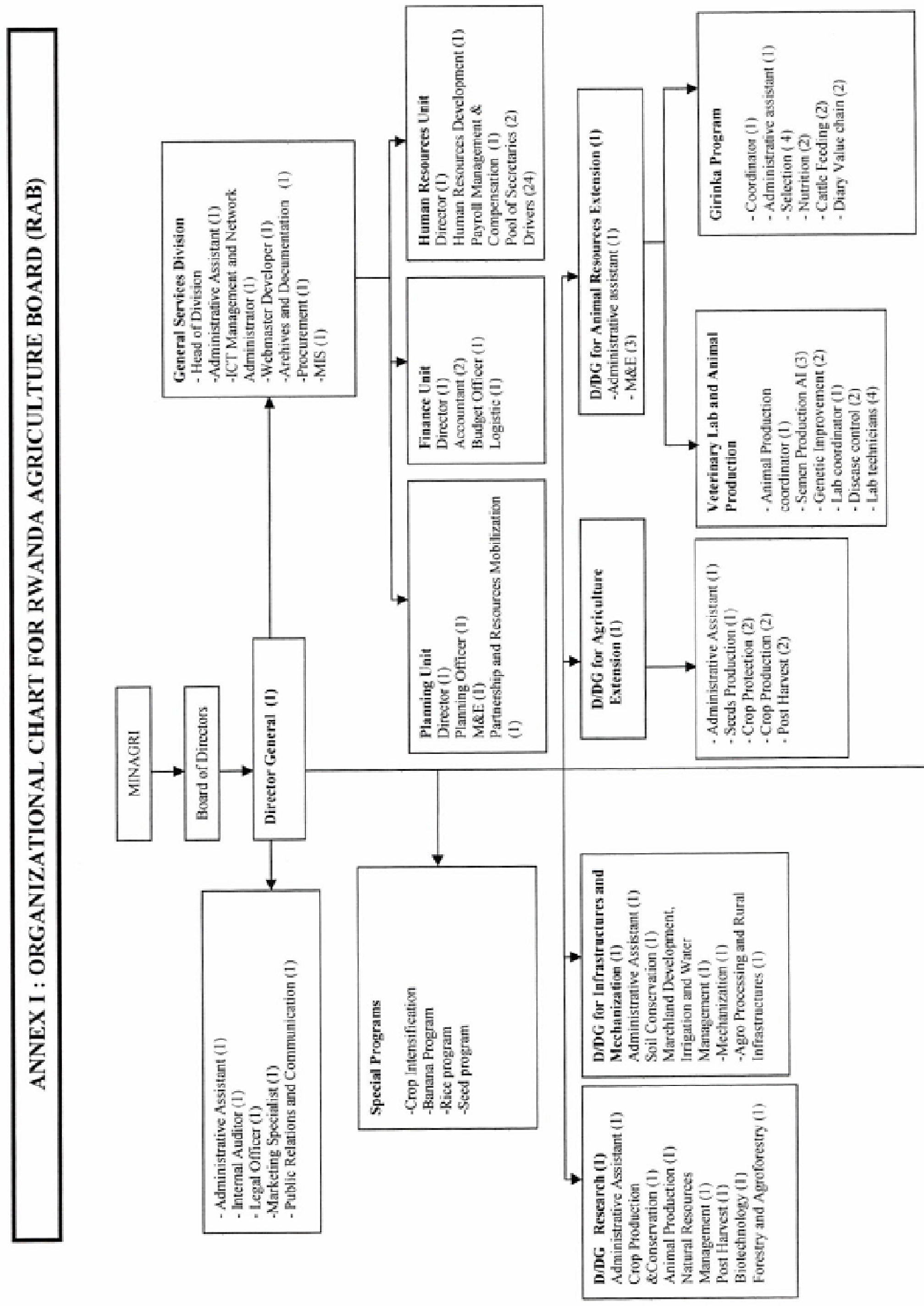
2. Every cooperative of rice farmers answers that seeds are obtained from RAB. Does RAB produce all the seeds provided to cooperatives in Rwanda?
    - RAB provides improved rice seeds to farmers free of charge
    - There is still resistance of farmers to adapt to improved seeds that's why RAB provides them for free

3. Upland rice
   We rate rice as an attractive crop from the view point of the market demand and the contribution to food security. But the further development of paddy fields on marshland has a dilemma of environmental destruction. Then, upland rice comes up to our consideration though this is not popular in Rwanda. Please lecture us on its suitableness/unsuitableness, the history/experiences of research as a crop in Rwanda.
    - There is an on – going upland rice research by Chinese which started in 2006 in KABUYE and now in NGOMA

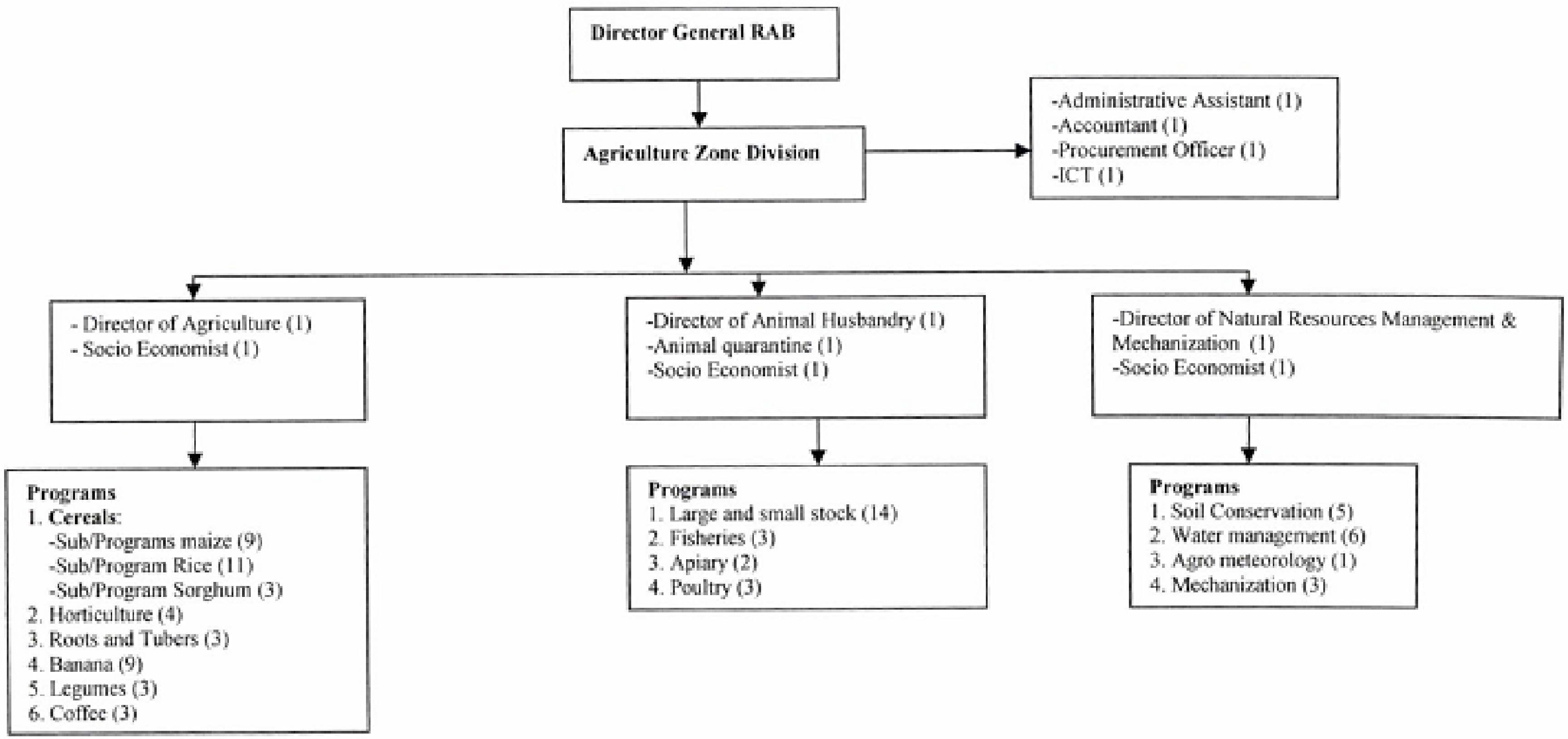
4. Floating rice
   Based on the recognition above, floating rice comes up to the surface as one of the alternatives for increasing rice production, because there are many lakes in Rwanda and wide space extends there. What opinion does RAB have to floating rice?
    - No experience of floating rice in Rwanda

5. Agronomists of RAB
   Please lecture us on the role of RAB's agronomists and the relationship between them and the sector/district agronomists.
    - There are several RAB workers in the 4 zones (Eastern, Northern, Western, and Southern) as referred to Organizational chart attached below

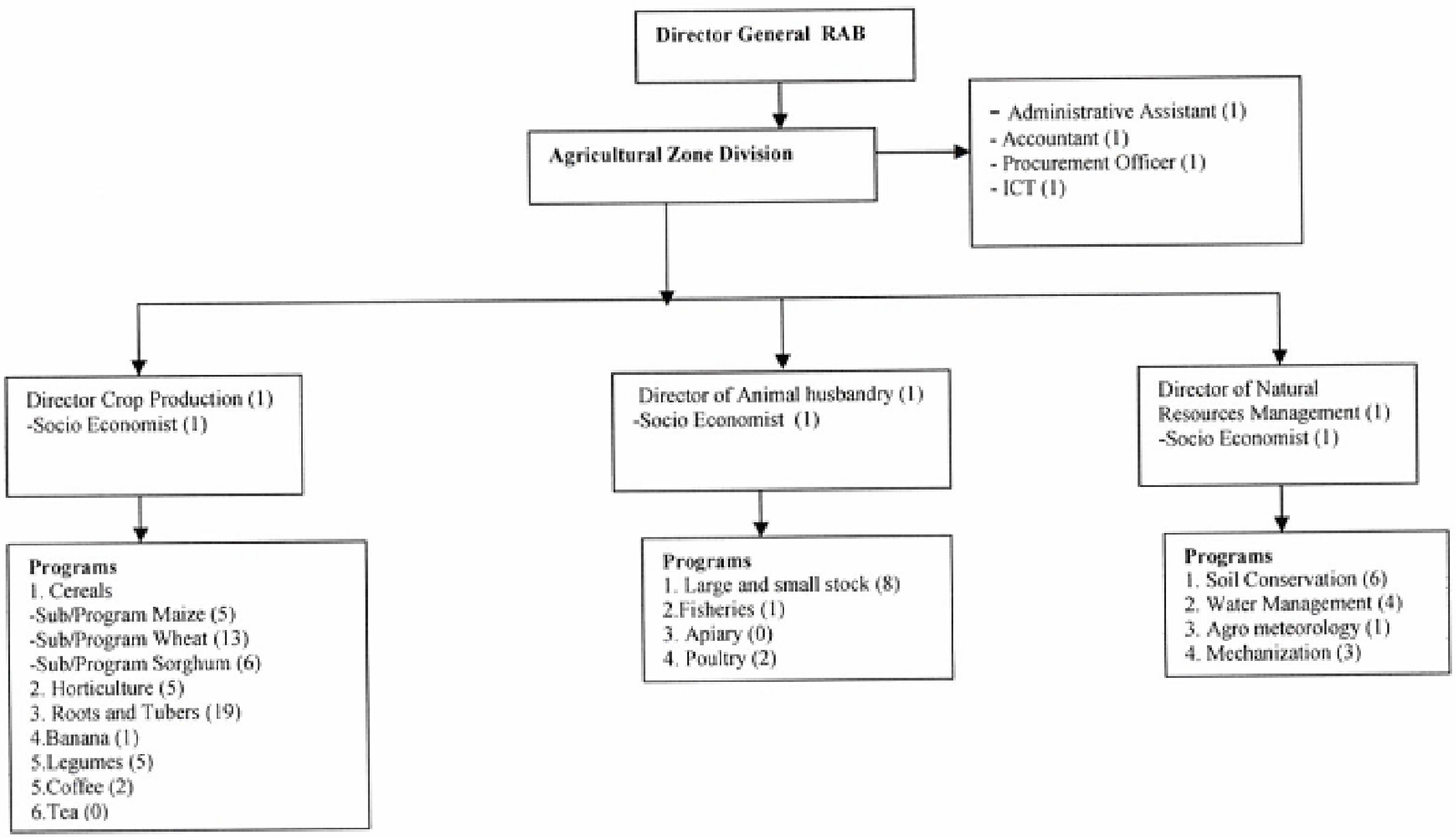
Please provide us with your organization chart and a national climate change risk map.



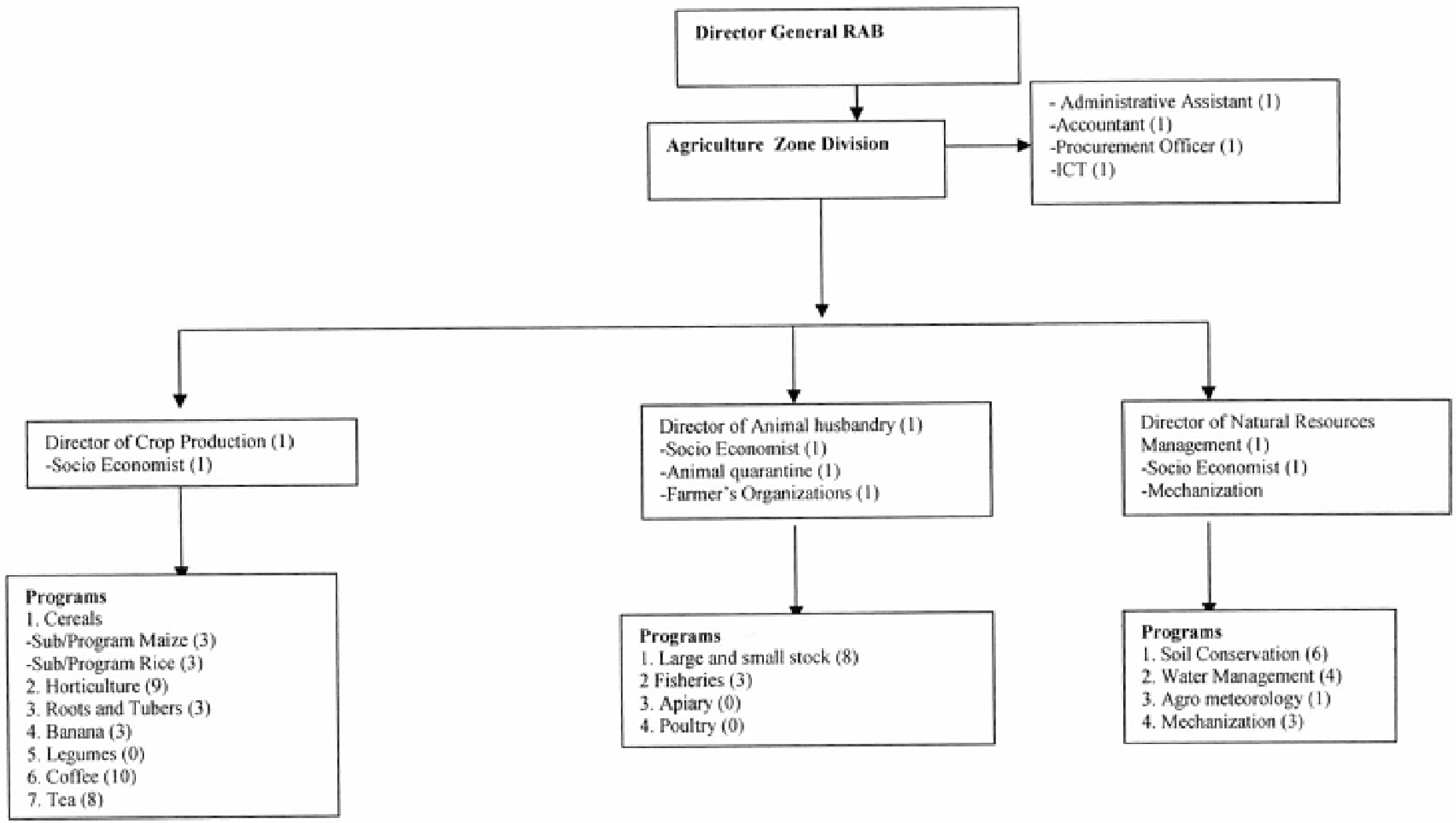
EASTERN AGRICULTURAL ZONE ORGANIZATIONAL CHART- 2011



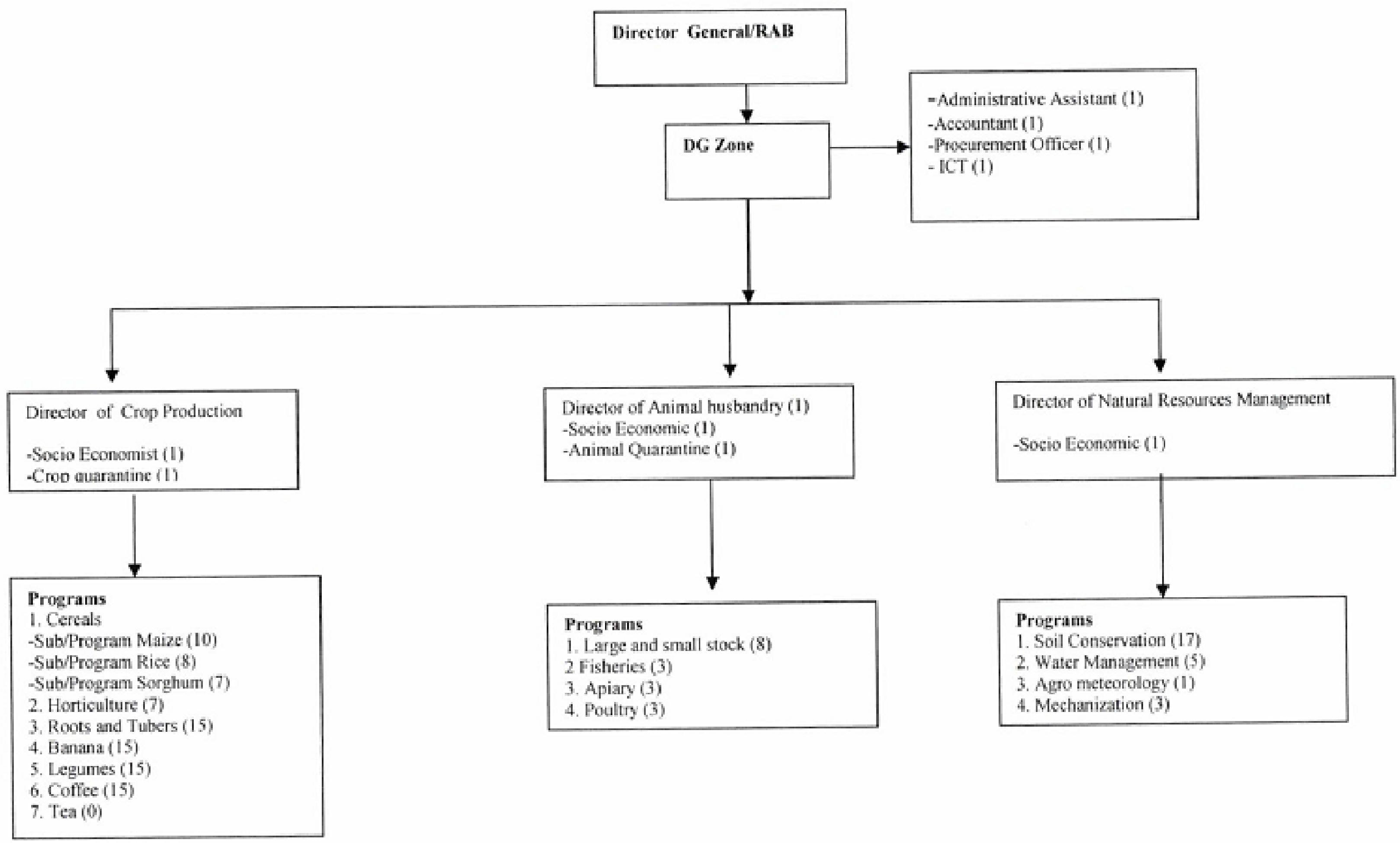
NORTHERN AGRICULTURAL ZONE ORGANIZATIONAL CHART- 2011



WESTERN AGRICULTURAL ZONE ORGANIZATIONAL CHART- 2011



SOUTHERN AGRICULTURAL ZONE ORGANIZATIONAL CHART- 2011



RAB in price support scheme

The prices of agricultural products such as maize, tea and coffee tend to fluctuate more than the prices of manufactured products and services. This is largely due to the **volatility in the market supply** of agricultural products coupled with the fact that demand and supply are price inelastic. One way to smooth out the fluctuations in prices is for the government of Rwanda to operate price support schemes through the use of **buffer stocks**.

It's due to this factor that the Rwandan government through Rwanda Agriculture Board (RAB) operates a **buffer stock scheme** (commonly implemented as **intervention storage),** in an attempt to use commodity storage for the purposes of stabilizing prices in an entire economy. Specifically, commodities maize in particular, are bought when there is a surplus in the economy, stored, and are then sold from these stores when there are economic shortages in the market.

資料-2．現地調査

Ntende Dam および Kiliba Dam 調査結果

NTENDE Valley Planting plan for season B 2012

No	Date	Item	Requirements	To be done by	To be done where
1	01/09-31/10/2011	Leveling	Labour	RSSP&COOPERATIVE	Every zone
2	01-15/11/2011	Nursery Preparation	Buying seeds on time	COOPERATIVE	NTENDE Valley
3	16/11-15/12/2011	Paddling Transplanting	Keeping time	Farmers	In NTENDE valley
4	15-20/12/2011	Destroying all seedlings that have surpassed transplanting stage in the nursery	Communal work	Groups	NTENDE Valley
5	20-31/01/2012	First weeding Application of NPK Pesticide application	Keeping time Acquiring inputs	Farmers COOPERATIVE	NTENDE Valley RAB RAB
6	01-29/02/2012	Second weeding First application of UREA Pesticide application	Keeping time Acquiring inputs	Farmers COOPERATIVE	NTENDE Valley RAB
7	01-31/03/2012	Third weeding Second application of UREA	Keeping time Acquiring inputs	Farmers COOPERATIVE	NTENDE Valley RAB
8	01-30/04/2012	Birds prevention Securing loan for season A 2013	Looking for noisy materials Preparing business plan	Farmers COOPERATIVE	NTENDE Valley Cooperative Office
9	01-31/05/2012	Drying the produce Selling of produce	Preparing drying yard & bags Looking for Market & truck to carry the produce	COOPERATIVE	Cooperative drying yards

Expenses Used on 20 Ares of Paddy in NTENDE Valley

No	Item	Quantity	Price per each (FRW)	Total Amount (FRW)
1	Land clearing	4	800	3,200
2	Sloughing	25	800	20,000
3	Leveling	18	800	14,400
4	Nursery Preparation	1	800	800
5	Paddling	18	800	14,400
6	Transplanting	15	800	12,000
7	First weeding	15	800	12,000
8	Second weeding	18	800	14,400
9	Third weeding	10	800	8,000
10	Fertilizer application (3 times)	3	800	2,400
11	Pesticide application (2 times)	2	800	1,600
12	Preventing paddy from birds	N/A		20,000
13	Harvesting	25	800	20,000
14	Drying	8	800	6,400
15	Winnowing	15	500	7,500
	Sub - Total			**157,100**
	Input costs			
16	Seeds	4	450	1,800
17	NPK	40	380	15,200
18	UREA	20	470	9,400
19	Pesticides	150	8	1,200
	Sub - Total			**27,600**

	Other equipments			
20	Bags	15	250	3,750
21	Hoes	1	1,500	1,500
22	Sickle	2	400	800
23	Panga/Machete	1	1,000	1,000
24	Plastic shitting	2	6,700	13,400
	Sub - Total			**20,450**
	Grand Total			**205,150**

Profit and Loss Account

Incomes	390,000
Less: Expenses	205,150
Profit	**184,850**

Rilima ポンプ灌漑プロジェクト調査結果

[経済分析]

	Maize
	KOAIGR
Agricultural Inputs	6 947 500
Plowing	9 900 000
Processing and transportation	5 265 000
Irrigation	4 708 025
Running cost and salary	4 102 000
Total of costs	30 922 525
Cost per Ha	343 584
Outputs	120 375 000
Gross margin benefit	89 452 475
GMB/ha	993 916
	Tomatoes
Agricultural Inputs	14 150 000
Plowing	5 640 000
Transportation	9 000 000
Irrigation	8 057 000
Running cost and salary	6 486 000
Total of costs	43 333 000
Cost per Ha	1 444 433
Outputs	90 000 000
Gross margin benefit	46 667 000
GMB/ha	1 555 567
capital rate factor/tomatoes	1,076939053

PiCROPP 野菜栽培モデル農場調査結果

Abakundamahoro Cooerative

Name of the cooperative	ABAKUNDAMAHORO			
Date of inquiry survey, Inquirer	14/04/2012 by Impeta Fred			
Interlocutor's name, position	Mr. Mudaheranwa Francois, Cooperative Secretary			
Planted vegetable	Tomatoes	Cabbages	Onions	Eggplant
Planted area	23 plots 35m/plot			
Irrigation method	Hand irrigation			
Timing of irrigation (When?)	Evening			
Quantity of irrigation water	16th Jan – 20th March 80cans of 21litres each Skipping one day			
Water price	20FRW/can			
Hours needed for irrigation	4 hours/day			
Farmers needed for irrigation	10 people 7 water collection 3 watering			
Market, transportation	Karembo & Local people Head, Bicycles			
Yield / ha	98kg/plot			
Selling price (FRW/kg or ton)	400FRW/Kg			
Input;				
Fertilizer etc.(quantity, price)				
・compost manure	5000FRW/ton			
・NPK	30gms/tomato			
Tax etc.				
Number of related farmers	10 people			
Net Income per person	No income sharing yet 87,000Frw first harvest			

Farmer 1

Questionnaire on the horticulture farming

JICA survey team for Ngoma-22 scheme, LWH project

Name of the project/cooperative	COPARWE	
Date of inquiry survey, Inquirer	2/5/2012, Muvunyi Yahaya	
Interlocutor's name, position	BICAMUMPAKA Berchmas/Advisor	
Planted vegetable	Tomato	Egg plant
Planted area	30x40	6x3
Irrigation method	Hand irrigation Water pump	Hand irrigation
Timing of irrigation (When?)	Hand irrigation: afternoon Water pump: Morning time.	Hand irrigation: afternoon
Quantity of irrigation water *20L/person x 15 times x 4 persons*	1200L/Day	40L/day
Water price	Water from the marshland	100F/Jerican
Hours needed for irrigation	4 hours (from 6 H to 10 H)	30 minutes
Farmers needed for irrigation	4 Persons 4 hours	1 person 30 minutes
Market, transportation	Rweru market, Nyamata Bicycle, Vehicle	Not yet harvested
Yield / ha	960/30x40	Not yet harvested
Selling price (FRW/kg or ton)	125/Kg	200/Kg next month
Input;	Compost manure made by farmers themselves	Compost manure
Fertilizer, etc.(quantity, price)	2 Kg /Total	25 Kg Compost manure
Urea	360 Kg	
Tax etc.	5500/30 days	
Number of related farmers	4 persons	

Coop. (20 persons)

1 labour: 600 RwF up to noon.

Farmer 2

Questionnaire on the horticulture farming

JICA survey team for Ngoma-22 scheme, LWH project

Name of the project/cooperative	COPARWE		
Date of inquiry survey, Inquirer	2/5/2012, Muvunyi Yahaya		
Interlocutor's name, position	UWIZEYIMANA J. Nep, Treasurer		
Planted vegetable	Tomato	Onion	Water Melon
Planted area	15 are	2 are	7 are
Irrigation method	Hand irrigation Water pump	Hand irrigation	Hand irrigation
Timing of irrigation (When?)	Morning & Afternoon	Afternoon	Afternoon
Quantity of irrigation water	200 cans of 12 liters each	30 cans of 12	80 cans of 12 liters
Water price	Water from the marshland	Water from the marshland	Water from the marshland
Hours needed for irrigation	4 hours: can 3 hours: 3 L petrol	1h 30 Minutes	3 Hours
Farmers needed for irrigation	5 persons: can 4 persons with water pump	3 persons including him	4 persons including him
Market, transportation	Rweru market Kicukiro Bicycle and vehicle	Rweru market Bicycle	Not yet harvest
Yield / ha	2.5 Tons	Not yet harvest	Not yet harvest
Selling price (FRW/kg or ton)	200 RwF/Kg	400 RwF/Kg	-
Input; compost manure	Made by himself	Made by himself	None
Fertilizer, etc.(quantity, price)			
・Urea	He uses 2 Kg 360RwF/Kg		
Tax etc.	5500/30 days	Same amount	
Number of related farmers	5 persons	3persons including him	4 persons Including him

Coop. (20 persons)

1 labour: 600 RwF before noon.

1 labour: 300 RwF after noon.

Farmer 3

Questionnaire on the horticulture farming

JICA survey team for Ngoma-22 scheme, LWH project

Name of the project/cooperative	COPARWE		
Date of inquiry survey, Inquirer	2/5/2012, Muvunyi Yahaya		
Interlocutor's name, position	MIBURO Léodomir, President		
Planted vegetable	Tomato	Onion	Cabbage
Planted area	15 are	6 are	4 are
Irrigation method	Hand irrigation Water pump	Hand irrigation	Hand irrigation
Timing of irrigation (When?)	Morning & Afternoon	Afternoon	Afternoon
Quantity of irrigation water	200 cans of 12 liters each	100 cans 5 persons x 2cans	80 cans 3 persons
Water price	Water from the marshland	Water from the marshland	Water from the marshland
Hours needed for irrigation With	4 hours/ day Water pump. 3 H: 3L petrol	3 hours/day	2 hours/day
Farmers needed for irrigation	5 persons: can 4: Water pump	5 persons	3 persons
Market, transportation	Rweru market Kicukiro Bicycle and vehicle	Rweru market Bicycle	Rweru market
Yield / ha	3 Tons	Not yet harvested	Not yet harvested
Selling price (FRW/kg or ton)	250 RwF/Kg	400 RwF/Kg Next month	100/kg
Input; compost manure	Made by himself	Made by himself	Made by himself
Fertilizer, etc.(quantity, price)			
・Urea	He uses 2 Kg 300RwF/Kg	-	-
Tax etc.	5500/30 days	30 days	30 days
Number of related farmers	5 persons	5persons	3 persons

Entire coop. (20 persons)

1 labour: 600 RwF before noon.

1 labour: 300 RwF after noon.

Farmer 4

Questionnaire on the horticulture farming

JICA survey team for Ngoma-22 scheme, LWH project

Name of the project/cooperative	KOPUBIGA	
Date of inquiry survey, Inquirer	2/5/2012, Muvunyi Yahaya	
Interlocutor’s name, position	BASANGIRA Etienne	
Planted vegetable	Tomato	Water melon
Planted area	1ha	1,5 ha
Irrigation method	Hand Irrigation, Water pump	Hand Irrigation, Water pump
Timing of irrigation (When?)	Morning From 5am to 9 am	Before noon After noon
Quantity of irrigation water 1 person: 20Lx 50 in 1000L	1000x6= 6000L 3L of petrol 1hour	1000x9= 9000 L 6L of petrol 2Hours
Water price	Water from the marshland	Water from the marshland
Hours needed for irrigation With	3 hour: hand irrigation 1 hour: water pump	3 hours 1 hour
Farmers needed for irrigation	6 persons: hand irrigation 3 persons: water pump	9 persons: Hand irrigation 9 persons water pump.
Market, transportation	Nyabugogo, Goma Vehicle (20,000 RwF/Trip)	Simba Super market Serena Hotel
Yield / ha	18 tons	2500 pcs
Selling price (FRW/kg or ton)	200 Rwf/kg	1pc/1000 Rwf
Input; compost manure *1 ton (RwF10,000*)	3 tons	3 tons
Fertilizer, etc.(quantity, price)		
・N.P.K 17.17.17	50 kg 1kg/400	50kg 1kg/400
・Urea	20 kg 1kg/420	
DAP		40 kg 1kg/600
Tax etc.		
Number of related farmers		

Coop. (20 persons)

1 labour: 800 RwF before noon.

1 labour: 400 RwF after noon.

60 days irrigating

Farmer 5

Questionnaire on the horticulture farming

JICA survey team for Ngoma-22 scheme, LWH project

Name of the project/cooperative	KOPUBIGA	
Date of inquiry survey, Inquirer	2/5/2012, Muvunyi Yahaya	
Interlocutor's name, position	MPORWIKI Evariste Store keeper	
Planted vegetable	Tomato	Green pepper
Planted area	80 are	20 are
Irrigation method	Hand Irrigation, Water Pump	Hand Irrigation, Water pump
Timing of irrigation (When?)	Afternoon afternoon	Afternoon Afternoon
Quantity of irrigation water *Petrol 8 L/ 5*	1 person x 50 20 L	1 person x 50 X 20 L
Water price	Water from the marshland	Water from the marshland
Hours needed for irrigation	5 hours with Water Pump 3 hours for hand irrigation	1 hour 30' for water pump 2H 30' hand irrigation
Farmers needed for irrigation	15 persons for hand irrigation 4 persons for water pump	5 persons for hand irrigation 4 persons for water pump
Market, transportation	SORWATOM, Nyabugogo Gashora Vehicle and bicycle	Kimisagara, Nyabugogo Gashora, Kimironko Vehicle, bicycle
Yield / ha	2.5 ton	400 water melon
Selling price (FRW/kg or ton)	200 RwF/Kg	150 RwF/Pc
Input; compost manure	-	4 tons
Fertilizer, etc.(quantity, price)		
・N.P.K 17.17.17	60 Kg, 400 RwF/Kg	30 Kg, 1 kg/400 RwF
Tax etc.	-	
Number of related farmers	15	5 persons x 20 days, hand irrigation 4 persons x 10 days, water pump Within two months

1 labour: 800 RwF before noon.

1 labour: 400 RwF after noon.

Farmer 6

Questionnaire on the horticulture farming

JICA survey team for Ngoma-22 scheme, LWH project

Name of the project/cooperative	KOPUBIGA	
Date of inquiry survey, Inquirer	2/5/2012, Muvunyi Yahaya	
Interlocutor's name, position	AHISHAKIYE Francois accountant	
Planted vegetable	Tomato	Water melon
Planted area	50x100	35x50
Irrigation method	Hand Irrigation, Water Pump	Hand Irrigation, Water pump
Timing of irrigation (When?)	Afternoon, afternoon	Afternoon, Afternoon
Quantity of irrigation water 1 person: 20Lx 10 Tin x 5 persons	1000L hand irrigation	- 700 L - 1 L petrol/1 hour
Water price	Marshland water	Marshaland water
Hours needed for irrigation	3 hours Hand Irrigation 2 hours for water pump	2 hours for hand irrigation 1 hour water for pump
Farmers needed for irrigation	5 persons hand irrigation 5 persons water pump	3 persons for hand irrigation 3 persons for water pump
Market, transportation	Nyabugogo, Gashora Vehicle and bicycle	Kimisagara, Kimironko Vehicle, 25,000 RwF/ hiring vehicle
Yield / ha	1 ton	500 water melon
Selling price (FRW/kg or ton)	250 RwF/Kg	900 RwF/Pc
Input; compost manure	2 tones	500 Kg
Fertilizer, etc.(quantity, price)		
・N.P.K 17.17.17	25Kg, 460 RwF/Kg	15 Kg 1 kg/460 RwF
Tax etc.	-	
Number of related farmers	10 persons/ 50 days	6 persons /40 days

1 labour: 800 RwF before noon.

1 labour: 350 RwF after noon.

Farmer 7

Questionnaire on the horticulture farming

JICA survey team for Ngoma-22 scheme, LWH project

Name of the project/cooperative	IMBARAGA				
Date of inquiry survey, Inquirer	2/5/2012, Muvunyi Yahaya				
Interlocutor's name, position	Nyanzungu Déo				
Planted vegetable	Tomato	Cabbage	Onion	Carrot	Egg plant
Planted area	24 are	97 are	19 are	10x15	20x30
Irrigation method	Hand Irrigation				
Timing of irrigation (When?)	Before noon, Afternoon				
Quantity of irrigation water 1 person: 20Lx 20	2000L	2000L	2500 L	1000L	3200L
Water price	Water from the marshland				
Hours needed for irrigation	4 Hours, 4-17H)	4 Hours	4 Hours	1 Hours	3 Hours
Farmers needed for irrigation	5 persons	5 persons	5 persons	5 persons	8 persons
Market, transportation	Mutenderi, Bicycle				
Yield / ha	173/Kg	4397Kg	108 Kg	120 Kg	465/Kg
Selling price (FRW/kg)	150/Kg	40/Kg	220/Kg	125/Kg	100/Kg
Input; *compost manure*	1680Kg	4 tones	1 ton	350 Kg	2 Tons
Fertilizer, etc.					
・DAP	Gift from JICA				
・Urea		480/Kg, 40 Kg			
・N.P.K 17.17.17			600/kg, 15Kg		
・Urea				480/Kg	
Tax etc.					
Number of related farmers	30 persons	30 persons	30 persons	30 persons	

Coop members 192

one Kg of Compost manure= 8F

Farmer 8

Questionnaire on the horticulture farming

JICA survey team for Ngoma-22 scheme, LWH project

Name of the project/cooperative	Private	
Date of inquiry survey, Inquirer	4/5/2012, Muvunyi Yahaya	
Interlocutor's name, position	Shyaka Francois	
Planted vegetable	Cabbage	Tomato
Planted area	5 are	4 are
Irrigation method	Hand irrigation	Hand irrigation
Timing of irrigation (When?)	Afternoon	Before noon and afternoon
Quantity of irrigation water 1 person: 20Lx 60 time	1200L	1 person 20L(Jerican x 2) 40Lx10 Tin= 400L
Water price	From Canal	Water tap, 20L= 20 RwF
Hours needed for irrigation	2 hours	2 hours
Farmers needed for irrigation	2 persons	2persons
Market, transportation	Gafunzo market, Karembo, Mugesera By bicycle	Karembo, Mugesera By bicycle
Yield / ha	350 Kg (5 Bags of 70 Kg each)	300 kg (25 baskets of 12 Kg each)
Selling price (FRW/kg or ton)	1 bag: 3500 Rw, 1 Cabbage: 50 Rwf	166 RwF/Kg
Input; *compost manure*	12000 RwF (estimation)	4000 RwF (estimation)
Fertilizer, etc.		
・N.P.K 17.17.17	32 Kg: 400 RwF/Kg	16Kg: 400 Rwf
・Urea ½ Kg	600 RwF	Ditane: 4Kg 2600/Kg
・Thioda	700 RwF	Indofile 3 kg: 1200 RwF/Kg
		Agrolax 2kg: 1500/Kg
Tax etc.	200 RwF/Bag	5000 RwF, 200Fx25 basket
Number of related farmers	4 farmers	4 farmers

2 labour 7 days: 1 labour 500 RwF/Day

Farmer 9

Questionnaire on the horticulture farming

JICA survey team for Ngoma-22 scheme, LWH project

Name of the project/cooperative	DUKORE	
Date of inquiry survey, Inquirer	4/4/2012, Muvunyi Yahaya	
Interlocutor's name, position	Habyarimana Juvenal	
Planted vegetable	Tomato	Cabbage
Planted area	25 x25	12x25
Irrigation method	Hand irrigation	Hand irrigation
Timing of irrigation (When?)	Afternoon	Afternoon
Quantity of irrigation water 1 person: 60Lx 25 persons	1500L	1500L
Water price	Water from the marshland	Water from the marshland
Hours needed for irrigation	3hours	3 hours
Farmers needed for irrigation	25persons	25persons
Market, transportation	Karembo, Ngoma market By bicycle	Karembo, Ngoma By bicycle
Yield / ha	235 Kg	210 Kg
Selling price (FRW/kg or ton)	200/Kg	57 RwF/Kg
Input; *compost manure*	10,000 RwF estimation	3000 RwF estimation
Fertilizer, etc.		
・N.P.K 17.17.17	16 Kg 400 RwF/1 Kg	-
Tax etc.	1000 RwF/Bag	600 RwF
Number of related farmers	25	25

Farmer 10

Questionnaire on the horticulture farming

JICA survey team for Ngoma-22 scheme, LWH project

Name of the project/cooperative	DUKORE	
Date of inquiry survey, Inquirer	4/4/2012, Muvunyi Yahaya	
Interlocutor's name, position	Mukakamanzi Gaudence (Vice President)	
Planted vegetable	Cabbage	
Planted area	5 x7	
Irrigation method	Hand irrigation	
Timing of irrigation (When?)	Afternoon	
Quantity of irrigation water 1 person: 60Lx 25 persons	200L	
Water price	Water from the marshland	
Hours needed for irrigation	1h 30	
Farmers needed for irrigation	1 person	
Market, transportation	Karembo, Mugesera market By bicycle	
Yield / ha	300Kg	
Selling price (FRW/kg or ton)	45 Rwf	
Input; *compost manure*	3,000 RwF (estimation)	
Fertilizer, etc.		
・N.P.K 17.17.17	400 RwF/1 Kg	
Tax etc.	300 RwF/	
Number of related farmers	2 farmers	

資料-3．水文等補足調査

実測データに基づく流出量の概算

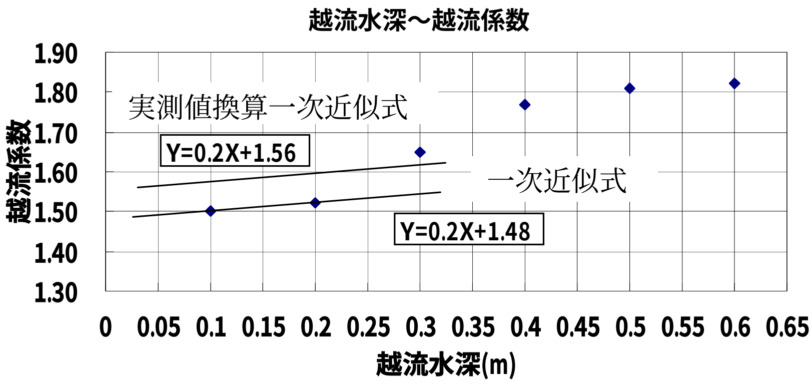
中野専門家・MINAGRI アドバイザーにより設置された雨量計および流量計の実測データ（観測期間：雨量 2012 年 2 月 29 日～4 月 25 日、流量 2012 年 2 月 21 日～4 月 25 日）に基づき、以下のとおり流出量を概算した。

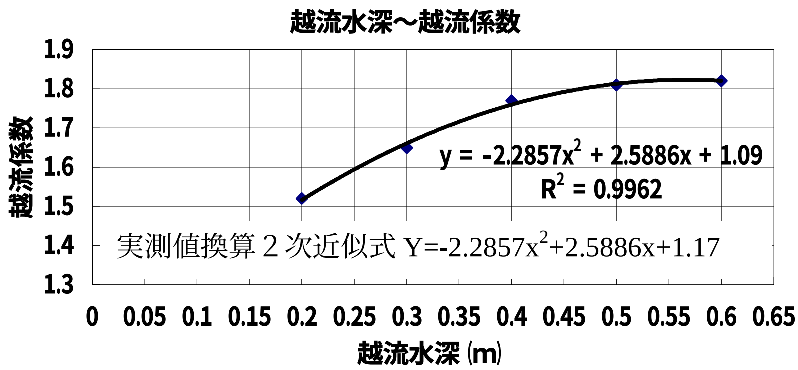
ｉ) 越流水深から越流量への換算

中野専門家は、越流水深と実測流量の対比から越流水深 H=0.05m 時の越流係数 C=1.57 を得ている。広頂堰の越流係数は、HAND BOOK OF HYDRAULICS (Horace Williams King and others, Boston Massachusetts)によれば堰頂幅 30cm に対し下表のとおりであるが、中野専門家が得た値はこの表の値よりも大きい。これは、表の越流水深が越流堰前面 2.5H の位置での値であるのに対し、測定の便宜上、越流堰直上での計測値にしたことによるものである。よってこの実測による越流係数を使うものとし、他の越流水深に対する適用値は、表の越流水深～越流係数関係を平行移動した式により求めるものとする。越流水深 0.1m, 0.2m に対しては一次近似式、以降については２次式による近似とする。

越流水深～越流係数

越流水深 (m)	越流係数
0.1	1.50
0.2	1.52
0.3	1.65
0.4	1.77
0.5	1.81
0.6	1.82



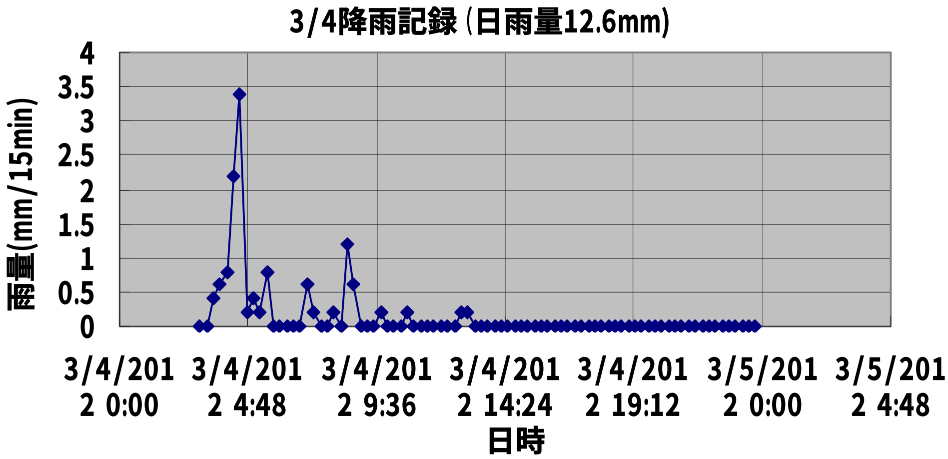


流量は越流堰の流量公式による。

$$Q=C\cdot L\cdot H^{3/2}$$

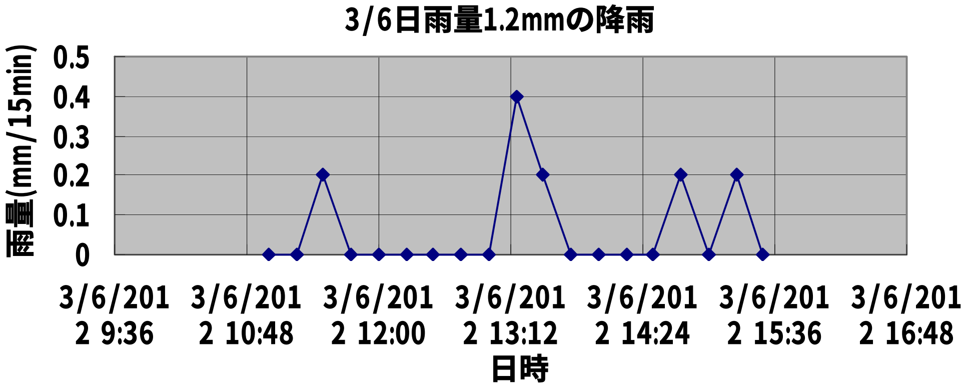
ここに、Q；流量(m3/sec)、C；越流係数、L；越流堰長、H；越流水深(m) ii）降雨～流出流量の検討

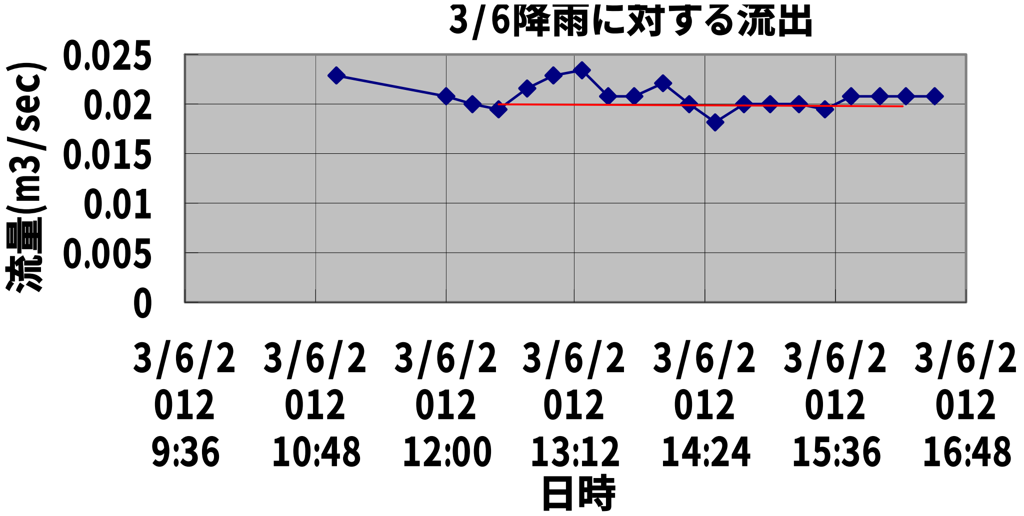
① 3/4 日雨量 12.6mm 降雨に対する流出



降雨の影響を受けた流出は、３月４日の４時４５分～３月４日 19 時 30 分の間であると評価し、この間の流量を積算すると、1,574.2m3 となる。その間の基底流量を 0.024m3/sec とすれば、基底流量分は 0.024m3/sec×(19.5-4.75)×60×60＝1,274.4m3 となり、降雨分は 299.8m3 である。流出率は、[299.8m3/{(0.0126m×(8.8×1,000,000)m2)}]×100=0.27%である。

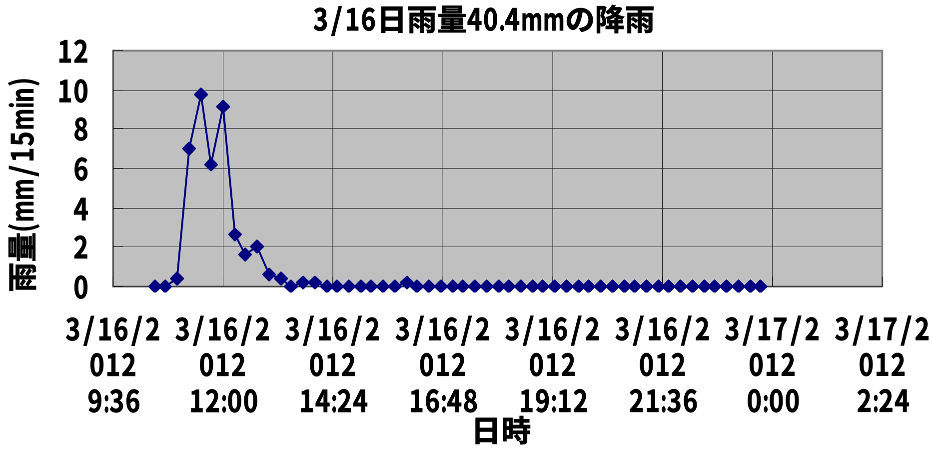
② 3/6 日雨量 1.2mm 降雨に対する流出

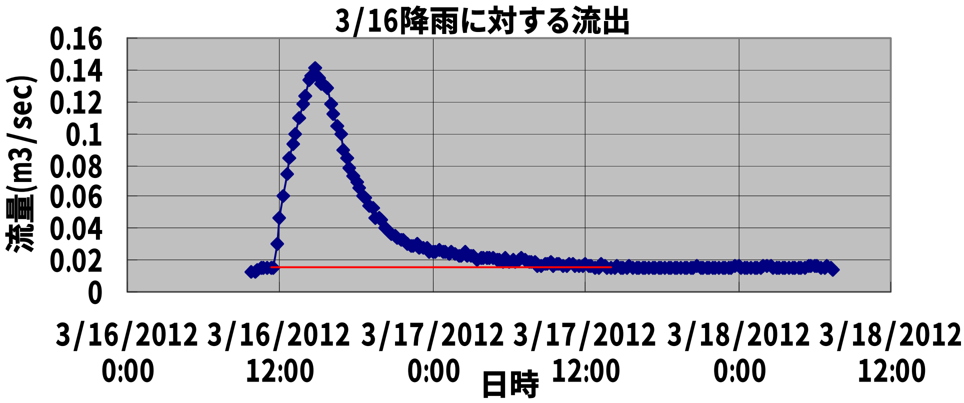




降雨の影響を受けた流出は、３月６日の 12 時 30 分～３月６日 16 時の間であると評価し、この間の流量を積算すると、273.6m3 となる。その間の基底流量を 0.02m3/sec とすれば、基底流量分は 0.02m3/sec×(16.0-1２.5)×60×60＝252m3 となり、降雨分は 21.6m3 である。流出率は、[21.6m3/{(0.0012m×(8.8×1,000,000)m2)}]×100=0.20%である。

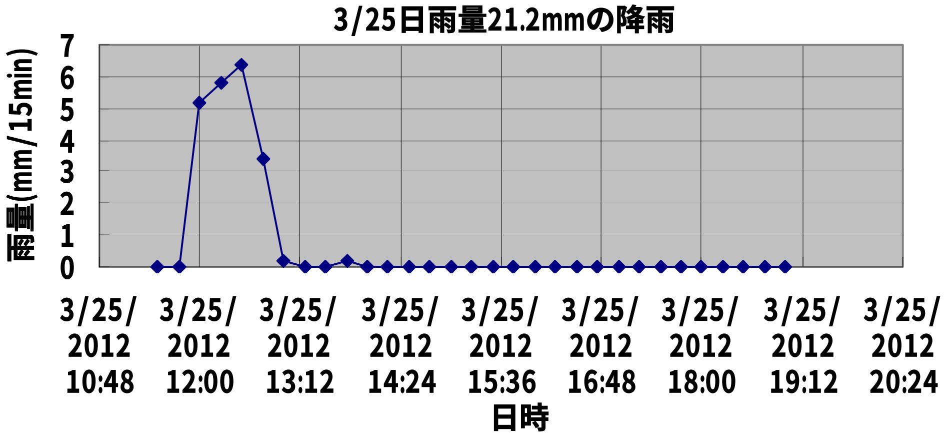
③ 3/16 日雨量 40.4mm 降雨に対する流出





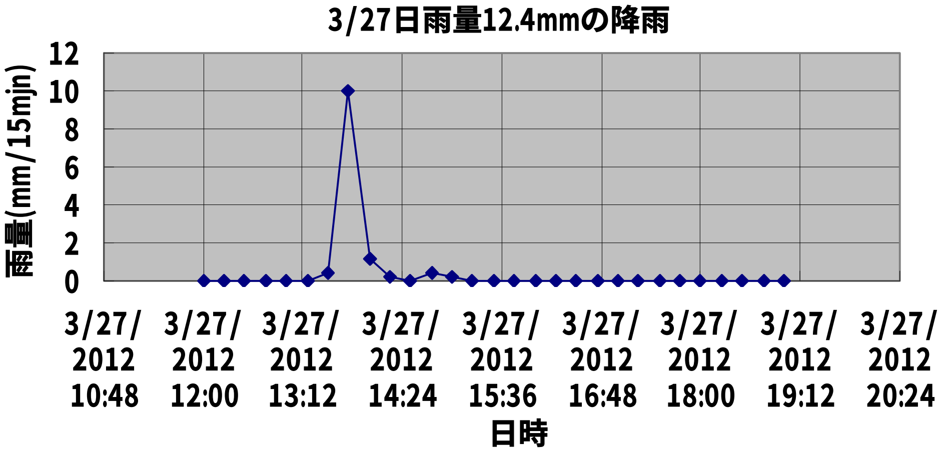
降雨の影響を受けた流出は、３月１6 日の 11 時 30 分～３月 17 日 12 時 30 分の間であると評価し、この間の流量を積算すると、4,101.8m3 となる。その間の基底流量を 0.017m3/sec とすれば､基底流量分は 0.017m3/sec×(24.0-11.5+12.5)×60×60＝1,530.0m3 となり､降雨分は 2,571.8m3 である。流出率は、[2,571.8m3/{(0.0404m×(8.8×1,000,000)m2)}]×100=0.72%である。

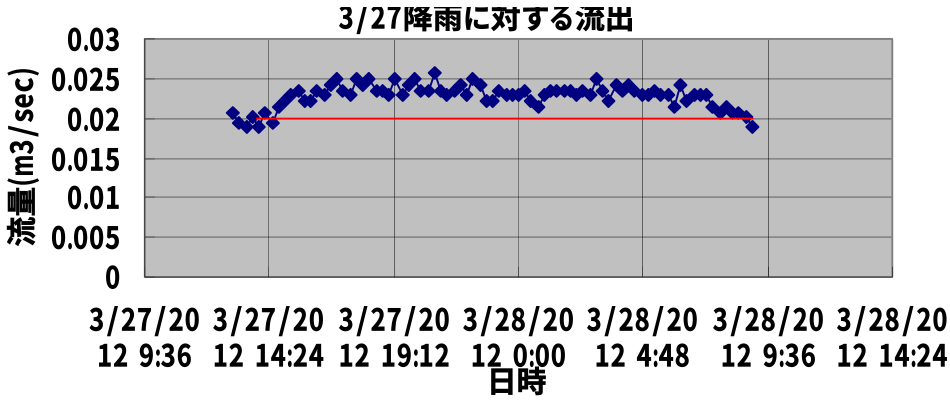
④ 3/25 日雨量 21.2mm 降雨に対する流出



降雨の影響を受けた流出は、３月 25 日の 12 時 30 分～３月 25 日 22 時の間であると評価し、この間の流量を積算すると、1,764.7m3 となる。その間の基底流量を 0.018m3/sec とすれば、基底流量分は 0.018m3/sec×(7+24-1２.5)×60×60＝1,198.8.0m3 となり、降雨分は 565.9m3 である。流出率は、[565.9m3/{(0.0212m×(8.8×1,000,000)m2)}]×100=0.30%である。

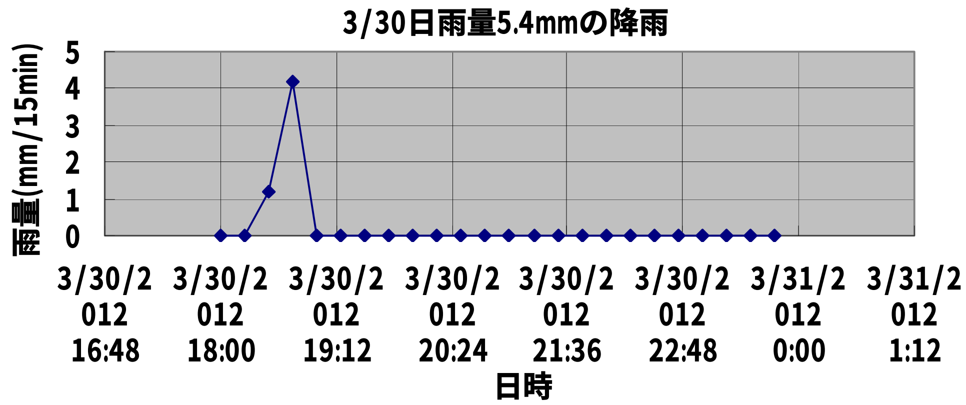
⑤ 3/27 日雨量 12.4mm 降雨に対する流出

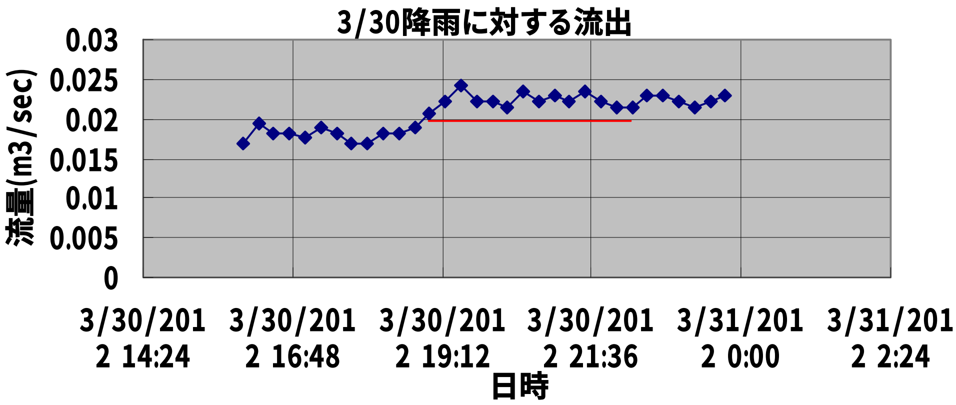




降雨の影響を受けた流出は、3 月 27 日の 13 時 45 分～3 月 28 日 8 時 30 分の間であると評価し、この間の流量を積算すると、1,571.6m3 となる。その間の基底流量を 0.02m3/sec とすれば、基底流量分は 0.02m3/sec×(24.0-13.75+8.5)×60×60＝1,350.0m3 となり、降雨分は 221.6m3 である。流出率は、[221.6m3/{(0.0124m×(8.8×1,000,000)m2)}]×100=0.20%である。

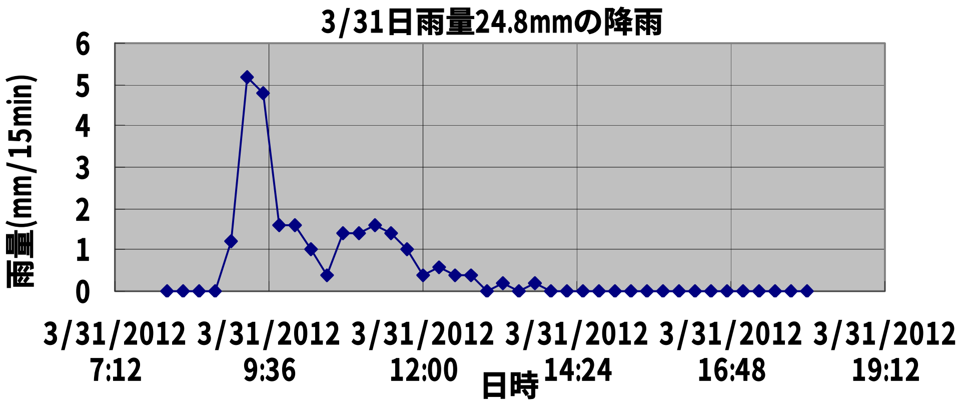
⑥ 3/30 日雨量 5.4mm 降雨に対する流出

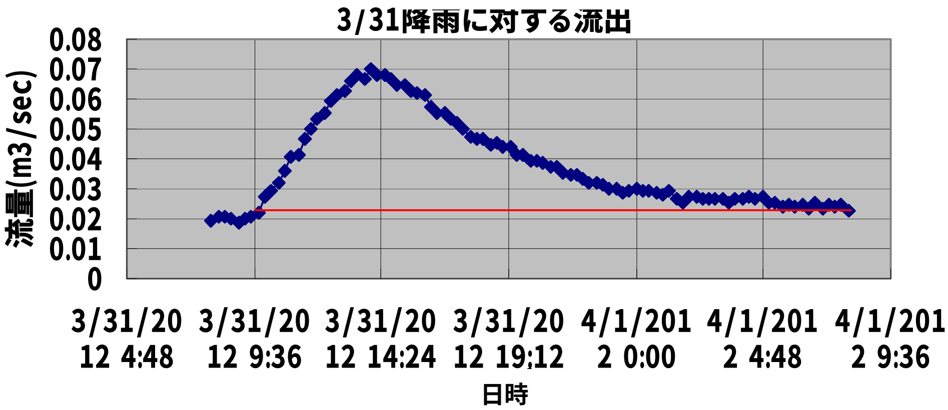




降雨の影響を受けた流出は、３月 30 日の 19 時～３月 30 日 22 時の間であると評価し、この間の流量を積算すると、261.5m3 となる。その間の基底流量を 0.02m3/sec とすれば、基底流量分は 0.02m3/sec×(22.0-19.0)×60×60＝216.0m3 となり、降雨分は 45.5m3 である。流出率は、[45.5m3/{(0.0054m×(8.8×1,000,000)m2)}]×100=0.10%である。

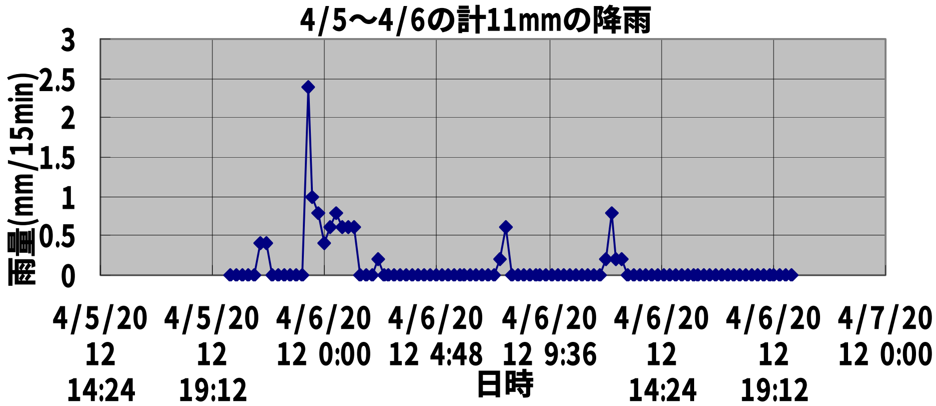
⑦ 3/31 日雨量 24.8mm 降雨に対する流出

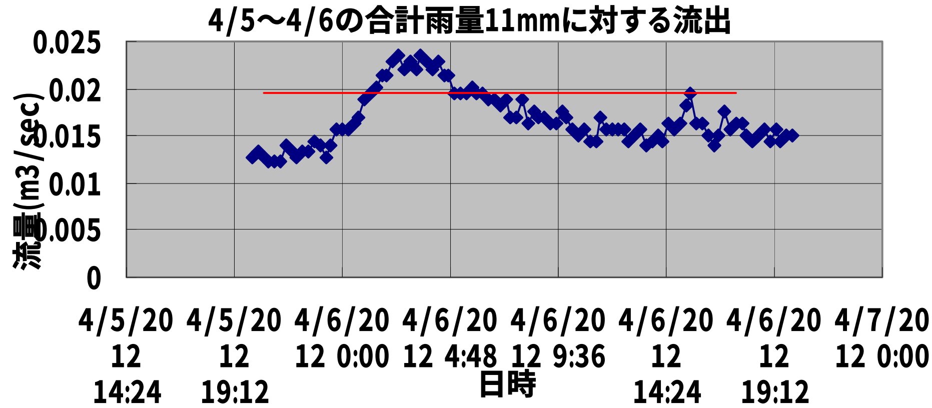




降雨の影響を受けた流出は、3 月 31 日の 9 時 30 分～4 月 1 日 5 時 30 分の間であると評価し、この間の流量を積算すると、2,983.0m3 となる。その間の基底流量を 0.0225m3/sec とすれば、基底流量分は 0.0225m3/sec×(29.5-9.5)×60×60＝1,620m3 となり、降雨分は 1,363m3 である。。流出率は、[1,363m3/{(0.0248m×(8.8×1,000,000)m2)}]×100=0.6%である。

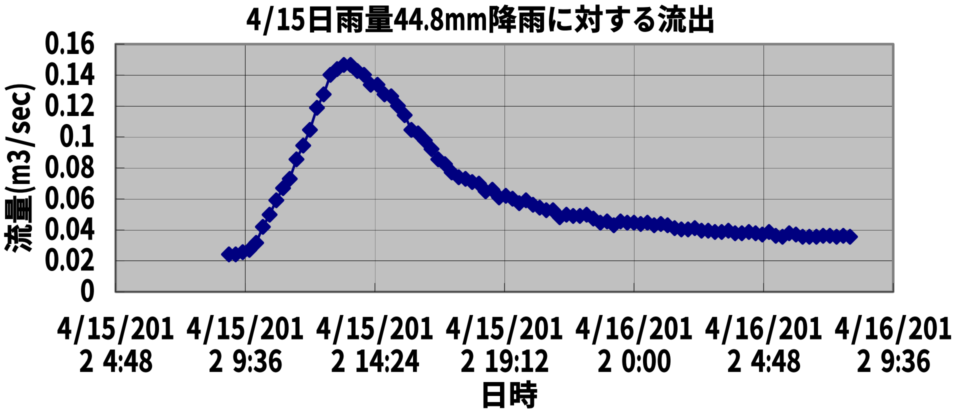
⑧ 4/5~4/6 の合計雨量 11mm 降雨に対する流出





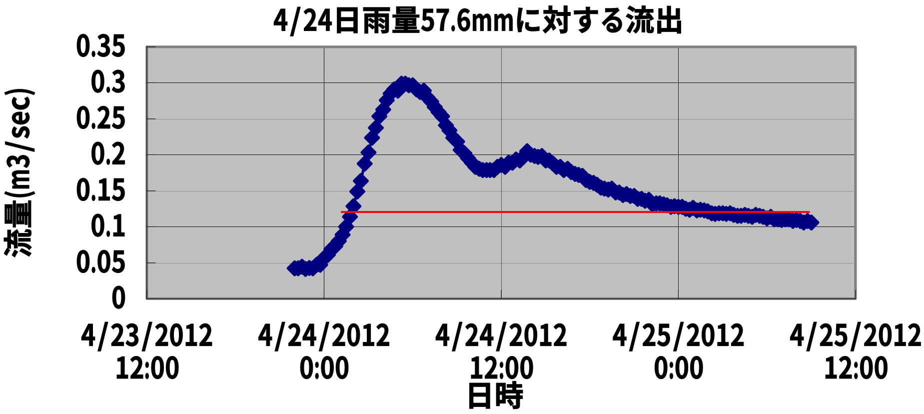
降雨の影響を受けた流出は、4 月 5 日の 21 時 30 分～4 月 6 日 19 時の間であると評価し、この間の流量を積算すると、1,343.4m3 となる。その間の基底流量を 0.014m3/sec とすれば、基底流量分は 0.014m3/sec×(19+24-21.5)×60×60＝1,083.6m3 となり、降雨分は 259.8m3 である。流出率は、[259.8m3/{(0.011m×(8.8×1,000,000)m2)}]×100=0.25%である。

⑨ 4/15 日雨量 44.8mm 降雨に対する流出



降雨の影響を受けた流出は、4 月 15 日の 10 時～4 月 16 日 5 時 30 分の間であると評価し、この間の流量を積算すると、4,934.7m3 となる。その間の基底流量を 0.035m3/sec とすれば、基底流量分は 0.035m3/sec×(5.5+24-10)×60×60＝2,457m3 となり、降雨分は 2,477.7m3 である。流出率は、[2,477.7m3/{(0.0448m×(8.8×1,000,000)m2)}]×100=0.63%である。

⑩ 4/24 日雨量 57.6mm 降雨に対する流出

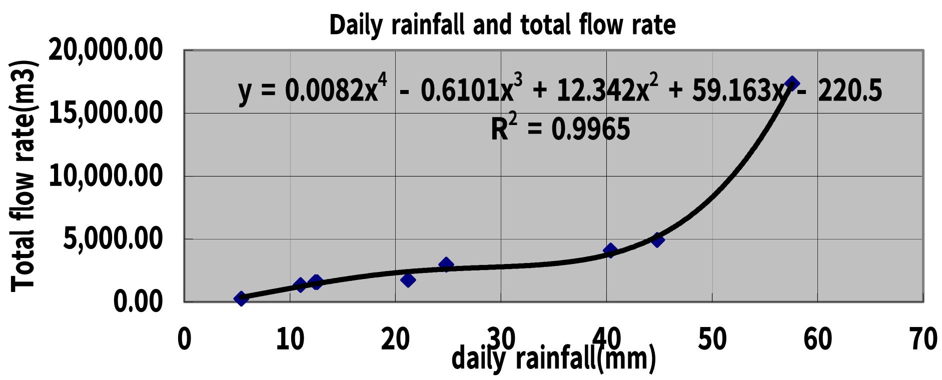


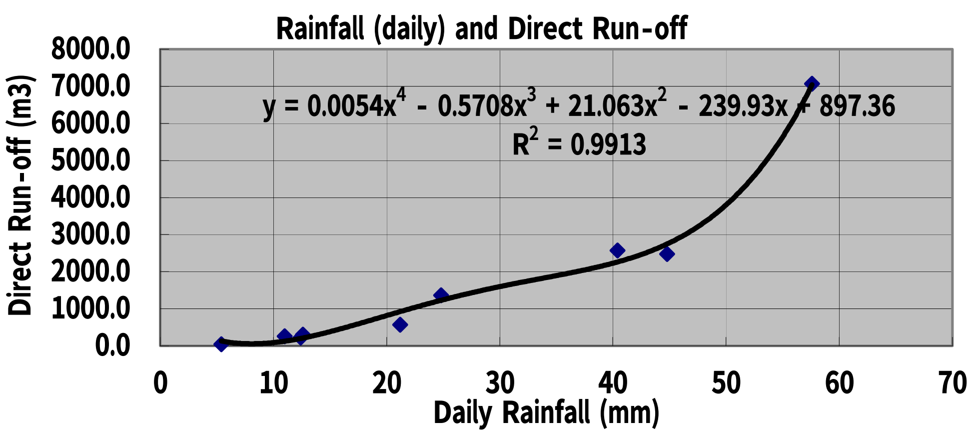
降雨の影響を受けた流出は、4 月 24 日の 2 時～4 月 25 日 4 時の間であると評価し、この間の流量を積算すると、17,361.6m3 となる。その間の基底流量を 0.11m3/sec とすれば、基底流量分は 0.11m3/sec×(4+24-2)×60×60＝10,296m3 となり、降雨分は 7,065.6m3 である。流出率は、[7,065.6m3/{(0.0576m×(8.8×1,000,000)m2)}]×100=1.39%である。

⑪ 降雨量と流出量の関係

以上を整理すると次のようになる。

Date	Daily Rainfall (mm)	Direct Run-off(m3)	Run-off ratio (%)	Total flow rate(m3)
3/4/2012	12.6	299.8	0.27	1,574.20
3/16/2012	40.4	2571.8	0.72	4,101.80
3/25/2012	21.2	565.9	0.30	1,764.70
3/27/2012	12.4	221.6	0.20	1,571.60
3/30/2012	5.4	45.5	0.10	261.50
3/31/2012	24.8	1363.0	0.60	2,983.00
4/5～6/2012	11	259.8	0.25	1,343.40
4/15/2012	44.8	2477.7	0.63	4,934.70
4/24/2012	57.6	7065.6	1.39	17,361.60
3/6/2012	1.2	21.6	0.20	273.60





iii) 年間流出量の概算

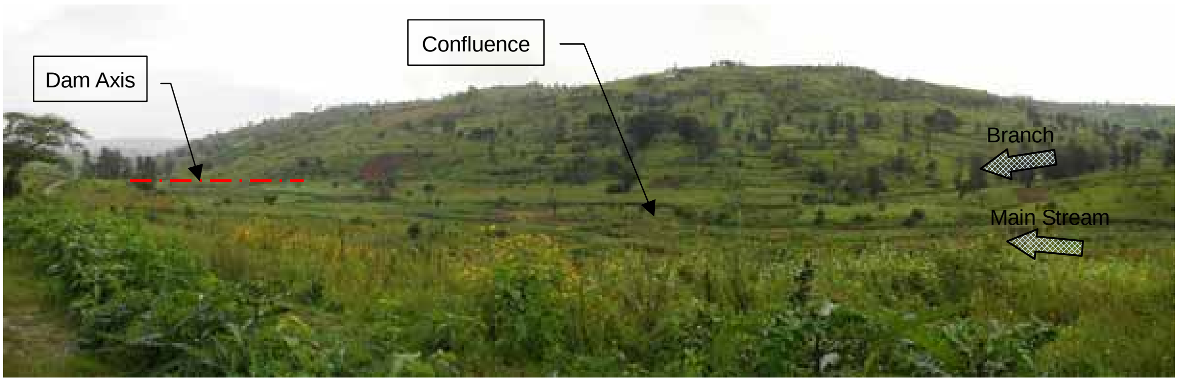
Kibungo，1992 年の日雨量に日雨量～直接流出関係式を適用して降雨流出を求め、これに基底流量分を加算する方法で年間流出量を求めてみた。基底流雨量は、3，4，5 月及び 9，10，11 月の雨期を 0.02m3/sec、12，1，2 月および 6，7，8 月の乾季を 0.015m3/sec としたが、結果は 591,000m3 となった。

資料-4．湛水域調査

Site Inspection of Reservoir Area – Photo Records

1. Panoramic View of Reservoir Area (May 28, '12)

View from Left Bank at Upstream to Reservoir Area



View from left Bank at Midway Point to Reservoir Area

View from Left Bank at Dam Axis to Reservoir Area

2. General View – Flat Area (May 28, '12)

General View in Flat Area (Left: Sweet Potato, Right: Sweet Potato)

General View in Flat Area (Left: Cabbage, Right: Carrot & Sweet Potato)

General View in Flat Area (Left: Cabbage, Right: Chinese Chive)

3. General View – Slope Area (May 28, '12)


General View in Flat Area (Left: Sorghum, Maize & Cassava, Right: Sorghum)


General View in Flat Area (Left: Sorghum, Right: Sorghum & Maize)


General View in Flat Area (Left: Sorghum, Right: Beans)

4. Main Stream #01 (May 28, ’12)

Main Stream #01 – Upstream View

Main Stream #01 – Downstream View

Main Stream #01 – Left Bank View

Main Stream #01 – Right Bank View

5. Main Stream #02 (May 28, '12)

Main Stream #02 – Upstream View

Main Stream #02 – Downstream View

Main Stream #02 – Left Bank View

Main Stream #02 – Right Bank View

6. Main Stream #03 (May 28, '12)

Main Stream #03 – Upstream View

Main Stream #03 – Downstream View

Main Stream #03 – Left Bank View

Main Stream #03 – Right Bank View

7. **Main Stream #04 (May 28, '12)**

Main Stream #04 – Upstream View

Main Stream #04 – Downstream View

Main Stream #04 – Left Bank View

Main Stream #04 – Right Bank View

8. Branch #01 (May 28, '12)

Branch #01 – Upstream View

Branch #01 – Downstream View

Branch #01 – Left Bank View

Branch #01 – Right Bank View

9. Branch #02 (May 28, '12)

Branch #02 – Upstream View

Branch #02 – Downstream View

Branch #02 – Left Bank View

Branch #02 – Right Bank View

10. Confluence (May 28, '12)

Confluence – Upstream View

Confluence – Downstream View

Confluence – Left Bank View

Confluence – Right Bank View

11. Midway Point between Confluence and Dam Axis (May 28, '12)

Midway Point between Confluence and Dam Axis – Upstream View

Midway Point between Confluence and Dam Axis – Downstream View

Midway Point between Confluence and Dam Axis – Left Bank View

Midway Point between Confluence and Dam Axis – Right Bank View

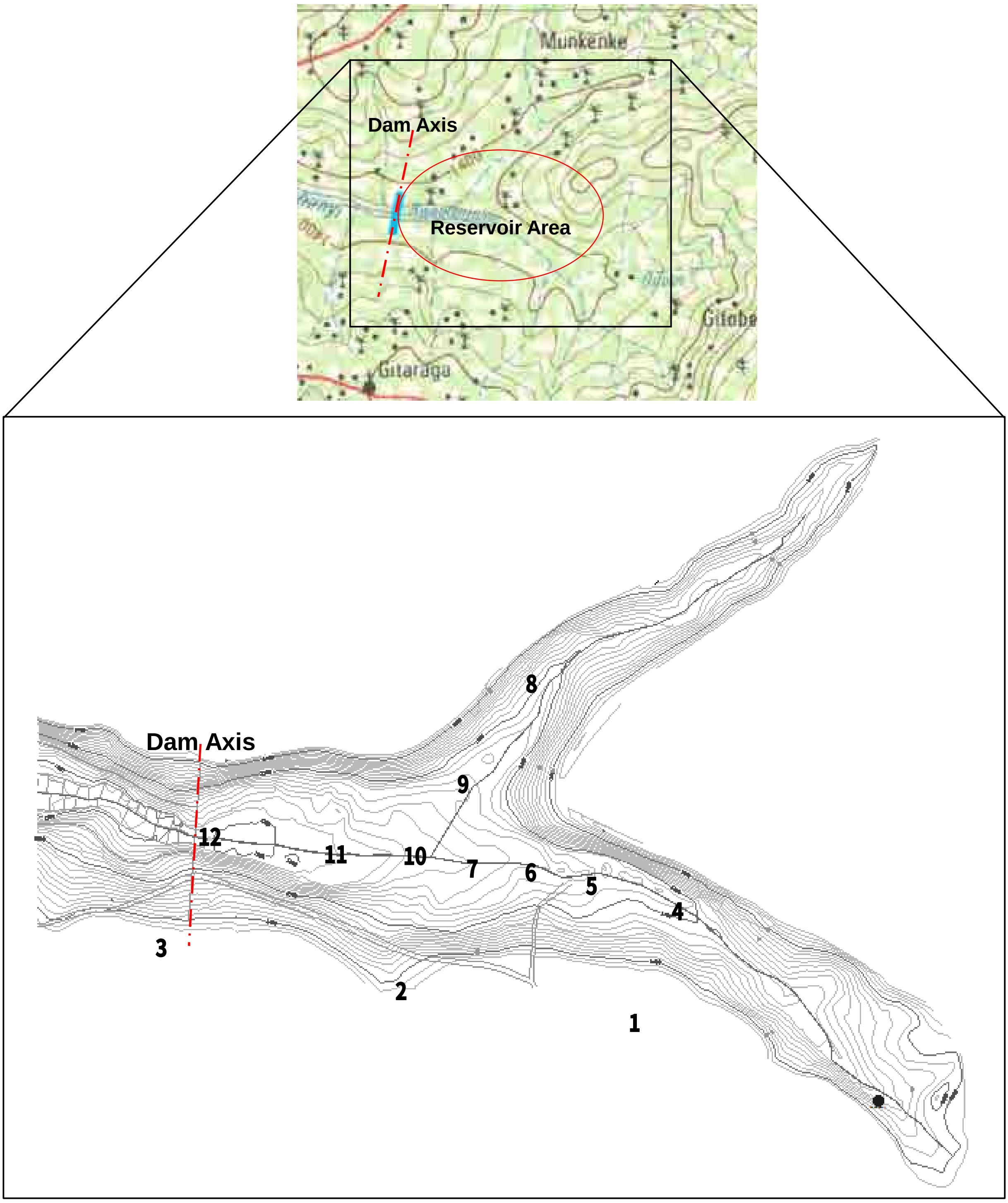
12. Dam Axis (May 28, ’12)

Dam Axis – Upstream View

Dam Axis – Downstream View

Dam Axis – Left Bank View

Dam Axis – Right Bank View



Legend

1	Left Bank at Upstream	7	Main Stream #04
2	Left Bank at Midway Point	8	Branch #01
3	Left Bank at Dam Axis	9	Branch #02
4	Main Stream #01	10	Confluence
5	Main Stream #02	11	Midway Point bet. Confluence and Dam Axis
6	Main Stream #03	12	Dam Axis

資料-5．数量計算・積算

(a) Bill of quantities

ⅰ) Temporary work and general work

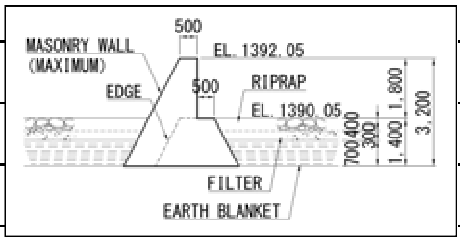
Description	Calculation				Uinit	Quantity
ⅰ-1 Road maintenance and improvement of dam site						
Protection retaining wall of excavation slope	H=1.5m wet stone masonry		=	1000	m	1,000
Drain development	triple soil-cement lining		=	2,500	m	2,500
Roadbed development	recompression of cut-and-cover (t=1m)	1.0×8.0×500.0	=	4,000	m^3	4,000
Subbase development	cement improved soil (t=40cm)	0.4×8.0×500.0	=	1,600	m^3	1,600
Paving gravel	t=20cm	0.2×8.0×2000.0	=	3,200	m^3	3,200
Vegetation of slope protection		2.0×2000.0	=	4,000	m^2	4,000
ⅰ-2 Temporary for dam						
Dewatering (temporary coffering)		Underwater pump driving			ls	1
Excavation of connecting canal of bottom outlet		2.0×1.0×50.0	=	100	m^3	100
Temporary road				1000	m	1,000
ⅰ-3 General temporary construction						
Preparation of site					ls	1
Site office construction					ls	1
Field test room					ls	1
Clearing and grubbing, deforestation				30000	m^2	30,000

ⅱ) Dam body

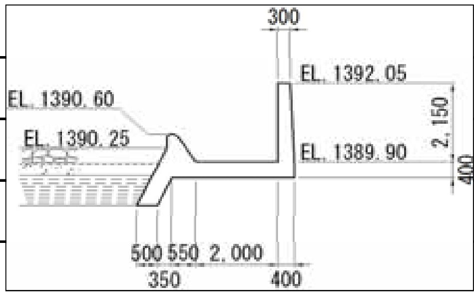
Description	Calculation	Uinit	Quantity
ⅱ-1 Main body			
Excavation	7450×1.5 = 11,175	m^3	11175
River bed drain	(1/2×(75+80)×8.5+1/2×(80+25.5)×14)×0.7 = 978	m^3	978
Intercepter	5.8×1.0×30.0+1/2×(5.8+0.0)×(16+30) = 307	m^3	307
Foot of slope	1.0×1.5×20.0 = 30	m^3	30
Riprap	1/2×(90.0+121.0)×18.15×(1+3^2)^0.5/3×0.6 = 1,211	m^3	1,211
Banking	1/2×6.0×13.55×(182.0+29.0)+1/6×(3.0+2.5)×13.55^2×(182.0+2×29.0) +2.5×6.5×1/2×(79.0+29.0)+2.5×7.5×1/2×(90.0+29.0)-1211		
	= 48,721	m^3	48,721
Vegetation of slope protection	{1/2×(163+78)×15.375+1/2×(80.0+30.0)×12.5}×1.08+2.5×80.0 = 2,943	m^2	2,943
Protection crest	164.0×6.0×0.3 = 295	m^3	295
ⅱ-2 Slope blanket			
Excavation	29221×0.5 = 14,611		14,611
Riprap	1/2×(72.0+83.0+82.0+86.0)×18.15×(1+3^2)^0.5/3×0.6 = 1,854	m^3	1,854
Banking	{1/2×(20.0+16.0)×7.5+1/2×(16.0+12.0)×2.7 +1/2×(12.0+4.0)×3.3}×(60.0+70.0)×1.2-1854 = 29,221	m^3	29,221
Protection crest	(78.0×6.0+75.0×9.0)×0.3 = 343	m^3	343
ⅱ-3 Horizontal blanket			
Excavation	53.0×60.0×1.5+1/2×(2.0+5.0)×3.0 = 4,781	m^3	4,781
Banking	50.0×60.0×2.0 = 6,000	m^3	6,000
Banking (cofferdam)	{1/2×(2.0+5.0)×3.0+1/2×(3.0+5.0)×2.5}×123.0 = 2,522	m^3	2,522

iii) Spillway

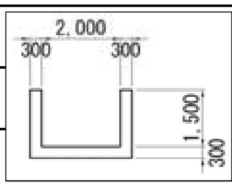
Description	Calculation		Uinit	Quantity
iii-1 Guide portion				
Masonry wall	1/2×{1/2×(1.0+2.4)×1.4+1/2×(0.5+2.1)×3.2+1/2×(0.5+1.2)×1.4} ×20.0×2	= 154.6	m^3	154.6
Earth blanket	2.95×20.0×0.7+1/2×1.5×5.0×0.7×2	= 47.0	m^3	47.0
Riprap filter	3.65×20.0×0.7+1/2×1.5×5.0×0.7×2	= 56.0	m^3	56.0



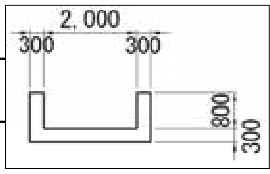
Description	Calculation		Uinit	Quantity
iii-2 Intake portion				
Excavation	4.8×6.0×2.5	= 72.0	m^3	72.0
back-filling	1/2×(1.0+2.25)×(4.8+6.0)	= 18.0	m^3	18.0
Reinforced concrete	{0.5×1.1+1/2×(0.9+0.2)×0.7+2.95×0.4}×5.0 +1/2×(0.3+0.4)×2.15×(5.0+2.95)	= 16.6	m^3	16.6
Vegetation of slope protection	1.0×5.0	= 5.0	m^2	5.0



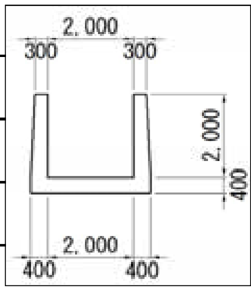
Description	Calculation		Uinit	Quantity
iii-3 Connecting canal portion				
Excavation	1/2×(4.6+6.6)×2.0×30.0	= 336.0	m^3	336.0
Back-filling	1/2×(1.0+1.8)×1.6×30.0×2	= 134.0	m^3	134.0
Reinforced conceret	(0.3×2.6+0.3×1.5×2)×30.0	= 50.0	m^3	50.0
Vegetation of slope protection	1.0×30.0×2	= 60.0	m^2	60.0



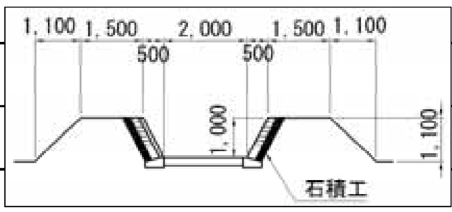
Description	Calculation			Uinit	Quantity
iii-4 Chute portion					
Excavation	1/2×(4.6+4.6+1.5)×1.5×50.0	=	401.0	m^3	401.0
back-filling	1/2×(1.0+1.0+0.9)×0.9×50.0×2	=	131.0	m^3	131.0
Reinforced concrete	(0.3×2.6+0.3×0.8×2)×50.0	=	63.0	m^3	63.0
Vegetation of slope protection	1.0×50.0×2	=	100.0	m^2	100.0



Description	Calculation			Uinit	Quantity
iii-5 Stilling basin portion					
Excavation	1/2×(4.6+4.6+1.5)×1.5×5.0	=	40.0	m^3	40.0
back-filling	1/2×(1.0+1.0+1.5)×1.5×5.0×2	=	26.0	m^3	26.0
Reinforced concrete	{0.4×2.8+1/2×(0.3+0.4)×2.0×2}×5.0	=	13.0	m^3	13.0
(chute block)	1/2×0.4×0.2×0.3×3	=	0.04	m^3	0.04



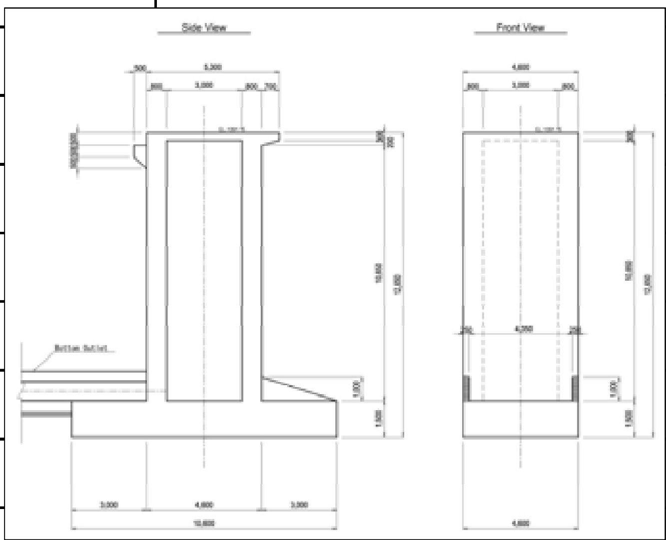
Description	Calculation			Uinit	Quantity
iii-6 wasteway portion					
Bank protection (wet stone masonry)	1.0×1.12×30.0×2	=	67.0	m^2	67.0
Bottom protection (wet stone masonry)	2.0×0.3×30.0	=	18.0	m^3	18.0
Back-filling	1/2×(1.2+3.2)×1.1×30.0×2	=	145.0	m^3	145.0
Vegetation of slope protection	(1.1×1.414+1.3)×30.0×2	=	171.0	m^2	171.0

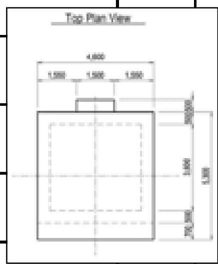


ⅳ) Intake facilities

ⅳ-1) Intake Tower

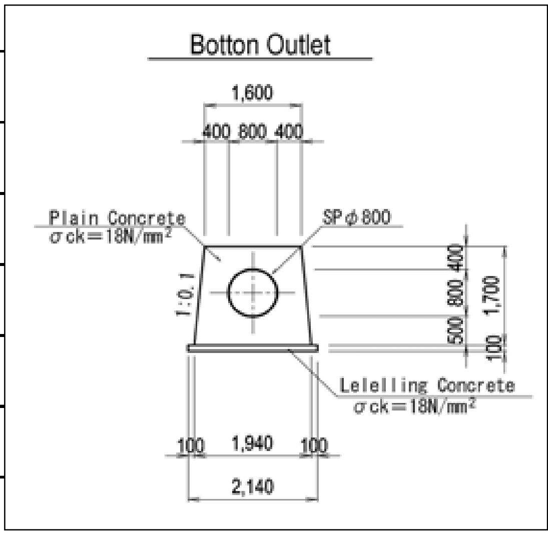
Description	Calculation			Uinit	Quantity
Rainforced concrete (including formwork)	4.6×(5.3-0.7)×(12.65-1.5)	=	235.9		
	-3.0×3.0×10.65	=	-95.9		
	1/2×(0.3+0.5)×0.7×4.6	=	1.3		
	1/2×(0.5+1.0)×0.5×1.5	=	0.6		
	4.6×10.6×1.5	=	73.1		
	2×1/2×1.0×3.0	=	3.0		
	Total		218.0	m^3	218





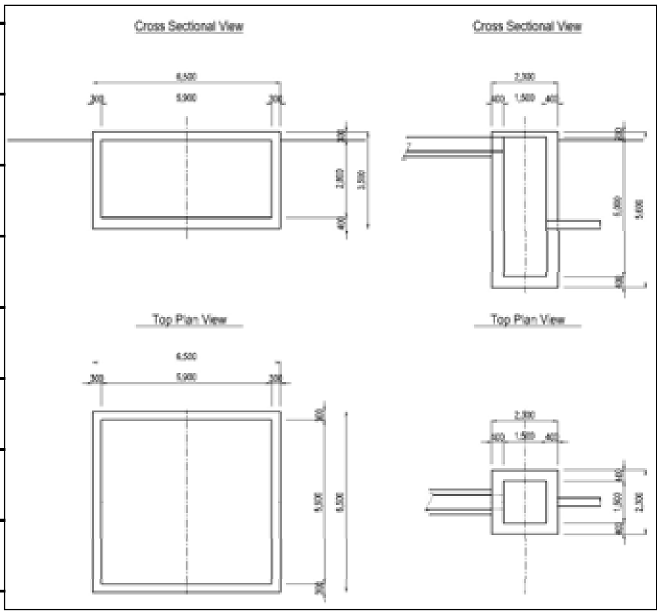
ⅳ-2) Bottom Outlet

Description	Calculation			Uinit	Quantity
Rainforced concrete (including formwork)	1/2×(1.6+1.94)×1.70	=	3.0		
	-π/4×0.8^2	=	-0.5		
	2.14×0.1	=	0.2		
	Total		2.7		
	2.7×80.0	=	216.0	m^3	216
Steel pipe φ800				m	80



ⅳ-3) Outlet Valve Chamber

Description	Calculation			Uinit	Quantity
Rainforced concrete (including formwork)	Diversion (1) 2×(6.5×6.5×3.5)	=	295.8		
	2×(-5.9×5.9×2.8)	=	-194.9		
		Sub Total	100.9	m^3	
	Diversion (2) 2×(2.3×2.3×5.6)	=	59.2		
	2×(-1.5×1.5×5.0)	=	-22.5		
		Sub Total	36.7	m^3	
		Total	138	m^3	138
Needle type valve					
500mm				piece	1
300mm				piece	1
Butterfly type valve					
500mm				piece	1
300mm				piece	3



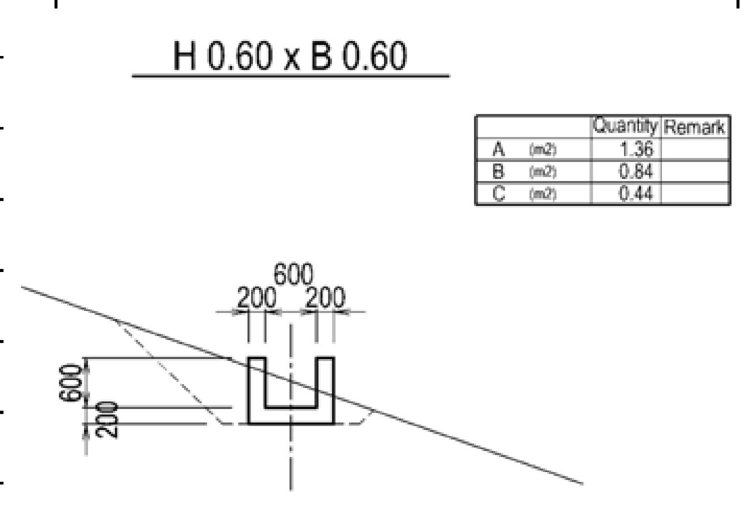
Ⅴ) Irrigation facilities

Ⅴ-1) Pipe Line

Description	Calculation			Uinit	Quantity
Rigth Side Main pipe					
HDPE φ500	50	=	50.0	m	50
Ligth Side Main Pipe					
HDPE φ300	80	=	80.0	m	80
Pressuer Pipe Line					
HDPE φ150	70+150+70+200+130+210+270+300+100+60+140+250+150+60+80+100+110	=	2,450.0	m	2,450
Pump	17	=	17.0	unit	17
Warehouse	17	=	17.0	unit	17
Tertiary					
HDPE φ90	240×(2×75)	=	36,000.0	m	36,000
Water tap	240×6	=	1,440.0	unit	1,440

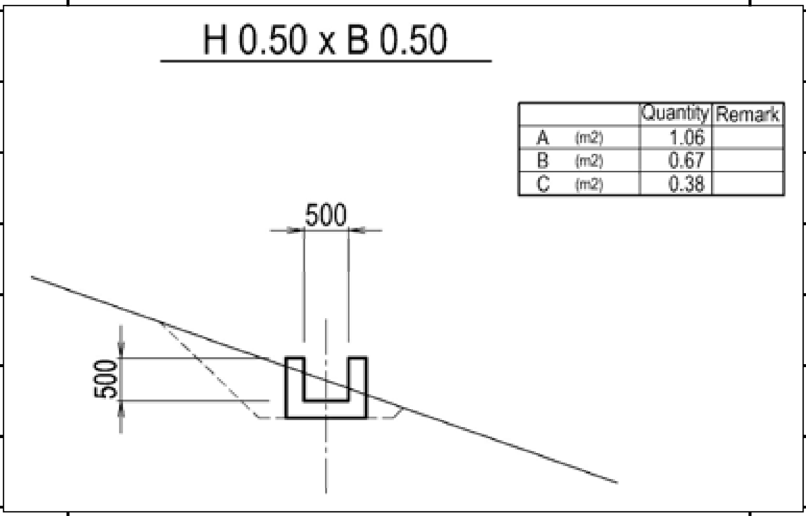
Ⅴ-2) H0.60×B0.60

Description	Calculation	Uinit	Quantity
Structure Length	160+470+420+600+490+320+200 = 2,660	m	2,660
Earth work			
Excavation work	2660×1.36 = 3,618	m^3	3,618
Backfilling work	2660×0.84 = 2,234	m^3	2,234
Canal work			
Wet masonry	2660×0.44 = 1,170	m^3	1,170



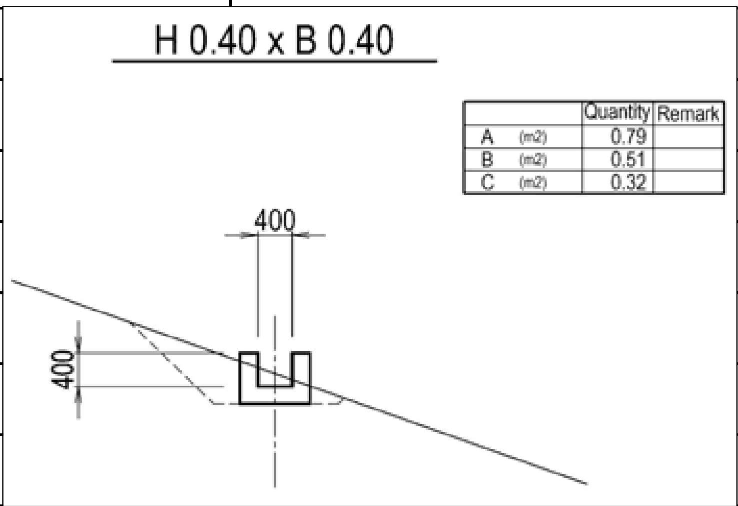
Ⅴ-3) H0.50×B0.50

Description	Calculation	Uinit	Quantity
Structure Length	510+910+1070+2280+1050+510+940 = 7,270	m	7,270
Earth work			
Excavation work	7270×1.06 = 7,706	m^3	7,706
Backfilling work	7270×0.67 = 4,871	m^3	4,871
Canal work			
Wet masonry	7270×0.38 = 2,763	m^3	2,763



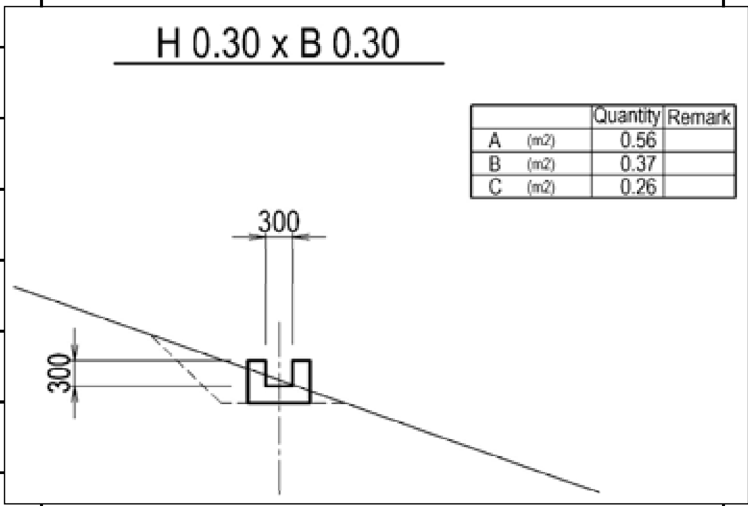
Ⅴ-4) H0.40×B0.40

Description	Calculation			Uinit	Quantity
Structure Length	920+830+950	=	2,700	m	2,700
Earth work					
Excavation work	2700×0.79	=	2,133	m^3	2,133
Backfilling work	2700×0.51	=	1,377	m^3	1,377
Canal work					
Wet masonry	2700×0.32	=	864	m^3	864



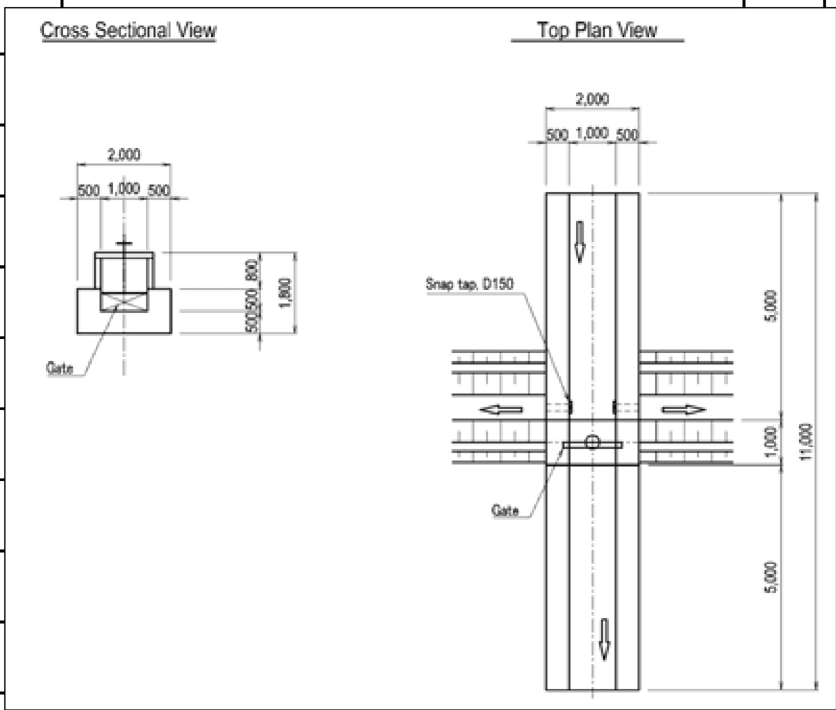
Ⅴ-5) H0.30×B0.30

Description	Calculation	Uinit	Quantity
Structure Length	1590+850+730+390+330+540+320+480+390+1190+980+470+940+850+900+1010+580+400 = 12,940	m	12,940
Earth work			
Excavation work	12940×0.56 = 7,246	m^3	7,246
Backfilling work	12940×0.37 = 4,788	m^3	4,788
Canal work			
Wet masonry	12940×0.26 = 3,364	m^3	3,364

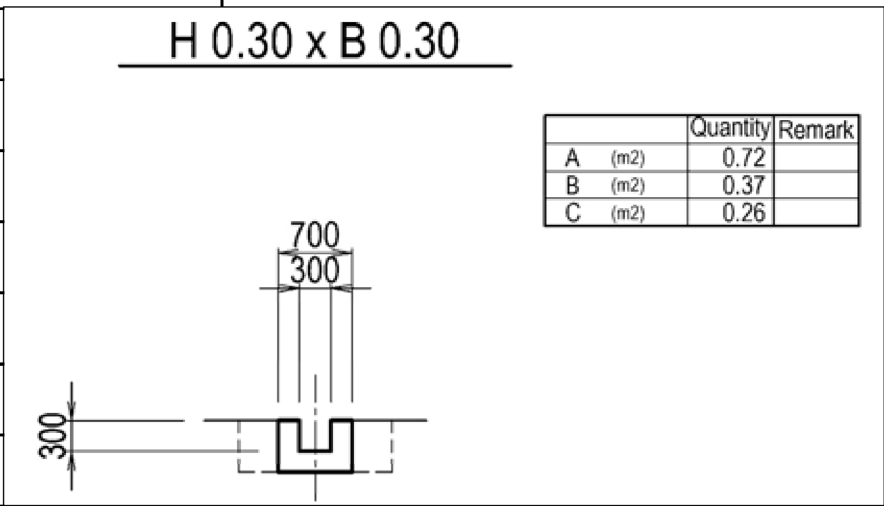


Ⅴ-6) Weir

Description	Calculation	Unit	Quantity
Earth work			
Excavation work	22×3.00×1.00×11.00 = 726	m^3	726
Backfilling work	22×1.00×1.00×11.00 = 242	m^3	242
Weir work			
Wet masonry	22×(2×0.50×1.00+1.00×0.50) = 33	m^3	33
Gate Steel gate		unit	22
Snap tap	2×22 = 44	unit	44



Description	Calculation	Unit	Quantity
Structure Length	200+60+60+200 Average length 60m = 520	m	520
Earth work			
Excavation work	22×520×0.72 = 8,237	m^3	8,237
Backfilling work	22×520×0.37 = 4,233	m^3	4,233
Canal work			
Wet masonry	22×520×0.26 = 2,974	m^3	2,974



Description	Calculation	Unit	Quantity
Levee borad	paddy field section 25m×25m 1000m/ha×35ha = 35,000	m	35,000

(b) Approximate cost estimation

(i) Summary of approximate cost estimation

Description	Unit	Quantity	Unit Cost (RWF)	Cost (RWF)	Remarks
i) Temporary work and general work	ls	1.0		467,485,000	
ii) Dam body	ls	1.0		1,099,675,600	
iii) Spillway	ls	1.0		67,042,000	
iv) Intake facilities	ls	1.0		266,256,000	
v) Irrigation facilities	ls	1.0		2,315,325,000	
vi) Approximate cost estimatio total			RWF	4,215,783,600	indirect construction cost included
			US$	6,968,237	1 US$=605 RWF
			Yen	557,458,988	1 US$=80 Yen

(ⅱ) Approximate cost estimation

Description	Unit	Quantity	Unit Cost (RWF)	Cost (RWF)	Remarks
ⅰ) Temporary work and general work					
Road maintenance and improvement of dam site					
Protection retaining wall of excavation slope	m	1000.0	51,750	51,750,000	Masonry；1.5m×0.3=0.45m3/m×75,000=33,750 Gravel；1.5m×0.3=0.45m3/m×40,000=18,000
Drain development (triple soil-cement lining)	m	2500.0	10,150	25,375,000	Soil-cement；(0.3+0.4×1.414×2)×0.2=0.29m3 0.29×35,000=10,150
Roadbed development (recompression of cut-and-cover)	m^3	4000.0	4,500	18,000,000	
Subbase development (cement improved soil)	m^3	1600.0	21,500	34,400,000	8,500+13,000(cement 50kg/m3)=21,500
Paving gravel	m^3	3200.0	40,000	128,000,000	coarse granular materials
Vegetation of slope protection	m^2	4000.0	1,500	6,000,000	
Sub total				263,525,000	
Temporary for dam					
Dewatering (temporary coffering)	ls			60,000	
Excavation of connecting canal of bottom outlet	m^3	100.0	6,500	650,000	
Temporary road	m	1000.0	147,000	147,000,000	7.0×1.0×1.0×13,000(cement 50kg/m3)=91,000 Gravel；7.0×0.2×1.0×40,000=56,000
Sub total				147,710,000	
General temporary construction					
Preparation of site	ls			7,500,000	
Site office construction	ls			30,000,000	
Field test room	ls			18,000,000	
Clearing and grubbing, deforestation	m^2	30000.0	25	750,000	
Sub total				56,250,000	
Temporary work and general work total				467,485,000	
ⅱ) Dam body					
Excavation	m^3	30657.0	4,500	137,956,500	
River bed drain, Intercepter	m^3	1285.0	30,000	38,550,000	
Foot of slope	m^3	30.0	25,300	759,000	0.3×75000+0.7×4000=25300
Riprap/ filter	m^3	3065.0	40,000	122,600,000	
Banking	m^3	86464.0	7,900	683,065,600	0.15×4500+0.85×8500=7900 （15%;excavation soil、85%;borrow area）
Protection crest (soil-cement)	m^3	638.0	35,000	22,330,000	Cement admixture 100kg/m3
Protection crest (soil-cement)	m^2	2943.0	1,500	4,414,500	
Observatory for dam	ls	1.0		90,000,000	
Dam body total				1,099,675,600	

Description	Unit	Quantity	Unit Cost (RWF)	Cost (RWF)	Remarks
iii) Spillway					
Masonry wall	m^3	156.4	75,000	11,730,000	
Earth blanket	m^3	47.0	8,500	399,500	
Riprap filter	m^3	56.0	40,000	2,240,000	
Excavation	m^3	849.0	4,500	3,820,500	
back-filling	m^3	309.0	5,500	1,699,500	
Reinforced concrete	m^3	142.6	300,000	42,792,000	
Vegetation of slope protection	m^3	165.0	1,500	247,500	
back-filling	m^3	145.0	4,500	652,500	
Bank protection (wet stone masonry)	m^3	67.0	31,500	2,110,500	Masonry；1.0×0.3×75000=22,500 Gravel；1.0×0.3×30,000=9,000
Bottom protection (wet stone masonry)	m^3	18.0	75,000	1,350,000	
Spillway total				67,042,000	
iv) Intake facilities					
Rainforced concrete					
including formwork	m^3	572	300,000	171,600,000	
Steel pipe					
φ800	m	80	500,000	40,000,000	
Needle type valve					
500mm	piece	1	42,000,000	42,000,000	
300mm	piece	1	6,000,000	6,000,000	
Butterfly type valve					
500mm	piece	1	2,972,000	2,972,000	
300mm	piece	3	1,228,000	3,684,000	
Intake facilities total				266,256,000	

Description	Unit	Quantity	Unit Cost (RWF)	Cost (RWF)	Remarks
V) Irrigation facilities					
HDPE					
φ500	m	50	140,000	7,000,000	
φ300	m	80	55,000	4,400,000	
φ150	m	2,450	16,000	39,200,000	
Pump	unit	17	18,150,000	308,550,000	
Warehouse	unit	17	3,000,000	51,000,000	
Tertiary					
HDPE φ90	m	36,000	6,000	216,000,000	
Water tap	m	1,440	200,000	288,000,000	
Earth work					
Excavation work	m^3	29,666	3,500	103,831,000	
Backfilling work	m^3	17,745	2,000	35,490,000	
Structure					
Wet masonry	m^3	11,168	75,000	837,600,000	
Gate	unit	22	5,000,000	110,000,000	
Snap tap	unit	44	65,000	2,860,000	
Levee borad	m	35,000	1,500	52,500,000	
Others	ls	1		258,894,000	Above Direct Construction Cost×10%
Irrigation facilities total				2,315,325,000	
Vi) Approximate cost estimatio total				4,215,783,600	indirect construction cost included
				6,968,237	1 US$=605 RWF
				557,458,988	1 US$=80 Yen

資料-6．6 月末までの観測データによる利用可能河川流量及び灌漑計画の見直し

第 4 章　ンゴマ 22 地区・灌漑セクターの計画

4-1．灌漑計画

4-1-1．用水計画調査

(1) 利用可能水量

(a) 利用可能河川流量

ｉ）検討方法

本年 2 月より観測されている雨量、流量データにより、日雨量を入力すると日流量を算出する流出解析モデルを作成する。

流出解析手法としては、年累加流量のような長期的な流量を対象としていることや、本地区の流量には過去からの降雨による地盤の飽和状況が強く影響していることから、このような場合に適する解析手法であるタンクモデル手法を用いることとする。

ⅱ）観測データの検討

本年 2 月より観測されている雨量、流量データの観測データを日単位（流出率は旬（10 日毎）単位の量）、及び観測開始以来の累加量として整理し、次図の履歴図に示す。

長期流出解析に重要な流出率に注目すると、旬流出率は 2 月～3 月中旬までは 15%程度、3 月下旬から 4 月下旬までは 5%程度に低下したまま継続した後、5 月初旬以降から５月下旬までは増加傾向を維持し、最大 40%を示すようになっている。６月にはいると降雨が全くなくなるので、流出率の分母がゼロとなり、流出率は発散してしまっている。

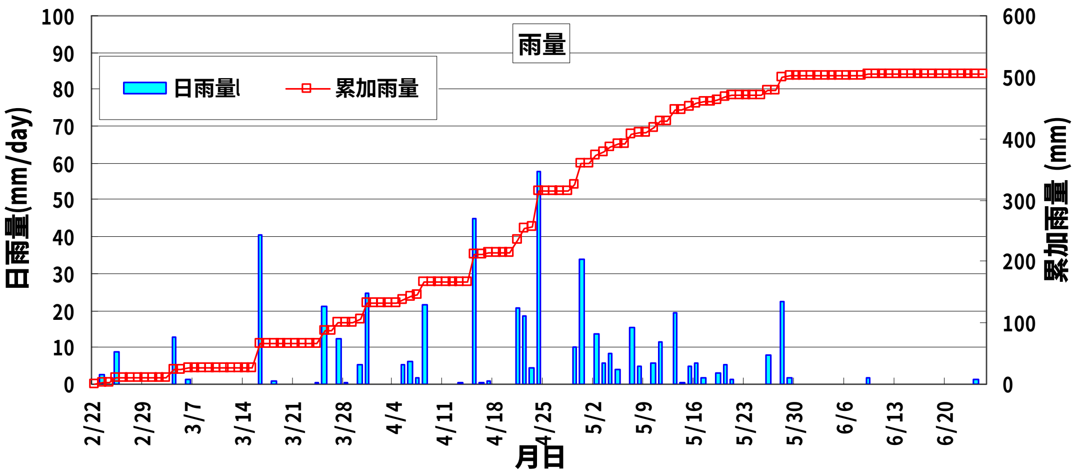
次に日流量に注目すると、2 月の観測開始から 4 月中旬まで 2 千 m3/日程度で概ね一定であり、20mm 以下の日雨量にはほとんど流量の増加を示していない。4 月下旬以降のまとまった降雨があって以降の日流量は、増加傾向を保ち、５月１０日にピークを示す。その後は減少傾向で推移するが、増加傾向～ピーク～減少傾向の変化はほぼ正三角形で、４圧２４日の最大降雨をピークとする日雨量の変化と相似している。ピークのずれは、ほぼ１５日である。

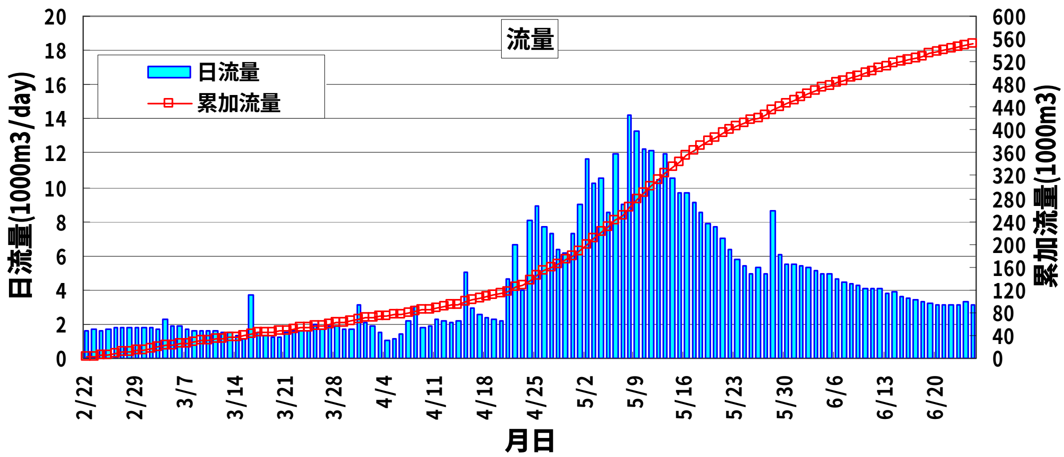
雨期に入って後の一定期間、流出率が 5%～15%程度と低い原因については、表層地盤が透水性のため降雨量が少なく地盤が乾燥している状況での降雨は、地盤へ浸透して流出し難いことと、蒸発散量が大きいことがその原因として考えられる。

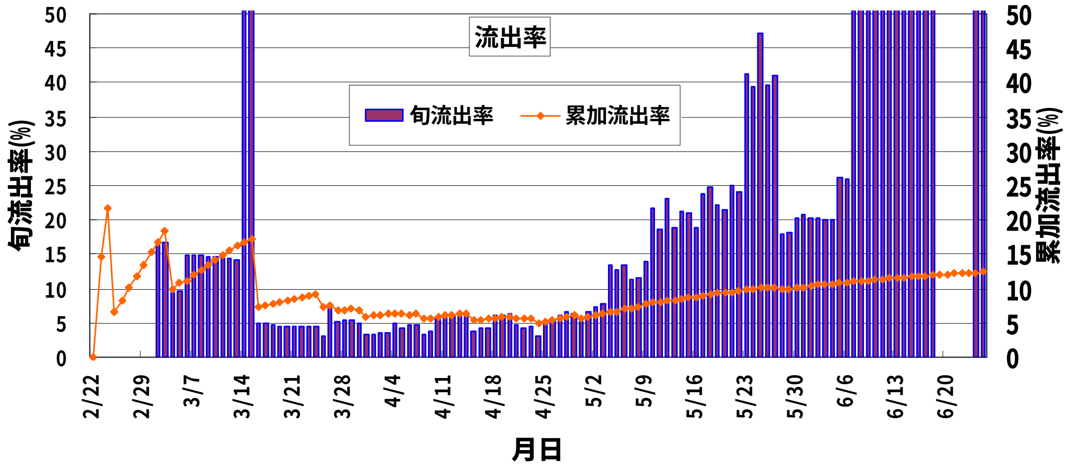
2 月～4 月に 2 千 m3/日程度の流量が継続していることについては、基底流量的な量と考えられる。

4 月下旬以降の降雨に対する日流量の増加については、ある程度まとまった降雨が継続すると、地盤が飽和して流出し易くなるためと考えられ、そのピーク時には 40%強の流出率となっている。観測期間中の全降雨に対する基底流量を含めた総流出率は 12.4%となっている。

2012/2/22～2012/6/25 (125日間) の観測結果(日データで整理)







流量・雨量の検討表

期間　2012/2/22-2012/6/25	
相関係数	0.996
累加流量	552　×1000 m3
累加雨量	505　mm
雨量の流量換算値	4,444　×1000 m3
(rainfall(mm)×8.8km2)	
流出率	12.4%

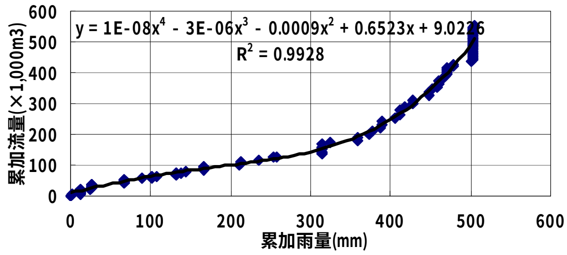


図 4-1-1-1 流量・雨量の観測結果

iii) タンクモデルの検討

a) 蒸発散量

タンクモデルの流出解析では、流域地表面からの蒸発散量を考慮する。ダム流域の斜面では、主としてメイズもしくはソルガムと豆類、コーヒー，バナナの果樹が栽培されている。これをメイズ～豆類とコーヒーに代表させると共に、将来の果樹作付け率の増加を考慮して両者の作付け率を 50%，50%として、旬毎に求めた蒸発散量を解析に適用する(表 4-1-1-1 参照)。

蒸発散量をタンク水深から差し引くタンクは上段（１段目）タンク、中段（２段目）タンクとし、上段タンクで水深が不足する場合のみ、不足量の 50%の範囲で中断タンク水深から差し引くこととした。

b) タンクモデル定数

観測値と計算値の相関係数が 0.9 以上であること、及び観測値と計算値の流出率が概ね一致することを目標に試算した結果、各定数を右図のようにした場合、次図の結果となり、相関係数は 0.961、流出量、流出率は観測値と同じそれぞれ 552,000m3，12.4%になったので、これを採用する。

なお、次節での各年の計算に用いるタンクの水深について、今回検証データが少ないことから、タンクの水深を前年からの継続で実施すると誤差が拡大する恐れがあるため、各年 1 月 1 日のタンク水深は右図の初期値で計算を開始することとする。

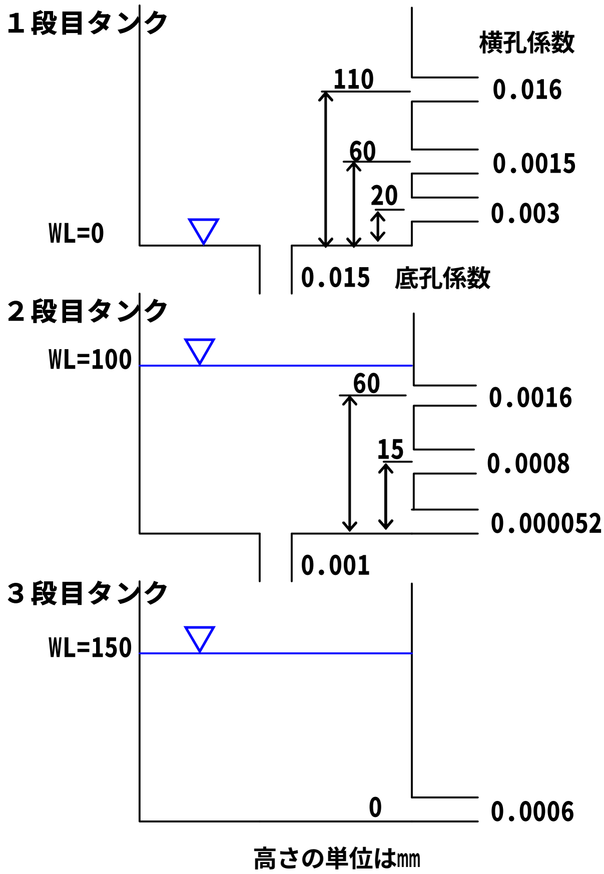
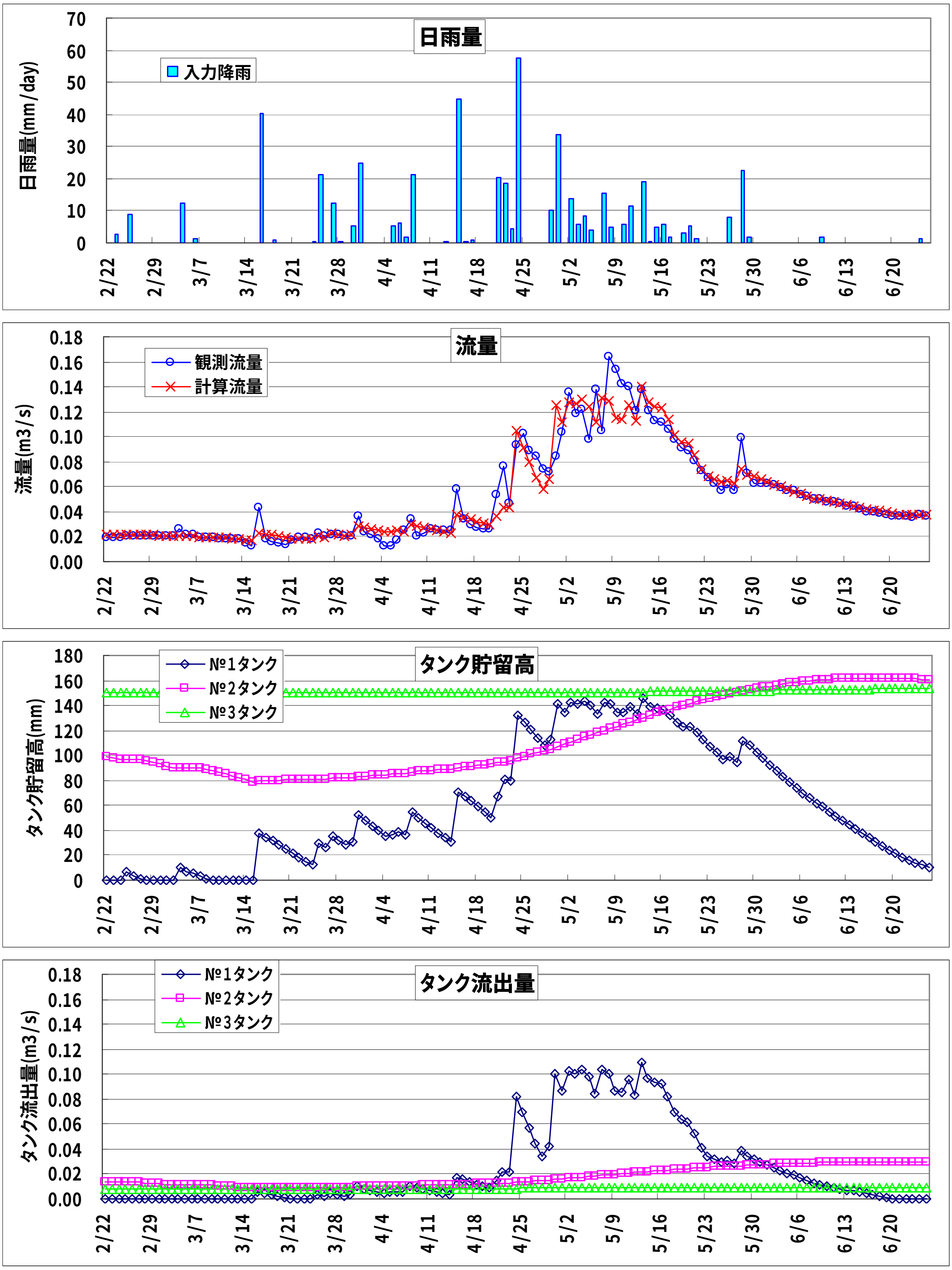


図 4-1-1-2 タンクモデル

Table 4-1-1-1 Weighed Average of Evapo-transpiration

Mon.	Dec.	Maize (Cultivation: 50%)			Beans (Cultivation: 50%)			Coffee (Cultivation: 50%)			Weighed Mean
1	1				1.86	1.86	1.86	3.38	3.91	3.89	2.79
	2				1.86	1.86	1.86	3.61	3.61	4.18	2.83
	3				1.86	1.86	1.86	3.67	3.67	3.67	2.77
2	1	1.24	1.24	1.24				3.72	3.72	3.72	2.48
	2	1.26	1.26	1.26				3.78	3.78	3.78	2.52
	3	1.30	1.23	1.23				3.70	3.70	3.71	2.48
3	1	2.00	1.26	1.21				3.62	3.62	3.62	2.56
	2	2.87	1.95	1.23				3.53	3.53	3.53	2.77
	3	3.65	2.77	1.90				3.37	3.37	3.37	3.07
4	1	4.25	3.51	2.68				3.20	3.20	3.20	3.34
	2	4.15	4.03	3.32				3.04	3.04	3.04	3.44
	3	4.08	4.08	3.96				2.99	2.99	2.99	3.52
5	1	4.01	4.01	4.01				2.98	2.94	2.94	3.48
	2	3.94	3.94	3.94				2.99	2.92	2.89	3.44
	3	3.43	3.89	3.89				3.03	2.96	2.89	3.35
6	1	2.42	3.34	3.84				3.06	3.00	2.93	3.10
	2	1.49	2.39	3.29				3.09	3.03	2.96	2.71
	3	1.54	1.54	2.47				3.26	3.20	3.13	2.52
7	1	1.55	1.55	1.55				3.32	3.30	3.24	2.42
	2	1.55	1.55	1.55				3.40	3.40	3.38	2.47
	3	1.55	1.55	1.55				3.91	3.91	3.92	2.73
8	1				1.87	1.87	1.87	4.53	4.53	4.55	3.20
	2				1.87	1.87	1.87	5.05	5.05	5.06	3.46
	3				1.87	1.87	1.87	4.95	4.96	4.97	3.42
9	1				1.87	1.87	1.87	4.83	4.83	4.84	3.35
	2				1.85	1.85	1.85	4.77	4.77	4.78	3.31
	3				2.53	1.86	1.86	4.79	4.79	4.81	3.44
10	1				3.83	2.57	1.89	4.88	4.88	4.90	3.83
	2				5.15	3.85	2.60	4.93	4.94	4.95	4.40
	3				4.21	4.69	3.55	4.50	4.50	4.51	4.33
11	1				4.58	4.54	4.16	3.96	3.96	3.97	4.20
	2				4.08	4.04	4.02	3.52	3.52	3.53	3.79
	3				4.00	3.97	3.96	3.47	3.47	3.48	3.73
12	1				3.01	3.86	3.86	3.38	3.38	3.39	3.48
	2				1.64	2.88	3.70	3.26	3.26	3.70	3.07
	3					1.78	3.06	3.50	3.55	3.56	2.58



タンクモデル計算結果

計算期間　2012/2/22-2012/6/25				
相関係数	0.961		流出率(%)	
累加流量　計算値	552　千m3		計算値	12.4%
累加流量　観測値	552　千m3		観測値	12.4%
累加雨量　観測値	505　mm			

図 4-1-1-3 タンクモデル計算流量と観測流量の比較

iv) 貯留可能量

ダムサイト近傍の降雨観測所として Gahororo と Kibungo があるが（共にダムサイトより直線距離で約 8km）、以下の理由により Gahororo のデータを採用する。

- Gahororo の降雨データは 1960 年から 1993 年まで 34 年間のものがある。
- 一方、Kibungo の降雨データは 1931 年から 63 年間のものがあるが、1981 年～1989 年の近年のデータが欠落している。
- 従って、近年の降雨減少傾向を踏まえると、近年の降雨データがそろっている Gahororo 観測所の降雨データを採用するのが妥当である。

図 4-1-1-4 GAHORORO 観測所とダムサイトの位置関係

Gahororo 観測所の 1960 年～1993 年まで 34 年間の日雨量データについて、各年の日流量をタンクモデルにより計算し、年累加流量を求めた結果を整理して**(表 4-1-1-2)**及び**(図 4-1-1-5)**に示す。

表 4-1-1-2 タンクモデルによる各年流量計算結果表

年	年流量(m3)	年雨量(mm)	流出率(%)	年流量の順位 豊水順位	渇水順位	
1960	1,467	1,133	14.7	10	25	
1961	1,616	1,320	13.9	6	29	
1962	787	1,067	8.4	26	9	
1963	1,368	1,183	13.1	12	23	
1964	896	1,094	9.3	22	13	
1965	1,536	1,304	13.4	8	27	
1966	1,663	1,366	13.8	5	30	データ修正
1967	372	856	4.9	34	1	
1968	2,483	1,349	20.9	1	34	
1969	1,049	1,095	10.9	16	19	
1970	894	1,134	9.0	23	12	
1971	670	984	7.7	29	6	
1972	921	1,147	9.1	21	14	
1973	634	918	7.8	30	5	
1974	722	1,002	8.2	27	8	
1975	526	1,022	5.8	32	3	
1976	888	1,145	8.8	24	11	
1977	1,335	1,166	13.0	13	22	
1978	1,608	1,268	14.4	7	28	
1979	2,470	1,269	22.1	2	33	
1980	706	883	9.1	28	7	欠測あり
1981	1,253	1,124	12.7	14	21	
1982	832	637	14.9	25	10	欠測あり
1983	455	822	6.3	33	2	欠測あり
1984	926	1,077	9.8	20	15	
1985	2,458	1,349	20.7	3	32	
1986	1,232	1,046	13.4	15	20	欠測あり
1987	1,008	1,161	9.9	18	17	欠測あり
1988	1,524	1,306	13.3	9	26	
1989	1,410	1,270	12.6	11	24	
1990	1,867	1,283	16.5	4	31	
1991	970	1,100	10.0	19	16	
1992	571	994	6.5	31	4	
1993	1,014	927	12.4	17	18	
平均	1,158	1,105	11.5			
最小	372	637	4.9			
最大	2,483	1,366	22.1			

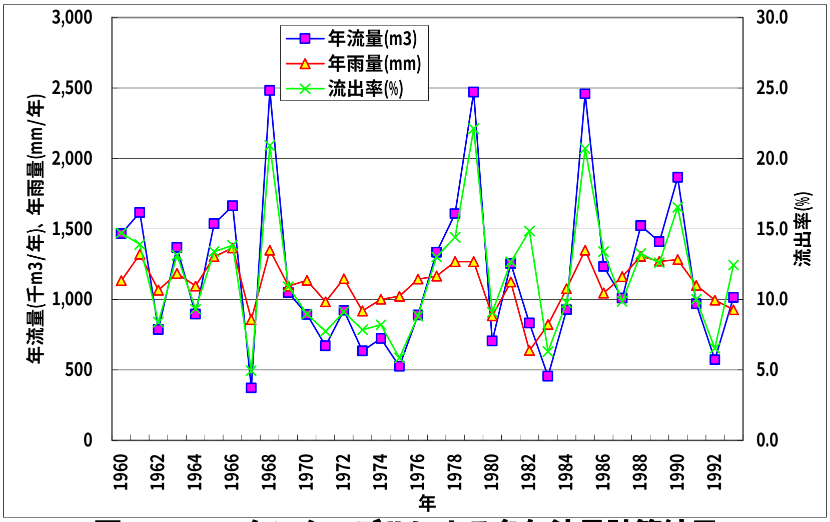


図 4-1-1-5 タンクモデルによる各年流量計算結果

ｖ）基準年及び利用可能河川流量

タンクモデルによる検討の結果得られた流入期待流量について、確率計算を行い、LWH・Nyanza-23 地区で採用している 3/10 確率に近い渇水年を基準年、そのときの流量を利用可能河川流量に設定する。

以下の計算結果から、3 年確率に相当する 894,000m[3] を利用可能水量、これに近い流量値となっている 1970 年を基準年に設定する。

表 4-1-1-3 確率雨量計算結果(1)

両端10% データ個数 N/10	下限定数 b
3	24.4

xl Max	xs Min	xg $\log_{10}xg$ $=\sum\log_{10}xi$	xl・xs-xg^2	2xg-(xl+xs)	bs xl･xs-xg^2 /2xg-(xl+xs)	b 平均bs
2,482.660	371.805	1097.9099	-282341.66	-658.64	428.67	428.7
2,470.078	525.779	1097.9099	93308.36	-800.04	-116.63	156.0
2,458.152	571.413	1097.9099	199213.67	-833.75	-238.94	24.4
1,867.161	633.948	1097.9099	-21723.66	-305.29	71.16	36.1
1,615.768	669.985	1097.9099	-122865.82	-89.93	1366.19	302.1
1,607.844	722.215	1097.9099	-44196.97	-134.24	329.24	306.6
1,535.836	787.150	1097.9099	3526.82	-127.17	-27.73	258.9
1,524.268	888.335	1097.9099	148653.52	-216.78	-685.73	140.8
1,466.800	893.767	1097.9099	105571.48	-164.75	-640.81	53.9
1,409.541	896.197	1097.9099	57820.46	-109.92	-526.03	-4.1

standard deviation Sx	1/a
0.19945	0.28724

(単位:×1000m3/year)

occurrence period of year T year	ξ	1/a・ξ	mean(Y) +1/a・ξ	x+b	Probability prediction to the occurrence x
1	0.0000	0.0000	3.0512	1125.1	1100.721
2	0.0000	0.0000	3.0512	1125.1	1100.721
3	0.3045	0.0875	2.9637	919.9	895.492
4	0.4769	0.1370	2.9142	820.7	796.363
5	0.5951	0.1709	2.8802	759.0	734.645
6	0.6858	0.1970	2.8542	714.8	690.451
7	0.7547	0.2168	2.8344	683.0	658.608
8	0.8134	0.2336	2.8175	657.0	632.600
9	0.8634	0.2480	2.8032	635.6	611.229
10	0.9062	0.2603	2.7909	617.9	593.489

表 4-1-1-3 確率雨量計算結果(2)

		②	③	④	⑤	⑥	⑦	⑧	⑨	⑩					
Effective samp	計 Tatal	0.00		85.136		85.433	261.787	50,932,043.6	88,757,922,391.4						
N= 28	計/N Total/N	0.00		3.041		3.051	9.350	1,819,001.6	3,169,925,799.7						
											※ In case of R.P. being less than 2.0, R.P.=1.0				
①		②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪				
Ranking	YEAR	xi	Fn(%)	$log_{10}xi$	xi+b	Y= log(xi+b)	Y^2	x^2	x^3	ξ	$period_1$	$period_2$	$ξ_1$	$ξ_2$	Repeat period (year)
1	1967	371.805	96.55	2.57031	396.172	2.59788	6.74900	138,238.705	51,397,794.8	1.5781	78	79	1.5780	1.5815	78.0
2	1975	525.779	93.10	2.72080	550.146	2.74048	7.51022	276,443.305	145,348,018.1	1.0817	15	16	1.0614	1.0848	15.9
3	1992	571.413	89.66	2.75695	595.780	2.77509	7.70110	326,512.682	186,573,552.4	0.9612	11	12	0.9442	0.9780	11.5
4	1973	633.948	86.21	2.80205	658.315	2.81843	7.94357	401,889.885	254,777,231.6	0.8103	7	8	0.7547	0.8134	7.9
5	1971	669.985	82.76	2.82607	694.353	2.84158	8.07458	448,880.047	300,742,947.2	0.7297	6	7	0.6858	0.7547	6.6
6	1974	722.215	79.31	2.85867	746.582	2.87308	8.25458	521,594.571	376,703,446.8	0.6201	5	6	0.5951	0.6858	5.3
7	1962	787.150	75.86	2.89606	811.517	2.90930	8.46401	619,604.523	487,721,464.0	0.4940	4	5	0.4769	0.5951	4.1
8	1976	888.335	72.41	2.94858	912.702	2.96033	8.76355	789,138.245	701,018,755.4	0.3163	3	4	0.3045	0.4769	3.1
9	1970	893.767	68.97	2.95122	918.134	2.96291	8.77881	798,819.468	713,958,487.5	0.3073	3	4	0.3045	0.4769	3.0
10	1964	896.197	65.52	2.95240	920.565	2.96405	8.78562	803,169.703	719,798,564.9	0.3033	2	3	0.0000	0.3045	3.0
11	1972	920.984	62.07	2.96425	945.351	2.97559	8.85416	848,211.487	781,189,188.8	0.2632	2	3	0.0000	0.3045	2.9
12	1984	925.900	58.62	2.96656	950.268	2.97785	8.86757	857,291.356	793,766,319.3	0.2553	2	3	0.0000	0.3045	2.8
13	1991	969.775	55.17	2.98667	994.142	2.99745	8.98470	940,463.250	912,037,603.2	0.1871	2	3	0.0000	0.3045	2.6
14	1993	1014.209	51.72	3.00613	1,038.577	3.01644	9.09890	1,028,620.377	1,043,236,288.3	0.1210	2	3	0.0000	0.3045	2.4
15	1969	1049.379	48.28	3.02093	1,073.746	3.03090	9.18637	1,101,196.072	1,155,571,921.4	0.0706	2	3	0.0000	0.3045	2.2
16	1981	1253.001	44.83	3.09795	1,277.369	3.10632	9.64920	1,570,012.463	1,967,227,785.4	-0.1919	1	2	0.0000	0.0000	1.0
17	1977	1334.529	41.38	3.12533	1,358.896	3.13319	9.81686	1,780,967.580	2,376,752,836.0	-0.2855	1	2	0.0000	0.0000	1.0
18	1963	1367.824	37.93	3.13603	1,392.191	3.14370	9.88284	1,870,941.895	2,559,118,816.1	-0.3221	1	2	0.0000	0.0000	1.0
19	1989	1409.541	34.48	3.14908	1,433.908	3.15652	9.96363	1,986,804.921	2,800,482,354.1	-0.3667	1	2	0.0000	0.0000	1.0
20	1960	1466.800	31.03	3.16637	1,491.168	3.17353	10.07127	2,151,502.909	3,155,824,958.0	-0.4259	1	2	0.0000	0.0000	1.0
21	1988	1524.268	27.59	3.18306	1,548.635	3.18995	10.17578	2,323,392.206	3,541,471,835.7	-0.4831	1	2	0.0000	0.0000	1.0
22	1965	1535.836	24.14	3.18634	1,560.204	3.19318	10.19641	2,358,793.262	3,622,720,409.2	-0.4943	1	2	0.0000	0.0000	1.0
23	1978	1607.844	20.69	3.20624	1,632.212	3.21278	10.32193	2,585,162.666	4,156,538,553.3	-0.5626	1	2	0.0000	0.0000	1.0
24	1961	1615.768	17.24	3.20838	1,640.135	3.21488	10.33545	2,610,705.493	4,218,293,796.9	-0.5699	1	2	0.0000	0.0000	1.0
25	1990	1867.161	13.79	3.27118	1,891.528	3.27681	10.73750	3,486,288.983	6,509,461,686.7	-0.7855	1	2	0.0000	0.0000	1.0
26	1985	2458.152	10.34	3.39061	2,482.520	3.39489	11.52530	6,042,512.338	14,853,415,119.3	-1.1966	1	2	0.0000	0.0000	1.0
27	1979	2470.078	6.90	3.39271	2,494.445	3.39697	11.53943	6,101,285.198	15,070,650,181.6	-1.2038	1	2	0.0000	0.0000	1.0
28	1968	2482.660	3.45	3.39492	2,507.027	3.39916	11.55428	6,163,600.037	15,302,122,475.5	-1.2114	1	2	0.0000	0.0000	1.0

(3) 灌漑計画

(a) 灌漑用水量（Irrigation Water Requirement）

本計画における灌漑用水量は、後述の「4.営農計画」で策定した作付体系に基づき、降水量や気温などの気象データを用いて算定した。

ｉ) 検討条件

1) 作付体系

本計画で提案する作付け体系（Cropping Pattern）および面積（Cropping Acreage）を以下に示す。

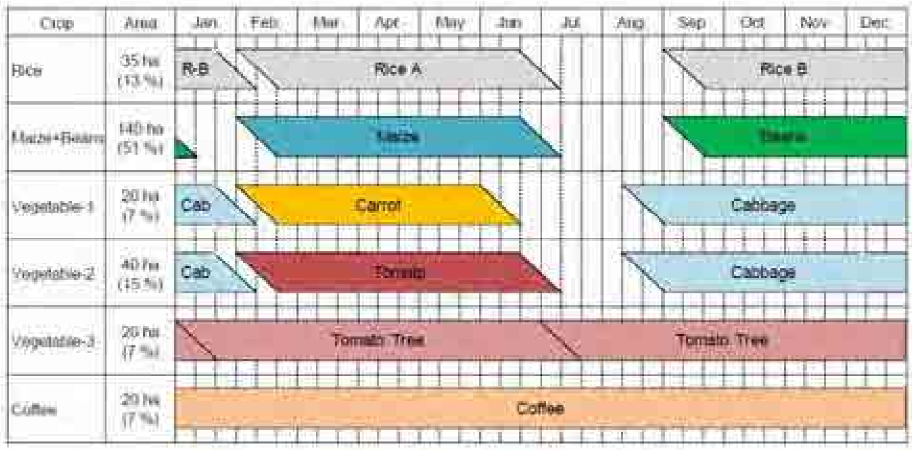


図 4-1-1-20 作付体系（Cropping Pattern）

表 4-1-1-11 作付面積（Cropping Acreage）

Crop		Cropping Acreage	Remarks
Rice Paddy		35 ha (13 %)	
Upland Cropping	Maize + Beans	140 ha (51 %)	
	Vegetable-1	20 ha (7 %)	Carrot + Cabbage
	Vegetable-2	40 ha (15 %)	Tomato + Cabbage
	Vegetable-3	20 ha (7 %)	Tomato Tree
	Coffee	20 ha (7 %)	
	Sub-total	240 ha (87 %)	
Total		275 ha (100 %)	

2) 気象データ

灌漑用水量（Irrigation Water Requirement）の算定に必要な気象データの内、降水量（Rainfall）および気温(Minimum & Maximum Temperature)はプロジェクト対象地域の近傍に位置するGahororo 観測所のデータを採用した。また、湿度（Relative Humidity）、風速（Wind Velocity）および日照時間（Sunshine Hours）についてはGahororo 観測所で観測されていないので、Kigali空港観測所のデータを採用した。

表 4-1-1-12 気象データ（Meteorological Data）

	Rainfall (mm)	Min.Temp. (℃)	Max.Temp (℃)	Humidity (%)	Wind (km/day)	Sunshine (hrs.)	Radiation (MJ/m^2/day)	RET (mm/day)
Jan.	188.2	10.0	25.3	77	324	6.1	18.6	4.01
Feb.	70.7	9.8	26.4	77	297	6.2	19.2	4.20
Mar.	91.8	10.3	26.6	77	257	4.9	17.2	3.93
Apr.	152.6	10.0	25.4	84	188	5.2	17.0	3.38
May	104.9	10.3	24.3	82	206	5.6	16.5	3.21
Jun.	4.5	11.1	25.6	84	197	5.4	15.6	3.09
Jul.	5.7	10.9	26.3	77	222	4.7	14.9	3.39
Aug.	53.5	9.9	26.8	64	292	7.7	20.2	4.79
Sep.	20.7	10.6	28.4	72	307	6.0	18.6	4.62
Oct.	118.4	9.5	27.5	74	336	6.7	19.9	4.68
Nov.	161.7	10.0	26.0	83	24	4.7	16.4	3.51
Dec.	161.6	10.4	23.8	85	226	5.4	17.3	3.26
Total/Ave	1,134.3	10.2	26.0	78	258	5.7	17.6	3.84

Notes

*1) Rainfall: Gahororo Station (Rurenge Sector, Ngoma District), 1970.01-12
*2) Minimum Temperature: Gahororo Station, 1970.01-12
*3) Maximum Temperature: Gahororo Station, 1970.01, 1974.02-04, 1970.05-12
*4) Humidity, Wind, and Sunshine: Kigali Station, 1974.01-12
*5)Radiation and RET (Reference Evapotranspiration) is calculated by CROPWAT8.0 based on other data.

ⅱ) 灌漑用水量の算定

1) 単位灌漑用水量（Unit Irrigation Water Requirement）

FAO（Food and Agriculture Organization，国連食糧農業機関）の灌漑用水推定モデル CROPWAT8.0 を用い、作物および作付体系毎に旬別の単位灌漑用水量（Unit Irrigation Water Requirement）を算定した。

（後掲「表 単位灌漑用水量（作物別）」，「表 単位灌漑用水量（作付体系別）」参照）

2) 純灌漑用水量（Net Irrigation Water Requirement）

単位灌漑用水量に基づき、作付面積を考慮して、作付体系毎に旬別の純灌漑用水量（Net Irrigation Water Requirement）を算定した。

（後掲「表 純灌漑用水量（作付体系別）」参照）

3) 粗灌漑用水量／取水量（Gross Irrigation Water Requirement）

純灌漑用水量に基づき、灌漑効率（Irrigation Efficiency）および灌水面積率（Wet Area Coefficient）を考慮して、旬別の粗灌漑用水量／取水量（Gross Irrigation Water Requirement）を算定した。

（後掲「表 粗灌漑用水量／取水量（作付体系別）」参照）

なお、本検討においては、灌漑効率および灌水面積率は以下のとおりとした。

灌漑効率（Irrigation Efficiency）

灌漑効率（E）は搬送効率（Ec: Conveyance Efficiency）と適用効率（Ea: Field Application Efficiency）の積として求められる。

ここで、FAO の”Irrigation Water Management Manual No.4: Irrigation Scheduling”によれば、搬送効率と適用効率は次のように示されている。

表 4-1-1-13 搬送効率（Ec: Conveyance Efficiency）

Description			Conveyance Efficiency (Ec)			
Canal Type			Earthen Canals			**Lined Canals**
Soil Type			Sand	Loam	Clay	-
Canal Length	Long	(> 2,000m)	60 %	70 %	80 %	**95 %**
	Medium	(200- 2,000m)	70 %	75 %	85 %	**95 %**
	Short	(< 200m)	80 %	85 %	90 %	**95 %**

表 4-1-1-14 適用効率（Ea: Field Application Efficiency）

Irrigation Methods	Field Application Efficiency (Ea)
Surface Irrigation (Border, Furrow, Basin)	60 %
Sprinkler Irrigation	75 %
Drip Irrigation	**90 %**

本地区では、幹線水路（Main Canal）および支線水路（Lateral Canal）が練石張り水路（Masonry Canal）で、また二次水路（Secondary Canal）が管水路（Pipeline）で計画されていることから、搬送効率は Lined Canal の場合の 95%とした。

また、圃場内ではホース灌漑を計画しているので、適用効率は Drip Irrigation の場合の 90%を採用した。

これらより、灌漑効率は以下のとおり 85%とした。

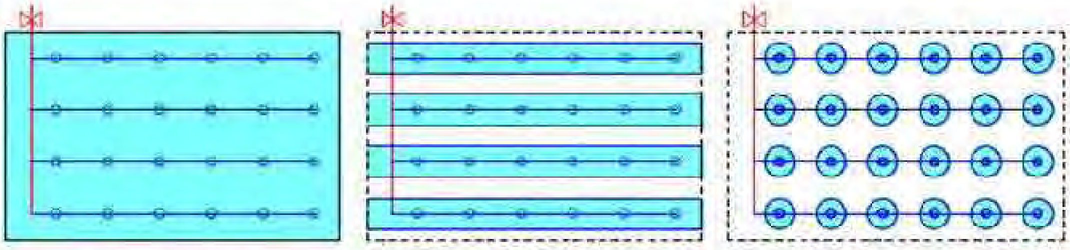
灌漑効率 E ＝ 搬送効率 Ec × Ea ＝ 95% × 90% ＝ 85%

なお、水田については、灌漑用水を循環利用することから、灌漑効率は 100%とした。

灌水面積率（Wet Area Coefficient）

JICA が 2005 年 3 月から 3 年間亘り実施した「シリア国節水灌漑農業普及計画プロジェクト」（”Project on Development of Efficient Irrigation Techniques and Extension in Syria (DEITEX)”）では、栽培作物それぞれに応じた節水灌漑技術・手法を確立し普及させるために、節水灌漑マニュアル（”Manual on Design Standard of Efficient Irrigation System and On-farm Irrigation Management”）を作成した。

それによれば、灌水面積率（Wet Are Coefficient）は以下のとおり灌漑方法や放水ノズル（emitter）の配置により異なるとされている。



Kw=100%　　　　　　　　　　　　Kw<100%

Table 4.5 Wetting area coefficient Kw

Irrigation method	Kw (%)	Remarks
Surface irrigation	100	
Sprinkler irrigation	100	
GR irrigation	70-100	GR : Drip tube
Micro irrigation	40–70	Micro emitter, Micro sprinkler

・地表灌漑（Surface Irrigation）およびスプリンクラー灌漑（Sprinkler Irrigation）

地表およびスプリンクラー灌漑は地表全面に対して灌水することから、灌水面積率（Kw: Wet Area Coefficient）は 100%となる。

・点滴灌漑（Drip/GR Irrigation）およびマイクロ灌漑（Micro Irrigation）

一方、点滴およびマイクロ灌漑の場合は、点滴チューブに沿った一定幅の範囲または作物の周囲など、局所的に灌水する。したがって、灌水面積率は点滴灌漑の場合 70-100%、またマイクロ灌漑の場合は 40-70%とされている。

ここで、本地区ではホース灌漑の導入を計画していることから、灌水面積率は「マイクロ灌漑」の値を採用するものとし、Kw=40、50、60 および 70%の 4 ケースについて検討した。

表 4-1-1-15 単位灌漑用水量（作物別） (Unit Irrigation Water Requirement (per Crop))

Unit Irrigation Water Requirement (per Crop)

(Units: mm/dec)

Month	Decade	Days	Rice Paddy: Rice A 1st.Plant	Rice A 2nd.Plant	Rice A 3rd.Plant	Rice A Average	Rice Paddy: Rice B 1st.Plant	Rice B 2nd.Plant	Rice B 3rd.Plant	Rice B Average	Upland Cropping: Maize 1st.Plant	Maize 2nd.Plant	Maize 3rd.Plant	Maize Average	Upland Cropping: Beans 1st.Plant	Beans 2nd.Plant	Beans 3rd.Plant	Beans Average
Jan.	1st.	10	0.0			**0.0**	0.0	0.0	1.3	**0.4**				**0.0**			0.0	**0.0**
	2nd.	10	101.6	0.0		**33.9**	0.0	0.0	0.0	**0.0**				**0.0**				**0.0**
	3rd.	11	182.7	106.8	0.0	**96.5**		0.0	9.5	**3.2**				**0.0**				**0.0**
Feb.	1st.	10	19.6	208.2	120.0	**115.9**			3.0	**1.0**	0.0			**0.0**				**0.0**
	2nd.	10	29.3	29.3	218.0	**92.2**				**0.0**	0.0	0.0		**0.0**				**0.0**
	3rd.	8	16.2	16.2	16.2	**16.2**				**0.0**	0.0	0.0	0.0	**0.0**				**0.0**
Mar.	1st.	10	21.0	20.5	20.5	**20.7**				**0.0**	0.0	0.0	0.0	**0.0**				**0.0**
	2nd.	10	20.0	18.6	18.1	**18.9**				**0.0**	3.6	0.0	0.0	**1.2**				**0.0**
	3rd.	11	19.2	17.8	16.3	**17.8**				**0.0**	10.6	1.0	0.0	**3.9**				**0.0**
Apr.	1st.	10	7.0	5.9	4.6	**5.8**				**0.0**	6.2	0.0	0.0	**2.1**				**0.0**
	2nd.	10	0.0	0.0	0.0	**0.0**				**0.0**	0.0	0.0	0.0	**0.0**				**0.0**
	3rd.	10	3.3	3.3	3.0	**3.2**				**0.0**	3.5	3.4	2.2	**3.0**				**0.0**
May	1st.	10	6.0	6.0	6.0	**6.0**				**0.0**	6.2	6.2	6.1	**6.2**				**0.0**
	2nd.	10	7.6	7.6	7.5	**7.6**				**0.0**	7.8	7.7	7.7	**7.7**				**0.0**
	3rd.	11	19.3	21.0	21.0	**20.4**				**0.0**	16.1	21.2	21.1	**19.5**				**0.0**
Jun.	1st.	10	29.1	32.2	33.9	**31.7**				**0.0**	19.9	29.1	34.1	**27.7**				**0.0**
	2nd.	10	29.8	32.9	36.0	**32.9**				**0.0**	14.9	23.9	32.9	**23.9**				**0.0**
	3rd.	10		30.5	33.8	**21.4**				**0.0**		15.1	24.4	**13.2**				**0.0**
Jul.	1st.	10			30.8	**10.3**				**0.0**			15.0	**5.0**				**0.0**
	2nd.	10				**0.0**				**0.0**				**0.0**				**0.0**
	3rd.	11				**0.0**				**0.0**				**0.0**				**0.0**
Aug.	1st.	10				**0.0**	0.0			**0.0**				**0.0**				**0.0**
	2nd.	10				**0.0**	129.7	0.0		**43.2**				**0.0**				**0.0**
	3rd.	11				**0.0**	231.2	138.3	0.0	**123.2**				**0.0**				**0.0**
Sep.	1st.	10				**0.0**	44.9	234.4	145.2	**141.5**				**0.0**	12.1			**4.0**
	2nd.	10				**0.0**	49.1	49.1	238.5	**112.2**				**0.0**	16.8	16.8		**11.2**
	3rd.	10				**0.0**	39.3	39.3	39.3	**39.3**				**0.0**	13.5	6.8	6.8	**9.0**
Oct.	1st.	10				**0.0**	27.9	26.8	26.8	**27.2**				**0.0**	13.2	0.5	0.0	**4.6**
	2nd.	10				**0.0**	21.2	19.2	18.2	**19.5**				**0.0**	17.0	4.0	0.0	**7.0**
	3rd.	11				**0.0**	21.4	19.4	17.6	**19.5**				**0.0**	21.0	15.3	2.8	**13.0**
Nov.	1st.	10				**0.0**	9.3	8.0	6.6	**8.0**				**0.0**	7.8	7.3	3.6	**6.2**
	2nd.	10				**0.0**	1.2	0.9	0.0	**0.7**				**0.0**	0.0	0.0	0.0	**0.0**
	3rd.	10				**0.0**	0.9	0.7	0.8	**0.8**				**0.0**	0.0	0.0	0.0	**0.0**
Dec.	1st.	10				**0.0**	0.9	0.8	0.9	**0.9**				**0.0**	0.0	0.0	0.0	**0.0**
	2nd.	10				**0.0**	0.0	0.0	0.0	**0.0**				**0.0**	0.0	0.0	0.0	**0.0**
	3rd.	11				**0.0**	3.4	5.7	5.9	**5.0**				**0.0**		0.0	0.0	**0.0**
Annual IWR (mm/yr.)			*511.7*	*556.8*	*585.7*	***551.4***	*580.4*	*542.6*	*513.6*	***545.5***	*88.8*	*107.6*	*143.5*	***113.3***	*101.4*	*50.7*	*13.2*	***55.1***
Max. IWR (mm/dec.)						***115.9***				***141.5***				***27.7***				***13.0***

Month	Decade	Days	Upland Cropping: Carrot 1st.Plant	Carrot 2nd.Plant	Carrot 3rd.Plant	Carrot Average	Cabbage 1st.Plant	Cabbage 2nd.Plant	Cabbage 3rd.Plant	Cabbage Average	Tomato 1st.Plant	Tomato 2nd.Plant	Tomato 3rd.Plant	Tomato Average	Tomato Tree 1st.Plant	Tomato Tree 2nd.Plant	Tomato Tree 3rd.Plant	Tomato Tree Average	Coffee 1st.Plant	Coffee 2nd.Plant	Coffee 3rd.Plant	Coffee Average
Jan.	1st.	10				**0.0**	0.0	0.0	0.0	**0.0**				**0.0**	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	**0.0**
	2nd.	10				**0.0**	0.0	0.0	0.0	**0.0**				**0.0**	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	**0.0**
	3rd.	11				**0.0**	8.2	7.6	9.8	**8.5**				**0.0**	0.0	0.0	0.0	**0.0**	1.6	1.6	1.6	**1.6**
Feb.	1st.	10	3.1			**1.0**		4.2	16.9	**7.0**	0.0			**0.0**	6.8	2.0	0.0	**2.9**	11.4	11.4	11.4	**11.4**
	2nd.	10	12.5	12.5		**8.3**			4.2	**1.4**	8.3	8.3		**5.5**	21.1	16.3	11.4	**16.3**	20.9	20.9	20.9	**20.9**
	3rd.	8	4.9	3.0	3.0	**3.6**				**0.0**	0.0	0.0	0.0	**0.0**	13.2	9.4	5.6	**9.4**	9.6	9.6	9.6	**9.6**
Mar.	1st.	10	11.1	6.2	4.4	**7.2**				**0.0**	2.5	0.4	0.4	**1.1**	21.0	16.3	11.6	**16.3**	12.5	12.5	12.5	**12.5**
	2nd.	10	13.8	8.9	4.1	**8.9**				**0.0**	6.0	0.5	0.0	**2.2**	21.1	18.5	13.9	**17.8**	10.2	10.2	10.2	**10.2**
	3rd.	11	14.5	11.4	6.3	**10.7**				**0.0**	9.2	3.4	0.0	**4.2**	18.9	18.8	16.3	**18.0**	7.5	7.5	7.5	**7.5**
Apr.	1st.	10	1.8	1.6	0.0	**1.1**				**0.0**	2.5	0.0	0.0	**0.8**	5.5	5.4	5.3	**5.4**	0.0	0.0	0.0	**0.0**
	2nd.	10	0.0	0.0	0.0	**0.0**				**0.0**	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	**0.0**
	3rd.	10	0.0	0.0	0.0	**0.0**				**0.0**	1.5	1.5	0.0	**1.0**	1.7	1.6	1.5	**1.6**	0.0	0.0	0.0	**0.0**
May	1st.	10	1.0	0.9	0.9	**0.9**				**0.0**	4.3	4.3	4.2	**4.3**	4.5	4.4	4.3	**4.4**	0.0	0.0	0.0	**0.0**
	2nd.	10	1.9	2.6	2.5	**2.3**				**0.0**	5.9	5.8	5.8	**5.8**	6.1	6.0	5.9	**6.0**	0.0	0.0	0.0	**0.0**
	3rd.	11	12.9	14.7	15.5	**14.4**				**0.0**	16.0	19.1	19.1	**18.1**	19.4	19.3	19.1	**19.3**	11.7	11.0	10.2	**11.0**
Jun.	1st.	10		26.6	28.2	**18.3**				**0.0**	23.6	29.2	32.3	**28.4**	32.4	32.4	32.3	**32.4**	26.4	25.7	25.0	**25.7**
	2nd.	10			30.5	**10.2**				**0.0**	11.6	27.5	33.0	**24.0**	31.7	36.1	36.1	**34.6**	30.9	30.3	29.6	**30.3**
	3rd.	10				**0.0**				**0.0**		11.9	28.1	**13.3**	22.9	32.4	36.9	**30.7**	32.3	31.7	31.0	**31.7**
Jul.	1st.	10				**0.0**				**0.0**			11.9	**4.0**	18.8	23.1	32.6	**24.8**	32.7	32.5	31.9	**32.4**
	2nd.	10				**0.0**				**0.0**				**0.0**	19.8	19.8	24.2	**21.3**	34.0	34.0	33.8	**33.9**
	3rd.	11				**0.0**				**0.0**				**0.0**	22.8	19.8	19.8	**20.8**	37.7	37.8	37.9	**37.8**
Aug.	1st.	10				**0.0**				**0.0**				**0.0**	21.4	16.0	12.6	**16.7**	31.5	31.6	31.7	**31.6**
	2nd.	10				**0.0**	14.5			**4.8**				**0.0**	25.4	19.4	13.5	**19.4**	30.8	30.8	30.9	**30.8**
	3rd.	11				**0.0**	21.6	21.6	3.4	**15.5**				**0.0**	40.1	33.5	27.1	**33.6**	39.1	39.2	39.3	**39.2**
Sep.	1st.	10				**0.0**	26.2	26.2	26.2	**26.2**				**0.0**	48.4	42.7	36.9	**42.7**	41.7	41.7	41.8	**41.7**
	2nd.	10				**0.0**	30.7	30.6	30.6	**30.6**				**0.0**	54.1	52.3	46.7	**51.0**	46.0	46.0	46.1	**46.0**
	3rd.	10				**0.0**	22.6	20.7	20.7	**21.3**				**0.0**	44.3	44.1	42.3	**43.6**	36.1	36.1	36.2	**36.1**
Oct.	1st.	10				**0.0**	12.8	9.9	8.0	**10.2**				**0.0**	32.0	31.7	31.5	**31.7**	23.6	23.6	23.8	**23.7**
	2nd.	10				**0.0**	7.0	4.1	1.1	**4.1**				**0.0**	23.4	23.1	22.9	**23.1**	14.9	14.9	15.1	**15.0**
	3rd.	11				**0.0**	8.5	5.5	2.6	**5.5**				**0.0**	21.7	21.4	21.2	**21.4**	13.2	13.2	13.4	**13.3**
Nov.	1st.	10				**0.0**	0.3	0.0	0.0	**0.1**				**0.0**	8.3	8.1	7.9	**8.1**	1.5	1.6	1.7	**1.6**
	2nd.	10				**0.0**	0.0	0.0	0.0	**0.0**				**0.0**	0.2	0.0	0.0	**0.1**	0.0	0.0	0.0	**0.0**
	3rd.	10				**0.0**	0.0	0.0	0.0	**0.0**				**0.0**	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	**0.0**
Dec.	1st.	10				**0.0**	0.0	0.0	0.0	**0.0**				**0.0**	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	**0.0**
	2nd.	10				**0.0**	0.0	0.0	0.0	**0.0**				**0.0**	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	**0.0**
	3rd.	11				**0.0**	0.0	0.0	0.3	**0.1**				**0.0**	0.0	0.0	3.7	**1.2**	0.0	0.0	0.0	**0.0**
Annual IWR (mm/yr.)			*77.5*	*88.4*	*95.4*	***87.1***	*152.4*	*130.4*	*123.8*	***135.5***	*91.4*	*111.9*	*134.8*	***112.7***	*226.3*	*242.0*	*257.0*	***574.7***	*557.8*	*555.4*	*553.1*	***555.4***
Max. IWR (mm/dec.)						***18.3***				***30.6***				***28.4***	*380.7*	*331.9*	*286.1*	***51.0***				***46.0***

Notes

*1) Irrigation Water Requirement : Calculated by CROPWAT8 based on cropping pattern for Ngoma22.

表 4-1-1-16 単位灌漑用水量（作付体系別）
(Unit Irrigation Water Requirement (per Cropping Pattern)

Unit Irrigation Water Requirement (per Cropping Pattern)

(Units: mm/dec)

Month	Decade	Days	Rice Paddy			Upland Cropping											
						Maize + Beans			Vegetable 1			Vegetable 2			Vegetable 3		
			Rice A (Average)	Rice B (Average)	Total	Maize (Average)	Beans (Average)	Sub-total	Carrot (Average)	Cabbage (Average)	Sub-total	Tomato (Average)	Cabbage (Average)	Sub-total	Tomato Tree (Average)	Coffee (Average)	Total
Jan.	1st.	10	0.0	0.4	**0.4**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
	2nd.	10	33.9	0.0	**33.9**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
	3rd.	11	96.5	3.2	**99.7**	0.0	0.0	0.0	0.0	8.5	8.5	0.0	8.5	8.5	0.0	1.6	**18.7**
Feb.	1st.	10	115.9	1.0	**116.9**	0.0	0.0	0.0	1.0	7.0	8.1	0.0	7.0	7.0	2.9	11.4	**29.4**
	2nd.	10	92.2	0.0	**92.2**	0.0	0.0	0.0	8.3	1.4	9.7	5.5	1.4	6.9	16.3	20.9	**53.8**
	3rd.	8	16.2	0.0	**16.2**	0.0	0.0	0.0	3.6	0.0	3.6	0.0	0.0	0.0	9.4	9.6	**22.6**
Mar.	1st.	10	20.7	0.0	**20.7**	0.0	0.0	0.0	7.2	0.0	7.2	1.1	0.0	1.1	16.3	12.5	**37.1**
	2nd.	10	18.9	0.0	**18.9**	1.2	0.0	1.2	8.9	0.0	8.9	2.2	0.0	2.2	17.8	10.2	**40.3**
	3rd.	11	17.8	0.0	**17.8**	3.9	0.0	3.9	10.7	0.0	10.7	4.2	0.0	4.2	18.0	7.5	**44.3**
Apr.	1st.	10	5.8	0.0	**5.8**	2.1	0.0	2.1	1.1	0.0	1.1	0.8	0.0	0.8	5.4	0.0	**9.4**
	2nd.	10	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
	3rd.	10	3.2	0.0	**3.2**	3.0	0.0	3.0	0.0	0.0	0.0	1.0	0.0	1.0	1.6	0.0	**5.6**
May	1st.	10	6.0	0.0	**6.0**	6.2	0.0	6.2	0.9	0.0	0.9	4.3	0.0	4.3	4.4	0.0	**15.8**
	2nd.	10	7.6	0.0	**7.6**	7.7	0.0	7.7	2.3	0.0	2.3	5.8	0.0	5.8	6.0	0.0	**21.9**
	3rd.	11	20.4	0.0	**20.4**	19.5	0.0	19.5	14.4	0.0	14.4	18.1	0.0	18.1	19.3	11.0	**82.1**
Jun.	1st.	10	31.7	0.0	**31.7**	27.7	0.0	27.7	18.3	0.0	18.3	28.4	0.0	28.4	32.4	25.7	**132.4**
	2nd.	10	32.9	0.0	**32.9**	23.9	0.0	23.9	10.2	0.0	10.2	24.0	0.0	24.0	34.6	30.3	**123.0**
	3rd.	10	21.4	0.0	**21.4**	13.2	0.0	13.2	0.0	0.0	0.0	13.3	0.0	13.3	30.7	31.7	**88.9**
Jul.	1st.	10	10.3	0.0	**10.3**	5.0	0.0	5.0	0.0	0.0	0.0	4.0	0.0	4.0	24.8	32.4	**66.2**
	2nd.	10	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.3	33.9	**55.2**
	3rd.	11	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.8	37.8	**58.6**
Aug.	1st.	10	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7	31.6	**48.3**
	2nd.	10	0.0	43.2	**43.2**	0.0	0.0	0.0	0.0	4.8	4.8	0.0	4.8	4.8	19.4	30.8	**59.9**
	3rd.	11	0.0	123.2	**123.2**	0.0	0.0	0.0	0.0	15.5	15.5	0.0	15.5	15.5	33.6	39.2	**103.8**
Sep.	1st.	10	0.0	141.5	**141.5**	0.0	4.0	4.0	0.0	26.2	26.2	0.0	26.2	26.2	42.7	41.7	**140.8**
	2nd.	10	0.0	112.2	**112.2**	0.0	11.2	11.2	0.0	30.6	30.6	0.0	30.6	30.6	51.0	46.0	**169.5**
	3rd.	10	0.0	39.3	**39.3**	0.0	9.0	9.0	0.0	21.3	21.3	0.0	21.3	21.3	43.6	36.1	**131.4**
Oct.	1st.	10	0.0	27.2	**27.2**	0.0	4.6	4.6	0.0	10.2	10.2	0.0	10.2	10.2	31.7	23.7	**80.4**
	2nd.	10	0.0	19.5	**19.5**	0.0	7.0	7.0	0.0	4.1	4.1	0.0	4.1	4.1	23.1	15.0	**53.2**
	3rd.	11	0.0	19.5	**19.5**	0.0	13.0	13.0	0.0	5.5	5.5	0.0	5.5	5.5	21.4	13.3	**58.8**
Nov.	1st.	10	0.0	8.0	**8.0**	0.0	6.2	6.2	0.0	0.1	0.1	0.0	0.1	0.1	8.1	1.6	**16.1**
	2nd.	10	0.0	0.7	**0.7**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	**0.1**
	3rd.	10	0.0	0.8	**0.8**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Dec.	1st.	10	0.0	0.9	**0.9**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
	2nd.	10	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
	3rd.	11	0.0	5.0	**5.0**	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.1	1.2	0.0	**1.4**
Annual IWR (mm/yr.)			*551.4*	*545.5*	***1,096.9***	*113.3*	*55.1*	*168.4*	*87.1*	*135.5*	*222.6*	*112.7*	*135.5*	*248.2*	*574.7*	*555.4*	***1,769.4***
Max. IWR (mm/dec.)			*115.9*	*141.5*	***141.5***	*27.7*	*13.0*	*27.7*	*18.3*	*30.6*	*30.6*	*28.4*	*30.6*	*30.6*	*51.0*	*46.0*	***169.5***

表 4-1-1-17 純灌漑用水量（作付体系別）
(Net Irrigation Water Requirement (per Cropping Pattern)

Net Irrigation Water Requirement (per Cropping Pattern)

(Unit: m^3/dec)

Month	Decade	Days	Rice Paddy			Upland Cropping												Grand Total
						Maize + Beans			Vegetable 1			Vegetable 2			Vegetable 3	Coffee	Total	
			Rice A	Rice B	**Total**	Maize	Beans	Sub-total	Carrot	Cabbage	Sub-total	Tomato	Cabbage	Sub-total	Tomato Tree			
			35.0 ha (13 %)			140.0 ha (51 %)			20.0 ha (7 %)			40.0 ha (15 %)			20.0 ha (7 %)	20.0 ha (7 %)	**240.0 ha (87 %)**	275.0 ha (100 %)
Jan.	1st.	10	0.0	151.7	**151.7**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	151.7
	2nd.	10	11,853.3	0.0	**11,853.3**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	11,853.3
	3rd.	11	33,775.0	1,108.3	**34,883.3**	0.0	0.0	0.0	0.0	1,706.7	1,706.7	0.0	3,413.3	3,413.3	0.0	320.0	**5,440.0**	40,323.3
Feb.	1st.	10	40,576.7	350.0	**40,926.7**	0.0	0.0	0.0	206.7	1,406.7	1,613.3	0.0	2,813.3	2,813.3	586.7	2,280.0	**7,293.3**	48,220.0
	2nd.	10	32,270.0	0.0	**32,270.0**	0.0	0.0	0.0	1,666.7	280.0	1,946.7	2,213.3	560.0	2,773.3	3,253.3	4,180.0	**12,153.3**	44,423.3
	3rd.	8	5,670.0	0.0	**5,670.0**	0.0	0.0	0.0	726.7	0.0	726.7	0.0	0.0	0.0	1,880.0	1,920.0	**4,526.7**	10,196.7
Mar.	1st.	10	7,233.3	0.0	**7,233.3**	0.0	0.0	0.0	1,446.7	0.0	1,446.7	440.0	0.0	440.0	3,260.0	2,500.0	**7,646.7**	14,880.0
	2nd.	10	6,615.0	0.0	**6,615.0**	1,680.0	0.0	1,680.0	1,786.7	0.0	1,786.7	866.7	0.0	866.7	3,566.7	2,040.0	**9,940.0**	16,555.0
	3rd.	11	6,218.3	0.0	**6,218.3**	5,413.3	0.0	5,413.3	2,146.7	0.0	2,146.7	1,680.0	0.0	1,680.0	3,600.0	1,500.0	**14,340.0**	20,558.3
Apr.	1st.	10	2,041.7	0.0	**2,041.7**	2,893.3	0.0	2,893.3	226.7	0.0	226.7	333.3	0.0	333.3	1,080.0	0.0	**4,533.3**	6,575.0
	2nd.	10	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0
	3rd.	10	1,120.0	0.0	**1,120.0**	4,246.7	0.0	4,246.7	0.0	0.0	0.0	400.0	0.0	400.0	320.0	0.0	**4,966.7**	6,086.7
May	1st.	10	2,100.0	0.0	**2,100.0**	8,633.3	0.0	8,633.3	186.7	0.0	186.7	1,706.7	0.0	1,706.7	880.0	0.0	**11,406.7**	13,506.7
	2nd.	10	2,648.3	0.0	**2,648.3**	10,826.7	0.0	10,826.7	466.7	0.0	466.7	2,333.3	0.0	2,333.3	1,200.0	0.0	**14,826.7**	17,475.0
	3rd.	11	7,151.7	0.0	**7,151.7**	27,253.3	0.0	27,253.3	2,873.3	0.0	2,873.3	7,226.7	0.0	7,226.7	3,853.3	2,193.3	**43,400.0**	50,551.7
Jun.	1st.	10	11,106.7	0.0	**11,106.7**	38,780.0	0.0	38,780.0	3,653.3	0.0	3,653.3	11,346.7	0.0	11,346.7	6,473.3	5,140.0	**65,393.3**	76,500.0
	2nd.	10	11,515.0	0.0	**11,515.0**	33,460.0	0.0	33,460.0	2,033.3	0.0	2,033.3	9,613.3	0.0	9,613.3	6,926.7	6,053.3	**58,086.7**	69,601.7
	3rd.	10	7,501.7	0.0	**7,501.7**	18,433.3	0.0	18,433.3	0.0	0.0	0.0	5,333.3	0.0	5,333.3	6,146.7	6,333.3	**36,246.7**	43,748.3
Jul.	1st.	10	3,593.3	0.0	**3,593.3**	7,000.0	0.0	7,000.0	0.0	0.0	0.0	1,586.7	0.0	1,586.7	4,966.7	6,473.3	**20,026.7**	23,620.0
	2nd.	10	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4,253.3	6,786.7	**11,040.0**	11,040.0
	3rd.	11	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4,160.0	7,560.0	**11,720.0**	11,720.0
Aug.	1st.	10	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3,333.3	6,320.0	**9,653.3**	9,653.3
	2nd.	10	0.0	15,131.7	**15,131.7**	0.0	0.0	0.0	0.0	966.7	966.7	0.0	1,933.3	1,933.3	3,886.7	6,166.7	**12,953.3**	28,085.0
	3rd.	11	0.0	43,108.3	**43,108.3**	0.0	0.0	0.0	0.0	3,106.7	3,106.7	0.0	6,213.3	6,213.3	6,713.3	7,840.0	**23,873.3**	66,981.7
Sep.	1st.	10	0.0	49,525.0	**49,525.0**	0.0	5,646.7	5,646.7	0.0	5,240.0	5,240.0	0.0	10,480.0	10,480.0	8,533.3	8,346.7	**38,246.7**	87,771.7
	2nd.	10	0.0	39,281.7	**39,281.7**	0.0	15,680.0	15,680.0	0.0	6,126.7	6,126.7	0.0	12,253.3	12,253.3	10,206.7	9,206.7	**53,473.3**	92,755.0
	3rd.	10	0.0	13,755.0	**13,755.0**	0.0	12,646.7	12,646.7	0.0	4,266.7	4,266.7	0.0	8,533.3	8,533.3	8,713.3	7,226.7	**41,386.7**	55,141.7
Oct.	1st.	10	0.0	9,508.3	**9,508.3**	0.0	6,393.3	6,393.3	0.0	2,046.7	2,046.7	0.0	4,093.3	4,093.3	6,346.7	4,733.3	**23,613.3**	33,121.7
	2nd.	10	0.0	6,836.7	**6,836.7**	0.0	9,800.0	9,800.0	0.0	813.3	813.3	0.0	1,626.7	1,626.7	4,626.7	2,993.3	**19,860.0**	26,696.7
	3rd.	11	0.0	6,813.3	**6,813.3**	0.0	18,246.7	18,246.7	0.0	1,106.7	1,106.7	0.0	2,213.3	2,213.3	4,286.7	2,653.3	**28,506.7**	35,320.0
Nov.	1st.	10	0.0	2,788.3	**2,788.3**	0.0	8,726.7	8,726.7	0.0	20.0	20.0	0.0	40.0	40.0	1,620.0	320.0	**10,726.7**	13,515.0
	2nd.	10	0.0	245.0	**245.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.3	0.0	**13.3**	258.3
	3rd.	10	0.0	280.0	**280.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	280.0
Dec.	1st.	10	0.0	303.3	**303.3**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	303.3
	2nd.	10	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0
	3rd.	11	0.0	1,750.0	**1,750.0**	0.0	0.0	0.0	0.0	20.0	20.0	0.0	40.0	40.0	246.7	0.0	**306.7**	2,056.7
Annual IWR (m^3/yr.)			*192,990.0*	*190,936.7*	***383,926.7***	*158,620.0*	*77,140.0*	*235,760.0*	*17,420.0*	*27,106.7*	*44,526.7*	*45,080.0*	*54,213.3*	*99,293.3*	*114,933.3*	*111,086.7*	***605,600.0***	*989,526.7*
Max IWR (m^3/dec.)			*40,576.7*	*49,525.0*	***49,525.0***	*38,780.0*	*18,246.7*	*38,780.0*	*3,653.3*	*6,126.7*	*6,126.7*	*11,346.7*	*12,253.3*	*12,253.3*	*10,206.7*	*9,206.7*	***65,393.3***	*92,755.0*

Notes

*1) Net Irrigation Water Requirement (m^3/dec) = Unit Irrigation Water Requirement (mm/dec) / 1,000 (mm/m) * Cropping Acreage (has) * 10,000 (m^2/ha)

Legend of Table

Crop Combination		
Crop	Crop	Total
Crop Acreage (ha) (Crop Acreage (%))		

表 4-1-1-18 粗灌漑用水量／取水量（作付体系別）

(Gross Irrigation Water Requirement (per Cropping Pattern)

Case-1：灌水面積率 (Wet Area Coefficient) = 40%

Gross Irrigation Water Requirement (per Cropping Pattern) (Unit: m^3/dec)

Month	Decade	Days	Rice Paddy			Upland Cropping												Grand Total
						Maize + Beans			Vegetable 1			Vegetable 2			Vegetable 3	Coffee	Total	
			Rice A	Rice B	Total	Maize	Beans	Sub-total	Carrot	Cabbage	Sub-total	Tomato	Cabbage	Sub-total	Tomato Tree			
			35.0 ha (13 %)			140.0 ha (51 %)			20.0 ha (7 %)			40.0 ha (15 %)			20.0 ha (7 %)	20.0 ha (7 %)	**240.0 ha (87 %)**	275.0 ha (100 %)
Jan.	1st.	10	0.0	151.7	**151.7**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	151.7
	2nd.	10	11,853.3	0.0	**11,853.3**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	11,853.3
	3rd.	11	33,775.0	1,108.3	**34,883.3**	0.0	0.0	0.0	0.0	803.1	803.1	0.0	1,606.3	1,606.3	0.0	150.6	**2,560.0**	37,443.3
Feb.	1st.	10	40,576.7	350.0	**40,926.7**	0.0	0.0	0.0	97.3	662.0	759.2	0.0	1,323.9	1,323.9	276.1	1,072.9	**3,432.2**	44,358.8
	2nd.	10	32,270.0	0.0	**32,270.0**	0.0	0.0	0.0	784.3	131.8	916.1	1,041.6	263.5	1,305.1	1,531.0	1,967.1	**5,719.2**	37,989.2
	3rd.	8	5,670.0	0.0	**5,670.0**	0.0	0.0	0.0	342.0	0.0	342.0	0.0	0.0	0.0	884.7	903.5	**2,130.2**	7,800.2
Mar.	1st.	10	7,233.3	0.0	**7,233.3**	0.0	0.0	0.0	680.8	0.0	680.8	207.1	0.0	207.1	1,534.1	1,176.5	**3,598.4**	10,831.8
	2nd.	10	6,615.0	0.0	**6,615.0**	790.6	0.0	790.6	840.8	0.0	840.8	407.8	0.0	407.8	1,678.4	960.0	**4,677.6**	11,292.6
	3rd.	11	6,218.3	0.0	**6,218.3**	2,547.5	0.0	2,547.5	1,010.2	0.0	1,010.2	790.6	0.0	790.6	1,694.1	705.9	**6,748.2**	12,966.6
Apr.	1st.	10	2,041.7	0.0	**2,041.7**	1,361.6	0.0	1,361.6	106.7	0.0	106.7	156.9	0.0	156.9	508.2	0.0	**2,133.3**	4,175.0
	2nd.	10	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0
	3rd.	10	1,120.0	0.0	**1,120.0**	1,998.4	0.0	1,998.4	0.0	0.0	0.0	188.2	0.0	188.2	150.6	0.0	**2,337.3**	3,457.3
May	1st.	10	2,100.0	0.0	**2,100.0**	4,062.7	0.0	4,062.7	87.8	0.0	87.8	803.1	0.0	803.1	414.1	0.0	**5,367.8**	7,467.8
	2nd.	10	2,648.3	0.0	**2,648.3**	5,094.9	0.0	5,094.9	219.6	0.0	219.6	1,098.0	0.0	1,098.0	564.7	0.0	**6,977.3**	9,625.6
	3rd.	11	7,151.7	0.0	**7,151.7**	12,825.1	0.0	12,825.1	1,352.2	0.0	1,352.2	3,400.8	0.0	3,400.8	1,813.3	1,032.2	**20,423.5**	27,575.2
Jun.	1st.	10	11,106.7	0.0	**11,106.7**	18,249.4	0.0	18,249.4	1,719.2	0.0	1,719.2	5,339.6	0.0	5,339.6	3,046.3	2,418.8	**30,773.3**	41,880.0
	2nd.	10	11,515.0	0.0	**11,515.0**	15,745.9	0.0	15,745.9	956.9	0.0	956.9	4,523.9	0.0	4,523.9	3,259.6	2,848.6	**27,334.9**	38,849.9
	3rd.	10	7,501.7	0.0	**7,501.7**	8,674.5	0.0	8,674.5	0.0	0.0	0.0	2,509.8	0.0	2,509.8	2,892.5	2,980.4	**17,057.3**	24,558.9
Jul.	1st.	10	3,593.3	0.0	**3,593.3**	3,294.1	0.0	3,294.1	0.0	0.0	0.0	746.7	0.0	746.7	2,337.3	3,046.3	**9,424.3**	13,017.6
	2nd.	10	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2,001.6	3,193.7	**5,195.3**	5,195.3
	3rd.	11	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1,957.6	3,557.6	**5,515.3**	5,515.3
Aug.	1st.	10	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1,568.6	2,974.1	**4,542.7**	4,542.7
	2nd.	10	0.0	15,131.7	**15,131.7**	0.0	0.0	0.0	0.0	454.9	454.9	0.0	909.8	909.8	1,829.0	2,902.0	**6,095.7**	21,227.4
	3rd.	11	0.0	43,108.3	**43,108.3**	0.0	0.0	0.0	0.0	1,462.0	1,462.0	0.0	2,923.9	2,923.9	3,159.2	3,689.4	**11,234.5**	54,342.8
Sep.	1st.	10	0.0	49,525.0	**49,525.0**	0.0	2,657.3	2,657.3	0.0	2,465.9	2,465.9	0.0	4,931.8	4,931.8	4,015.7	3,927.8	**17,998.4**	67,523.4
	2nd.	10	0.0	39,281.7	**39,281.7**	0.0	7,378.8	7,378.8	0.0	2,883.1	2,883.1	0.0	5,766.3	5,766.3	4,803.1	4,332.5	**25,163.9**	64,445.6
	3rd.	10	0.0	13,755.0	**13,755.0**	0.0	5,951.4	5,951.4	0.0	2,007.8	2,007.8	0.0	4,015.7	4,015.7	4,100.4	3,400.8	**19,476.1**	33,231.1
Oct.	1st.	10	0.0	9,508.3	**9,508.3**	0.0	3,008.6	3,008.6	0.0	963.1	963.1	0.0	1,926.3	1,926.3	2,986.7	2,227.5	**11,112.2**	20,620.5
	2nd.	10	0.0	6,836.7	**6,836.7**	0.0	4,611.8	4,611.8	0.0	382.7	382.7	0.0	765.5	765.5	2,177.3	1,408.6	**9,345.9**	16,182.5
	3rd.	11	0.0	6,813.3	**6,813.3**	0.0	8,586.7	8,586.7	0.0	520.8	520.8	0.0	1,041.6	1,041.6	2,017.3	1,248.6	**13,414.9**	20,228.2
Nov.	1st.	10	0.0	2,788.3	**2,788.3**	0.0	4,106.7	4,106.7	0.0	9.4	9.4	0.0	18.8	18.8	762.4	150.6	**5,047.8**	7,836.2
	2nd.	10	0.0	245.0	**245.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3	0.0	**6.3**	251.3
	3rd.	10	0.0	280.0	**280.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	280.0
Dec.	1st.	10	0.0	303.3	**303.3**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	303.3
	2nd.	10	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0
	3rd.	11	0.0	1,750.0	**1,750.0**	0.0	0.0	0.0	0.0	9.4	9.4	0.0	18.8	18.8	116.1	0.0	**144.3**	1,894.3
Annual IWR (m^3/yr.)			*192,990.0*	*190,936.7*	***383,926.7***	*74,644.7*	*36,301.2*	*110,945.9*	*8,197.6*	*12,756.1*	*20,953.7*	*21,214.1*	*25,512.2*	*46,726.3*	*54,086.3*	*52,276.1*	***284,988.2***	*668,914.9*
Max IWR (m^3/dec.)			*40,576.7*	*49,525.0*	***49,525.0***	*18,249.4*	*8,586.7*	*18,249.4*	*1,719.2*	*2,883.1*	*2,883.1*	*5,339.6*	*5,766.3*	*5,766.3*	*4,803.1*	*4,332.5*	***30,773.3***	*67,523.4*

Notes

*1) Gross Irrigation Water Requirement (m^3/dec) = Net Irrigation Water Requirement (m^3/dec) / Irrigation Efficiency (%) * Wet Area Coefficient (%)

*2)	Irrigation Efficiency	: Rice	100 %	
		: Upland Cropping	85 %	(= 95% (Conveyance Efficiency, "Lined Canal" FAO) * 90% (Field Application Efficiency, "Drip Irrigation" FAO)
*3)	Wet Area Coefficient	: Rice	100 %	(= "Surface Irrigation", JICA)
		: Upland Cropping	**40 %**	(= "Micro Irrigation", JICA)

Legend of Table

Crop Combination		
Crop	Crop	Total
Crop Acreage (ha)		
(Crop Acreage (%))		

表 4-1-1-19 粗灌漑用水量／取水量（作付体系別）
(Gross Irrigation Water Requirement (per Cropping Pattern)
Case-2：灌水面積率 (Wet Area Coefficient) = 50%

Gross Irrigation Water Requirement (per Cropping Pattern)

(Unit: m^3/dec)

Month	Decade	Days	Rice Paddy			Upland Cropping												Grand Total
						Maize + Beans			Vegetable 1			Vegetable 2			Vegetable 3	Coffee	Total	
			Rice A	Rice B	Total	Maize	Beans	Sub-total	Carrot	Cabbage	Sub-total	Tomato	Cabbage	Sub-total	Tomato Tree			
			35.0 ha (13 %)			140.0 ha (51 %)			20.0 ha (7 %)			40.0 ha (15 %)			20.0 ha (7 %)	20.0 ha (7 %)	240.0 ha (87 %)	275.0 ha (100 %)
Jan.	1st.	10	0.0	151.7	**151.7**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	151.7
	2nd.	10	11,853.3	0.0	**11,853.3**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	11,853.3
	3rd.	11	33,775.0	1,108.3	**34,883.3**	0.0	0.0	0.0	0.0	1,003.9	1,003.9	0.0	2,007.8	2,007.8	0.0	188.2	**3,200.0**	38,083.3
Feb.	1st.	10	40,576.7	350.0	**40,926.7**	0.0	0.0	0.0	121.6	827.5	949.0	0.0	1,654.9	1,654.9	345.1	1,341.2	**4,290.2**	45,216.9
	2nd.	10	32,270.0	0.0	**32,270.0**	0.0	0.0	0.0	980.4	164.7	1,145.1	1,302.0	329.4	1,631.4	1,913.7	2,458.8	**7,149.0**	39,419.0
	3rd.	8	5,670.0	0.0	**5,670.0**	0.0	0.0	0.0	427.5	0.0	427.5	0.0	0.0	0.0	1,105.9	1,129.4	**2,662.7**	8,332.7
Mar.	1st.	10	7,233.3	0.0	**7,233.3**	0.0	0.0	0.0	851.0	0.0	851.0	258.8	0.0	258.8	1,917.6	1,470.6	**4,498.0**	11,731.4
	2nd.	10	6,615.0	0.0	**6,615.0**	988.2	0.0	988.2	1,051.0	0.0	1,051.0	509.8	0.0	509.8	2,098.0	1,200.0	**5,847.1**	12,462.1
	3rd.	11	6,218.3	0.0	**6,218.3**	3,184.3	0.0	3,184.3	1,262.7	0.0	1,262.7	988.2	0.0	988.2	2,117.6	882.4	**8,435.3**	14,653.6
Apr.	1st.	10	2,041.7	0.0	**2,041.7**	1,702.0	0.0	1,702.0	133.3	0.0	133.3	196.1	0.0	196.1	635.3	0.0	**2,666.7**	4,708.3
	2nd.	10	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0
	3rd.	10	1,120.0	0.0	**1,120.0**	2,498.0	0.0	2,498.0	0.0	0.0	0.0	235.3	0.0	235.3	188.2	0.0	**2,921.6**	4,041.6
May	1st.	10	2,100.0	0.0	**2,100.0**	5,078.4	0.0	5,078.4	109.8	0.0	109.8	1,003.9	0.0	1,003.9	517.6	0.0	**6,709.8**	8,809.8
	2nd.	10	2,648.3	0.0	**2,648.3**	6,368.6	0.0	6,368.6	274.5	0.0	274.5	1,372.5	0.0	1,372.5	705.9	0.0	**8,721.6**	11,369.9
	3rd.	11	7,151.7	0.0	**7,151.7**	16,031.4	0.0	16,031.4	1,690.2	0.0	1,690.2	4,251.0	0.0	4,251.0	2,266.7	1,290.2	**25,529.4**	32,681.1
Jun.	1st.	10	11,106.7	0.0	**11,106.7**	22,811.8	0.0	22,811.8	2,149.0	0.0	2,149.0	6,674.5	0.0	6,674.5	3,807.8	3,023.5	**38,466.7**	49,573.3
	2nd.	10	11,515.0	0.0	**11,515.0**	19,682.4	0.0	19,682.4	1,196.1	0.0	1,196.1	5,654.9	0.0	5,654.9	4,074.5	3,560.8	**34,168.6**	45,683.6
	3rd.	10	7,501.7	0.0	**7,501.7**	10,843.1	0.0	10,843.1	0.0	0.0	0.0	3,137.3	0.0	3,137.3	3,615.7	3,725.5	**21,321.6**	28,823.2
Jul.	1st.	10	3,593.3	0.0	**3,593.3**	4,117.6	0.0	4,117.6	0.0	0.0	0.0	933.3	0.0	933.3	2,921.6	3,807.8	**11,780.4**	15,373.7
	2nd.	10	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2,502.0	3,992.2	**6,494.1**	6,494.1
	3rd.	11	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2,447.1	4,447.1	**6,894.1**	6,894.1
Aug.	1st.	10	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1,960.8	3,717.6	**5,678.4**	5,678.4
	2nd.	10	0.0	15,131.7	**15,131.7**	0.0	0.0	0.0	0.0	568.6	568.6	0.0	1,137.3	1,137.3	2,286.3	3,627.5	**7,619.6**	22,751.3
	3rd.	11	0.0	43,108.3	**43,108.3**	0.0	0.0	0.0	0.0	1,827.5	1,827.5	0.0	3,654.9	3,654.9	3,949.0	4,611.8	**14,043.1**	57,151.5
Sep.	1st.	10	0.0	49,525.0	**49,525.0**	0.0	3,321.6	3,321.6	0.0	3,082.4	3,082.4	0.0	6,164.7	6,164.7	5,019.6	4,909.8	**22,498.0**	72,023.0
	2nd.	10	0.0	39,281.7	**39,281.7**	0.0	9,223.5	9,223.5	0.0	3,603.9	3,603.9	0.0	7,207.8	7,207.8	6,003.9	5,415.7	**31,454.9**	70,736.6
	3rd.	10	0.0	13,755.0	**13,755.0**	0.0	7,439.2	7,439.2	0.0	2,509.8	2,509.8	0.0	5,019.6	5,019.6	5,125.5	4,251.0	**24,345.1**	38,100.1
Oct.	1st.	10	0.0	9,508.3	**9,508.3**	0.0	3,760.8	3,760.8	0.0	1,203.9	1,203.9	0.0	2,407.8	2,407.8	3,733.3	2,784.3	**13,890.2**	23,398.5
	2nd.	10	0.0	6,836.7	**6,836.7**	0.0	5,764.7	5,764.7	0.0	478.4	478.4	0.0	956.9	956.9	2,721.6	1,760.8	**11,682.4**	18,519.0
	3rd.	11	0.0	6,813.3	**6,813.3**	0.0	10,733.3	10,733.3	0.0	651.0	651.0	0.0	1,302.0	1,302.0	2,521.6	1,560.8	**16,768.6**	23,582.0
Nov.	1st.	10	0.0	2,788.3	**2,788.3**	0.0	5,133.3	5,133.3	0.0	11.8	11.8	0.0	23.5	23.5	952.9	188.2	**6,309.8**	9,098.1
	2nd.	10	0.0	245.0	**245.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8	0.0	**7.8**	252.8
	3rd.	10	0.0	280.0	**280.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	280.0
Dec.	1st.	10	0.0	303.3	**303.3**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	303.3
	2nd.	10	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0
	3rd.	11	0.0	1,750.0	**1,750.0**	0.0	0.0	0.0	0.0	11.8	11.8	0.0	23.5	23.5	145.1	0.0	**180.4**	1,930.4
Annual IWR (m^3/yr.)			*192,990.0*	*190,936.7*	***383,926.7***	*93,305.9*	*45,376.5*	*138,682.4*	*10,247.1*	*15,945.1*	*26,192.2*	*26,517.6*	*31,890.2*	*58,407.8*	*67,607.8*	*65,345.1*	***356,235.3***	*740,162.0*
Max IWR (m^3/dec.)			*40,576.7*	*49,525.0*	***49,525.0***	*22,811.8*	*10,733.3*	*22,811.8*	*2,149.0*	*3,603.9*	*3,603.9*	*6,674.5*	*7,207.8*	*7,207.8*	*6,003.9*	*5,415.7*	***38,466.7***	*72,023.0*

Notes

*1) Gross Irrigation Water Requirement (m^3/dec) = Net Irrigation Water Requirement (m^3/dec) / Irrigation Efficiency (%) * Wet Area Coefficient (%)

*2) Irrigation Efficiency : Rice 100 %
: Upland Cropping 85 % (= 95% (Conveyance Efficiency, "Lined Canal" FAO) * 90% (Field Application Efficiency, "Drip Irrigation" FAO)

*3) Wet Area Coefficient : Rice 100 % (= "Surface Irrigation", JICA)
: Upland Cropping **50 %** (= "Micro Irrigation", JICA)

Legend of Table

Crop Combination		
Crop	Crop	Total
Crop Acreage (ha)		
(Crop Acreage (%))		

表 4-1-1-20 粗灌漑用水量／取水量（作付体系別）
(Gross Irrigation Water Requirement (per Cropping Pattern)
Case-3：灌水面積率 (Wet Area Coefficient) = 60%

Gross Irrigation Water Requirement (per Cropping Pattern)

(Unit: m³/dec)

Month	Decade	Days	Rice Paddy			Upland Cropping													Grand Total
						Maize + Beans			Vegetable 1			Vegetable 2			Vegetable 3	Coffee	Total		
			Rice A	Rice B	Total	Maize	Beans	Sub-total	Carrot	Cabbage	Sub-total	Tomato	Cabbage	Sub-total	Tomato Tree				
			35.0 ha (13 %)			140.0 ha (51 %)			20.0 ha (7 %)			40.0 ha (15 %)			20.0 ha (7 %)	20.0 ha (7 %)	240.0 ha (87 %)		275.0 ha (100 %)
Jan.	1st.	10	0.0	151.7	151.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		151.7
	2nd.	10	11,853.3	0.0	11,853.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		11,853.3
	3rd.	11	33,775.0	1,108.3	34,883.3	0.0	0.0	0.0	0.0	1,204.7	1,204.7	0.0	2,409.4	2,409.4	0.0	225.9	3,840.0		38,723.3
Feb.	1st.	10	40,576.7	350.0	40,926.7	0.0	0.0	0.0	145.9	992.9	1,138.8	0.0	1,985.9	1,985.9	414.1	1,609.4	5,148.2		46,074.9
	2nd.	10	32,270.0	0.0	32,270.0	0.0	0.0	0.0	1,176.5	197.6	1,374.1	1,562.4	395.3	1,957.6	2,296.5	2,950.6	8,578.8		40,848.8
	3rd.	8	5,670.0	0.0	5,670.0	0.0	0.0	0.0	512.9	0.0	512.9	0.0	0.0	0.0	1,327.1	1,355.3	3,195.3		8,865.3
Mar.	1st.	10	7,233.3	0.0	7,233.3	0.0	0.0	0.0	1,021.2	0.0	1,021.2	310.6	0.0	310.6	2,301.2	1,764.7	5,397.6		12,631.0
	2nd.	10	6,615.0	0.0	6,615.0	1,185.9	0.0	1,185.9	1,261.2	0.0	1,261.2	611.8	0.0	611.8	2,517.6	1,440.0	7,016.5		13,631.5
	3rd.	11	6,218.3	0.0	6,218.3	3,821.2	0.0	3,821.2	1,515.3	0.0	1,515.3	1,185.9	0.0	1,185.9	2,541.2	1,058.8	10,122.4		16,340.7
Apr.	1st.	10	2,041.7	0.0	2,041.7	2,042.4	0.0	2,042.4	160.0	0.0	160.0	235.3	0.0	235.3	762.4	0.0	3,200.0		5,241.7
	2nd.	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0
	3rd.	10	1,120.0	0.0	1,120.0	2,997.6	0.0	2,997.6	0.0	0.0	0.0	282.4	0.0	282.4	225.9	0.0	3,505.9		4,625.9
May	1st.	10	2,100.0	0.0	2,100.0	6,094.1	0.0	6,094.1	131.8	0.0	131.8	1,204.7	0.0	1,204.7	621.2	0.0	8,051.8		10,151.8
	2nd.	10	2,648.3	0.0	2,648.3	7,642.4	0.0	7,642.4	329.4	0.0	329.4	1,647.1	0.0	1,647.1	847.1	0.0	10,465.9		13,114.2
	3rd.	11	7,151.7	0.0	7,151.7	19,237.6	0.0	19,237.6	2,028.2	0.0	2,028.2	5,101.2	0.0	5,101.2	2,720.0	1,548.2	30,635.3		37,787.0
Jun.	1st.	10	11,106.7	0.0	11,106.7	27,374.1	0.0	27,374.1	2,578.8	0.0	2,578.8	8,009.4	0.0	8,009.4	4,569.4	3,628.2	46,160.0		57,266.7
	2nd.	10	11,515.0	0.0	11,515.0	23,618.8	0.0	23,618.8	1,435.3	0.0	1,435.3	6,785.9	0.0	6,785.9	4,889.4	4,272.9	41,002.4		52,517.4
	3rd.	10	7,501.7	0.0	7,501.7	13,011.8	0.0	13,011.8	0.0	0.0	0.0	3,764.7	0.0	3,764.7	4,338.8	4,470.6	25,585.9		33,087.5
Jul.	1st.	10	3,593.3	0.0	3,593.3	4,941.2	0.0	4,941.2	0.0	0.0	0.0	1,120.0	0.0	1,120.0	3,505.9	4,569.4	14,136.5		17,729.8
	2nd.	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3,002.4	4,790.6	7,792.9		7,792.9
	3rd.	11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2,936.5	5,336.5	8,272.9		8,272.9
Aug.	1st.	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2,352.9	4,461.2	6,814.1		6,814.1
	2nd.	10	0.0	15,131.7	15,131.7	0.0	0.0	0.0	0.0	682.4	682.4	0.0	1,364.7	1,364.7	2,743.5	4,352.9	9,143.5		24,275.2
	3rd.	11	0.0	43,108.3	43,108.3	0.0	0.0	0.0	0.0	2,192.9	2,192.9	0.0	4,385.9	4,385.9	4,738.8	5,534.1	16,851.8		59,960.1
Sep.	1st.	10	0.0	49,525.0	49,525.0	0.0	3,985.9	3,985.9	0.0	3,698.8	3,698.8	0.0	7,397.6	7,397.6	6,023.5	5,891.8	26,997.6		76,522.6
	2nd.	10	0.0	39,281.7	39,281.7	0.0	11,068.2	11,068.2	0.0	4,324.7	4,324.7	0.0	8,649.4	8,649.4	7,204.7	6,498.8	37,745.9		77,027.5
	3rd.	10	0.0	13,755.0	13,755.0	0.0	8,927.1	8,927.1	0.0	3,011.8	3,011.8	0.0	6,023.5	6,023.5	6,150.6	5,101.2	29,214.1		42,969.1
Oct.	1st.	10	0.0	9,508.3	9,508.3	0.0	4,512.9	4,512.9	0.0	1,444.7	1,444.7	0.0	2,889.4	2,889.4	4,480.0	3,341.2	16,668.2		26,176.6
	2nd.	10	0.0	6,836.7	6,836.7	0.0	6,917.6	6,917.6	0.0	574.1	574.1	0.0	1,148.2	1,148.2	3,265.9	2,112.9	14,018.8		20,855.5
	3rd.	11	0.0	6,813.3	6,813.3	0.0	12,880.0	12,880.0	0.0	781.2	781.2	0.0	1,562.4	1,562.4	3,025.9	1,872.9	20,122.4		26,935.7
Nov.	1st.	10	0.0	2,788.3	2,788.3	0.0	6,160.0	6,160.0	0.0	14.1	14.1	0.0	28.2	28.2	1,143.5	225.9	7,571.8		10,360.1
	2nd.	10	0.0	245.0	245.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.4	0.0	9.4		254.4
	3rd.	10	0.0	280.0	280.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		280.0
Dec.	1st.	10	0.0	303.3	303.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		303.3
	2nd.	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0
	3rd.	11	0.0	1,750.0	1,750.0	0.0	0.0	0.0	0.0	14.1	14.1	0.0	28.2	28.2	174.1	0.0	216.5		1,966.5
Annual IWR (m³/yr.)			*192,990.0*	*190,936.7*	*383,926.7*	*111,967.1*	*54,451.8*	*166,418.8*	*12,296.5*	*19,134.1*	*31,430.6*	*31,821.2*	*38,268.2*	*70,089.4*	*81,129.4*	*78,414.1*	*427,482.4*		*811,409.0*
Max IWR (m³/dec.)			*40,576.7*	*49,525.0*	*49,525.0*	*27,374.1*	*12,880.0*	*27,374.1*	*2,578.8*	*4,324.7*	*4,324.7*	*8,009.4*	*8,649.4*	*8,649.4*	*7,204.7*	*6,498.8*	*46,160.0*		*77,027.5*

Notes

*1) Gross Irrigation Water Requirement (m³/dec) = Net Irrigation Water Requirement (m³/dec) / Irrigation Efficiency (%) * Wet Area Coefficient (%)

*2) Irrigation Efficiency : Rice 100 %
: Upland Cropping 85 % (= 95% (Conveyance Efficiency, "Lined Canal" FAO) * 90% (Field Application Efficiency, "Drip Irrigation" FAO)

*3) Wet Area Coefficient : Rice 100 % (= "Surface Irrigation", JICA)
: Upland Cropping 60 % (= "Micro Irrigation", JICA)

Legend of Table

Crop Combination		
Crop	Crop	Total
Crop Acreage (ha)		
(Crop Acreage (%))		

表 4-1-1-21 粗灌漑用水量／取水量（作付体系別）

(Gross Irrigation Water Requirement (per Cropping Pattern)

Case-4：灌水面積率 (Wet Area Coefficient) = 70%

Gross Irrigation Water Requirement (per Cropping Pattern)

(Unit: m^3/dec)

Month	Decade	Days	Rice Paddy			Upland Cropping												Grand Total
						Maize + Beans			Vegetable 1			Vegetable 2			Vegetable 3	Coffee	Total	
			Rice A	Rice B	Total	Maize	Beans	Sub-total	Carrot	Cabbage	Sub-total	Tomato	Cabbage	Sub-total	Tomato Tree			
			35.0 ha (13 %)			140.0 ha (51 %)			20.0 ha (7 %)			40.0 ha (15 %)			20.0 ha (7 %)	20.0 ha (7 %)	**240.0 ha (87 %)**	275.0 ha (100 %)
Jan.	1st.	10	0.0	151.7	**151.7**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	151.7
	2nd.	10	11,853.3	0.0	**11,853.3**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	11,853.3
	3rd.	11	33,775.0	1,108.3	**34,883.3**	0.0	0.0	0.0	0.0	1,405.5	1,405.5	0.0	2,811.0	2,811.0	0.0	263.5	**4,480.0**	39,363.3
Feb.	1st.	10	40,576.7	350.0	**40,926.7**	0.0	0.0	0.0	170.2	1,158.4	1,328.6	0.0	2,316.9	2,316.9	483.1	1,877.6	**6,006.3**	46,932.9
	2nd.	10	32,270.0	0.0	**32,270.0**	0.0	0.0	0.0	1,372.5	230.6	1,603.1	1,822.7	461.2	2,283.9	2,679.2	3,442.4	**10,008.6**	42,278.6
	3rd.	8	5,670.0	0.0	**5,670.0**	0.0	0.0	0.0	598.4	0.0	598.4	0.0	0.0	0.0	1,548.2	1,581.2	**3,727.8**	9,397.8
Mar.	1st.	10	7,233.3	0.0	**7,233.3**	0.0	0.0	0.0	1,191.4	0.0	1,191.4	362.4	0.0	362.4	2,684.7	2,058.8	**6,297.3**	13,530.6
	2nd.	10	6,615.0	0.0	**6,615.0**	1,383.5	0.0	1,383.5	1,471.4	0.0	1,471.4	713.7	0.0	713.7	2,937.3	1,680.0	**8,185.9**	14,800.9
	3rd.	11	6,218.3	0.0	**6,218.3**	4,458.0	0.0	4,458.0	1,767.8	0.0	1,767.8	1,383.5	0.0	1,383.5	2,964.7	1,235.3	**11,809.4**	18,027.7
Apr.	1st.	10	2,041.7	0.0	**2,041.7**	2,382.7	0.0	2,382.7	186.7	0.0	186.7	274.5	0.0	274.5	889.4	0.0	**3,733.3**	5,775.0
	2nd.	10	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0
	3rd.	10	1,120.0	0.0	**1,120.0**	3,497.3	0.0	3,497.3	0.0	0.0	0.0	329.4	0.0	329.4	263.5	0.0	**4,090.2**	5,210.2
May	1st.	10	2,100.0	0.0	**2,100.0**	7,109.8	0.0	7,109.8	153.7	0.0	153.7	1,405.5	0.0	1,405.5	724.7	0.0	**9,393.7**	11,493.7
	2nd.	10	2,648.3	0.0	**2,648.3**	8,916.1	0.0	8,916.1	384.3	0.0	384.3	1,921.6	0.0	1,921.6	988.2	0.0	**12,210.2**	14,858.5
	3rd.	11	7,151.7	0.0	**7,151.7**	22,443.9	0.0	22,443.9	2,366.3	0.0	2,366.3	5,951.4	0.0	5,951.4	3,173.3	1,806.3	**35,741.2**	42,892.8
Jun.	1st.	10	11,106.7	0.0	**11,106.7**	31,936.5	0.0	31,936.5	3,008.6	0.0	3,008.6	9,344.3	0.0	9,344.3	5,331.0	4,232.9	**53,853.3**	64,960.0
	2nd.	10	11,515.0	0.0	**11,515.0**	27,555.3	0.0	27,555.3	1,674.5	0.0	1,674.5	7,916.9	0.0	7,916.9	5,704.3	4,985.1	**47,836.1**	59,351.1
	3rd.	10	7,501.7	0.0	**7,501.7**	15,180.4	0.0	15,180.4	0.0	0.0	0.0	4,392.2	0.0	4,392.2	5,062.0	5,215.7	**29,850.2**	37,351.9
Jul.	1st.	10	3,593.3	0.0	**3,593.3**	5,764.7	0.0	5,764.7	0.0	0.0	0.0	1,306.7	0.0	1,306.7	4,090.2	5,331.0	**16,492.5**	20,085.9
	2nd.	10	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3,502.7	5,589.0	**9,091.8**	9,091.8
	3rd.	11	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3,425.9	6,225.9	**9,651.8**	9,651.8
Aug.	1st.	10	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2,745.1	5,204.7	**7,949.8**	7,949.8
	2nd.	10	0.0	15,131.7	**15,131.7**	0.0	0.0	0.0	0.0	796.1	796.1	0.0	1,592.2	1,592.2	3,200.8	5,078.4	**10,667.5**	25,799.1
	3rd.	11	0.0	43,108.3	**43,108.3**	0.0	0.0	0.0	0.0	2,558.4	2,558.4	0.0	5,116.9	5,116.9	5,528.6	6,456.5	**19,660.4**	62,768.7
Sep.	1st.	10	0.0	49,525.0	**49,525.0**	0.0	4,650.2	4,650.2	0.0	4,315.3	4,315.3	0.0	8,630.6	8,630.6	7,027.5	6,873.7	**31,497.3**	81,022.3
	2nd.	10	0.0	39,281.7	**39,281.7**	0.0	12,912.9	12,912.9	0.0	5,045.5	5,045.5	0.0	10,091.0	10,091.0	8,405.5	7,582.0	**44,036.9**	83,318.5
	3rd.	10	0.0	13,755.0	**13,755.0**	0.0	10,414.9	10,414.9	0.0	3,513.7	3,513.7	0.0	7,027.5	7,027.5	7,175.7	5,951.4	**34,083.1**	47,838.1
Oct.	1st.	10	0.0	9,508.3	**9,508.3**	0.0	5,265.1	5,265.1	0.0	1,685.5	1,685.5	0.0	3,371.0	3,371.0	5,226.7	3,898.0	**19,446.3**	28,954.6
	2nd.	10	0.0	6,836.7	**6,836.7**	0.0	8,070.6	8,070.6	0.0	669.8	669.8	0.0	1,339.6	1,339.6	3,810.2	2,465.1	**16,355.3**	23,192.0
	3rd.	11	0.0	6,813.3	**6,813.3**	0.0	15,026.7	15,026.7	0.0	911.4	911.4	0.0	1,822.7	1,822.7	3,530.2	2,185.1	**23,476.1**	30,289.4
Nov.	1st.	10	0.0	2,788.3	**2,788.3**	0.0	7,186.7	7,186.7	0.0	16.5	16.5	0.0	32.9	32.9	1,334.1	263.5	**8,833.7**	11,622.1
	2nd.	10	0.0	245.0	**245.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.0	0.0	**11.0**	256.0
	3rd.	10	0.0	280.0	**280.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	280.0
Dec.	1st.	10	0.0	303.3	**303.3**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	303.3
	2nd.	10	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0
	3rd.	11	0.0	1,750.0	**1,750.0**	0.0	0.0	0.0	0.0	16.5	16.5	0.0	32.9	32.9	203.1	0.0	**252.5**	2,002.5
Annual IWR (m^3/yr.)			*192,990.0*	*190,936.7*	***383,926.7***	*130,628.2*	*63,527.1*	*194,155.3*	*14,345.9*	*22,323.1*	*36,669.0*	*37,124.7*	*44,646.3*	*81,771.0*	*94,651.0*	*91,483.1*	***498,729.4***	*882,656.1*
Max IWR (m^3/dec.)			*40,576.7*	*49,525.0*	***49,525.0***	*31,936.5*	*15,026.7*	*31,936.5*	*3,008.6*	*5,045.5*	*5,045.5*	*9,344.3*	*10,091.0*	*10,091.0*	*8,405.5*	*7,582.0*	***53,853.3***	*83,318.5*

Notes

*1) Gross Irrigation Water Requirement (m^3/dec) = Net Irrigation Water Requirement (m^3/dec) / Irrigation Efficiency (%) * Wet Area Coefficient (%)

*2) Irrigation Efficiency	: Rice	100 %	
	: Upland Cropping	85 %	(= 95% (Conveyance Efficiency, "Lined Canal" FAO) * 90% (Field Application Efficiency, "Drip Irrigation" FAO)
*3) Wet Area Coefficient	: Rice	100 %	(= "Surface Irrigation", JICA)
	: Upland Cropping	70 %	(= "Micro Irrigation", JICA)

Legend of Table

Crop Combination		
Crop	Crop	Total
Crop Acreage (ha)		
(Crop Acreage (%))		

(b) 水収支シミュレーション

先に検討した貯水池内への流入量および灌漑用水量に基づき、旬別の水収支シミュレーションを行い有効貯水量を決定した。

シミュレーションでは、貯水池の降雨量と蒸発量、貯水池からの浸透量など、以下の条件を設定した。

ｉ) 計算条件

1) 流入量（Inflow）

貯水池への流入量は、河川流入量を考慮し、タンクモデルで求めた基準年 1970 年の流入量（約 894 千m^3/年）とした。

2) 流出量（流出量）

貯水池からの流出量は、①水田灌漑用水量、②畑地灌漑用水量、③浸透量を考慮した。

<u>水田灌漑用水量</u>

先に算定した水田補給用水量（Supply Water for Rice Paddy）の約 170 千 m^3/年を見込んだ。

表 4-1-1-22 河川流入量および水田補給用水量

Month	Decade	days	Inflow (m^3)			Supply Water for Rice Paddy (m^3)		
			Decade	Monthly	Cumulative	Decade	Monthly	Cumulative
Jan.	1st.	10	21,595	109,665	109,665	469	1,453	1,453
	2nd.	10	43,927			469		
	3rd.	11	44,143			516		
Feb.	1st.	10	37,257	106,232	215,898	6,228	17,438	18,891
	2nd.	10	40,417			6,228		
	3rd.	8	28,559			4,982		
Mar.	1st.	10	31,307	97,478	313,376	854	2,647	21,538
	2nd.	10	29,033			854		
	3rd.	11	37,139			939		
Apr.	1st.	10	33,398	102,702	416,077	658	1,974	23,512
	2nd.	10	33,160			658		
	3rd.	10	36,144			658		
May	1st.	10	48,003	133,739	549,817	468	1,452	24,964
	2nd.	10	45,660			468		
	3rd.	11	40,077			515		
Jun.	1st.	10	33,656	91,537	641,353	1,232	3,695	28,659
	2nd.	10	30,742			1,232		
	3rd.	10	27,139			1,232		
Jul.	1st.	10	23,852	63,977	705,330	895	2,774	31,433
	2nd.	10	20,719			895		
	3rd.	11	19,405			984		
Aug.	1st.	10	13,923	38,502	743,832	12,943	40,122	71,555
	2nd.	10	10,887			12,943		
	3rd.	11	13,692			14,237		
Sep.	1st.	10	9,935	27,513	771,345	30,117	90,350	161,905
	2nd.	10	9,271			30,117		
	3rd.	10	8,307			30,117		
Oct.	1st.	10	7,701	28,879	800,224	965	2,990	164,895
	2nd.	10	11,698			965		
	3rd.	11	9,480			1,061		
Nov.	1st.	10	11,612	33,237	833,461	665	1,995	166,890
	2nd.	10	10,690			665		
	3rd.	10	10,935			665		
Dec.	1st.	10	15,099	60,306	893,767	455	1,409	168,299
	2nd.	10	17,035			455		
	3rd.	11	28,172			500		
Total			**893,767**	893,767	-	**168,299**	168,299	-

畑地灌漑用水量

先に算定した粗灌漑用水量／取水量（Gross Irrigation Water Requirement）を見込むものとし、灌水面積率 Kw=40、50、60 および 70%の 4 ケースについて検討した。

表 4-1-1-23 畑地灌漑用水量（年間）

Wet Area Coefficient Kw (%)	Gross Irrigation Water Requirement (m^3/年)
40	284,988
50	356,235
60	427,482
70	498,729

貯水池からの浸透量

貯水池からの浸透量（Seepage Loss）として、貯水量の 0.05%を考慮した。

3) 貯水池の降水量と蒸発量（Balance between Rainfall and Evaporation on Reservoir）

水収支シミュレーションには、上記の貯水池への流入量および流出量の他に、貯水池における降水量および蒸発量を考慮した。

ここで、湖面面積（Water Surface Area）は、貯水位が満水位（Full Water Surface）FWS.1,390.60m にある場合とし、H-Q 曲線から算定した 14.96ha とした。

湖面への降水量 Rd

湖面への降水量（Rainfall）は、プロジェクト対象地区近傍に位置する Gahororo 観測所における基準年 1970 年の降水量を用いた。（前出「気象データ」参照。）

湖面からの蒸発量 Eo

湖面からの蒸発量（Evaporation）Eo は、CROPWAT08 を用いて求めた基準蒸発散量（Reference Evapotranspiration）ETo と作物係数（Crop Coefficient）kc より、以下のとおり算定した。

$$Eo = ETo \times Kc$$

ここで、作物係数は ”FAO Irrigation and Drainage Paper No.24: Crop Water Requirements” より、Kc=1.1 とした。

貯水池における降水量と蒸発量のバランス（Ev＝Eo―Rd）を計算し、次表「 貯水池における降水量と蒸発量」に取り纏めた。

表 4-1-1-24 貯水池における降水量と蒸発量

(Balance between Rainfall and Evaporation on Reservoir)

Evaporation from Water Surface of Reservoir (@ FWS)

Crop Coefficient: kc = 1.1 Water Surface Area: A = 14.96 ha (@ FWS.1,390.60m)

Month	Decade	days	Provable Rainfall		Reference Evapotranspiration	Evaporation	Evaporation from Water Surface		Remarks
			Rm (mm/month)	Rd (mm/decade)	ETo (mm/day)	Eo = ETo * kc (mm/decade)	E = Eo - Rd (mm/decade)	Ev = E * A (m^3/decade)	
Jan.	1st.	10	188.2	60.7	4.01	44.1	-16.6	-2,485	
	2nd.	10		60.7		44.1	-16.6	-2,485	
	3rd.	11		66.8		48.5	-18.3	-2,735	
Feb.	1st.	10	70.7	25.3	4.20	46.2	21.0	3,134	
	2nd.	10		25.3		46.2	21.0	3,134	
	3rd.	8		20.2		37.0	16.8	2,513	
Mar.	1st.	10	91.8	29.6	3.93	43.2	13.6	2,033	
	2nd.	10		29.6		43.2	13.6	2,033	
	3rd.	11		32.6		47.6	15.0	2,248	
Apr.	1st.	10	152.6	50.9	3.38	37.2	-13.7	-2,045	
	2nd.	10		50.9		37.2	-13.7	-2,045	
	3rd.	10		50.9		37.2	-13.7	-2,045	
May	1st.	10	104.9	33.8	3.21	35.3	1.5	219	
	2nd.	10		33.8		35.3	1.5	219	
	3rd.	11		37.2		38.8	1.6	236	
Jun.	1st.	10	4.5	1.5	3.09	34.0	32.5	4,862	
	2nd.	10		1.5		34.0	32.5	4,862	
	3rd.	10		1.5		34.0	32.5	4,862	
Jul.	1st.	10	5.7	1.8	3.39	37.3	35.5	5,305	
	2nd.	10		1.8		37.3	35.5	5,305	
	3rd.	11		2.0		41.0	39.0	5,831	
Aug.	1st.	10	53.5	17.3	4.79	52.7	35.4	5,302	
	2nd.	10		17.3		52.7	35.4	5,302	
	3rd.	11		19.0		58.0	39.0	5,837	
Sep.	1st.	10	20.7	6.9	4.62	50.8	43.9	6,567	
	2nd.	10		6.9		50.8	43.9	6,567	
	3rd.	10		6.9		50.8	43.9	6,567	
Oct.	1st.	10	118.4	38.2	4.68	51.5	13.3	1,991	
	2nd.	10		38.2		51.5	13.3	1,991	
	3rd.	11		42.0		56.6	14.6	2,182	
Nov.	1st.	10	161.7	53.9	3.51	38.6	-15.3	-2,289	
	2nd.	10		53.9		38.6	-15.3	-2,289	
	3rd.	10		53.9		38.6	-15.3	-2,289	
Dec.	1st.	10	161.6	52.1	3.26	35.9	-16.2	-2,428	
	2nd.	10		52.1		35.9	-16.2	-2,428	
	3rd.	11		57.3		39.4	-17.9	-2,684	
Total / Average			1,134.3	1,134.3	3.84	1,541.1	407	60,855	

Notes

*1) Provable Rainfall : 1970, Gahororo Station, Rurenge Sector, Ngoma District

*2) Reference Evapotranspiration : Calculated from Climate Data (Temperature, Humidity, Wind Velocity, Sunshine Hours) by CROPWAT8

*3) Climate Data / Min. Temp. : 1970, Gahororo Station, Rurenge Sector, Ngoma District

Max. Temp. : 1970 & 1974, Gahororo Station, Rurenge Sector, Ngoma District

Humidity : 1974, Kigali International Airport

Wind Velocity : 1974, Kigali International Airport

Sunshine : 1974, Kigali International Airport

*4) Crop Coefficient : kc from water surface of 1.1 is applied based on FAO Irrigation and drainage paper No. 24.

*5) Water Surface Area : 14.96 ha at Full Water Surface (FWS.) EL. 1,390.60 m is applied.

ⅱ) 水収支シミュレーション結果

水収支シミュレーションの結果は次頁以降の「水収支シミュレーション結果」に示すとおりであるが、各ケースにおける必要貯水容量を整理すると下表のとおりとなる。

表 4-1-1-25 必要貯水容量

Wet Area Coefficient Kw (%)	Effective Dam Storage Volume (m^3)		
	Maximum (1)	Minimum (2)	Balance / Required Storage Volume (3) = (1)-(2)
40	450,000	250,693	199,307
50	440,015	209926	230,089
60	423,489	139,979	283,510
70	406,963	70,031	**336,931**

以上より、本計画におけるダム貯水容量（Effective Dam Storage Volume）45 万 m^3 は、灌水面積率がより厳しい条件下にある場合（Kw=70%）においても十分に余裕があると言える。

ダム貯水容量　450,000m^3 ＞ 必要貯水容量 336,931m^3

なお、この場合の設計取水量（Design Discharge Volume）は以下のとおりとなる。

（後掲「表　設計取水量」参照。）

・ 設計取水量（水田）　：　0.0349m^3/sec

・ 設計取水量（畑）　：　0.1760m^3/sec

表 4-1-1-26 水収支シミュレーション結果 (Water Balance Study)

Case-1：灌水面積率 (Wet Area Coefficient) = 40%

Cropping Acreage

Crop		Area	
Rice Paddy		35 ha	13 %
Upland Cropping	Maize+Beans	140 ha	51 %
	Vegitable-1	20 ha	7 %
	Vegetable-2	40 ha	15 %
	Vegetable-3	20 ha	7 %
	Coffee	20 ha	7 %
	Sub-total	240 ha	87 %
Total		275 ha	100 %

Efficiencies

Description		Coefficient	Remarks
Irrigation Efficiency	Rice Paddy	100 %	
	Upland Cropping	85 %	= 95% (Conveyance: Lined Canal) * 90% (Field Application: Drip)
Wetting Area	Rice Paddy	100 %	"Suface Irrigation"
	Upland Cropping	**40 %**	"Micro Irrigation"

Reservoir

Description	EL & Volume	Remarks
Full Water Surface	EL. 1,390.60 m	FWS (Water Surface Area: 14.96 ha)
Dead Water Surface	EL. 1,386.50 m	DWS (Water Surface Area: 8.15 ha)
Bottom of Reservoir	EL. 1,380.00 m	ELbttm
Active Storage Capacity	450,000 m3	between FWS and DWS (H=4.10m)
Dead Water Volume	250,000 m3	between DWS and ELbttm (H=6.50m)

Results of Water Balance Study

Month	Decade	days	Inflow (m^3) ①	Outflow (m^3): Rice Supply Water ②	Outflow (m^3): Upland Crop Irrigation Water Requirement ③	Outflow (m^3): Seepage Loss ④	Outflow (m^3): Evaporation from W. Surface ⑤	Outflow (m^3): Total ⑥=Σ②-⑤	Balance between In & Outflow (m^3) ⑦=①-⑥	Cumulative Storage Volume of Reservoir (m^3) ⑧	Remarks
										0	
Jan.	1st.	10	21,595	469	0	11	-2,485	-2,005	23,600	23,600	
	2nd.	10	43,927	469	0	22	-2,485	-1,994	45,921	69,522	
	3rd.	11	44,143	516	2,560	22	-2,735	363	43,781	113,302	
Feb.	1st.	10	37,257	6,228	3,432	19	3,134	12,813	24,444	137,746	
	2nd.	10	40,417	6,228	5,719	20	3,134	15,101	25,316	163,062	
	3rd.	8	28,559	4,982	2,130	14	2,513	9,639	18,919	181,981	
Mar.	1st.	10	31,307	854	3,598	16	2,033	6,501	24,805	206,786	
	2nd.	10	29,033	854	4,678	15	2,033	7,580	21,453	228,240	
	3rd.	11	37,139	939	6,748	19	2,248	9,954	27,184	255,424	
Apr.	1st.	10	33,398	658	2,133	17	-2,045	763	32,634	288,058	
	2nd.	10	33,160	658	0	17	-2,045	-1,370	34,530	322,588	
	3rd.	10	36,144	658	2,337	18	-2,045	968	35,176	357,764	
May	1st.	10	48,003	468	5,368	24	219	6,079	41,923	399,687	
	2nd.	10	45,660	468	6,977	23	219	7,688	37,972	437,660	
	3rd.	11	40,077	515	20,424	20	236	21,195	18,882	**450,000**	**Max.**
Jun.	1st.	10	33,656	1,232	30,773	17	4,862	36,884	-3,229	446,772	
	2nd.	10	30,742	1,232	27,335	15	4,862	33,444	-2,701	444,070	
	3rd.	10	27,139	1,232	17,057	14	4,862	23,165	3,974	448,044	
Jul.	1st.	10	23,852	895	9,424	12	5,305	15,636	8,216	450,000	
	2nd.	10	20,719	895	5,195	10	5,305	11,405	9,314	450,000	
	3rd.	11	19,405	984	5,515	10	5,831	12,341	7,064	450,000	
Aug.	1st.	10	13,923	12,943	4,543	7	5,302	22,794	-8,871	441,129	
	2nd.	10	10,887	12,943	6,096	5	5,302	24,345	-13,458	427,671	
	3rd.	11	13,692	14,237	11,235	7	5,837	31,315	-17,623	410,047	
Sep.	1st.	10	9,935	30,117	17,998	5	6,567	54,687	-44,752	365,295	
	2nd.	10	9,271	30,117	25,164	5	6,567	61,853	-52,582	312,713	
	3rd.	10	8,307	30,117	19,476	4	6,567	56,164	-47,857	264,857	
Oct.	1st.	10	7,701	965	11,112	4	1,991	14,072	-6,371	258,486	
	2nd.	10	11,698	965	9,346	6	1,991	12,307	-610	257,876	
	3rd.	11	9,480	1,061	13,415	5	2,182	16,663	-7,183	**250,693**	**Min.**
Nov.	1st.	10	11,612	665	5,048	6	-2,289	3,430	8,182	258,875	
	2nd.	10	10,690	665	6	5	-2,289	-1,613	12,303	271,179	
	3rd.	10	10,935	665	0	5	-2,289	-1,619	12,554	283,732	
Dec.	1st.	10	15,099	455	0	8	-2,428	-1,965	17,065	300,797	
	2nd.	10	17,035	455	0	9	-2,428	-1,964	19,000	319,797	
	3rd.	11	28,172	500	144	14	-2,684	-2,026	30,197	349,995	
Total			**893,767**	168,299	284,988	450	60,855	**514,592**	379,175	-	-
									Max. - Min. =	**199,307**	

Notes

*1) Seepage loss from dam body of 0.05 % of storage volume is assumed.

*2) Evaporation from water surface is estimated based on balance of rainfall and evaporation with kc of 1.1 from FAO Irrigation and Drainage Paper No.24.
(See Table "Evaporation from Water Surface of Reservoir, Ngoma 22" for reference.)

*3) Water Supply for Rice Paddy 168,299 m3/yr.

*4) Cumu. Storage Volume : Start at DWS.1,386.50m 0 m3 (Effective Dam Storage Volume)

表 4-1-1-27 水収支シミュレーション結果 (Water Balance Study)

Case-2：灌水面積率 (Wet Area Coefficient) = 50%

Cropping Acreage

Crop		Area	
Rice Paddy		35 ha	13 %
Upland Cropping	Maize+Beans	140 ha	51 %
	Vegitable-1	20 ha	7 %
	Vegetable-2	40 ha	15 %
	Vegetable-3	20 ha	7 %
	Coffee	20 ha	7 %
	Sub-total	240 ha	87 %
Total		275 ha	100 %

Efficiencies

Description		Coefficient	Remarks
Irrigation Efficiency	Rice Paddy	100 %	
	Upland Cropping	85 %	= 95% (Conveyance: Lined Canal) * 90% (Field Application: Drip)
Wetting Area	Rice Paddy	100 %	"Suface Irrigation"
	Upland Cropping	**50 %**	"Micro Irrigation"

Reservoir

Description	EL & Volume	Remarks
Full Water Surface	EL. 1,390.60 m	FWS (Water Surface Area: 14.96 ha)
Dead Water Surface	EL. 1,386.50 m	DWS (Water Surface Area: 8.15 ha)
Bottom of Reservoir	EL. 1,380.00 m	ELbttm
Active Storage Capacity	450,000 m3	between FWS and DWS (H=4.10m)
Dead Water Volume	250,000 m3	between DWS and ELbttm (H=6.50m)

Results of Water Balance Study

Month	Decade	days	Inflow (m^3) ①	Outflow (m^3): Rice Supply Water ②	Outflow (m^3): Upland Crop Irrigation Water Requirement ③	Outflow (m^3): Seepage Loss ④	Outflow (m^3): Evaporation from W. Surface ⑤	Outflow (m^3): Total ⑥=Σ②-⑤	Balance between In & Outflow (m^3) ⑦=①-⑥	Cumulative Storage Volume of Reservoir (m^3) ⑧	Remarks
										0	
Jan.	1st.	10	21,595	469	0	11	-2,485	-2,005	23,600	23,600	
	2nd.	10	43,927	469	0	22	-2,485	-1,994	45,921	69,522	
	3rd.	11	44,143	516	3,200	22	-2,735	1,003	43,141	112,662	
Feb.	1st.	10	37,257	6,228	4,290	19	3,134	13,671	23,586	136,248	
	2nd.	10	40,417	6,228	7,149	20	3,134	16,531	23,886	160,134	
	3rd.	8	28,559	4,982	2,663	14	2,513	10,172	18,386	178,521	
Mar.	1st.	10	31,307	854	4,498	16	2,033	7,401	23,906	202,426	
	2nd.	10	29,033	854	5,847	15	2,033	8,749	20,284	222,710	
	3rd.	11	37,139	939	8,435	19	2,248	11,642	25,497	248,207	
Apr.	1st.	10	33,398	658	2,667	17	-2,045	1,297	32,101	280,309	
	2nd.	10	33,160	658	0	17	-2,045	-1,370	34,530	314,838	
	3rd.	10	36,144	658	2,922	18	-2,045	1,553	34,592	349,430	
May	1st.	10	48,003	468	6,710	24	219	7,421	40,581	390,011	
	2nd.	10	45,660	468	8,722	23	219	9,432	36,228	426,239	
	3rd.	11	40,077	515	25,529	20	236	26,301	13,776	**440,015**	**Max.**
Jun.	1st.	10	33,656	1,232	38,467	17	4,862	44,577	-10,922	429,093	
	2nd.	10	30,742	1,232	34,169	15	4,862	40,277	-9,535	419,558	
	3rd.	10	27,139	1,232	21,322	14	4,862	27,429	-290	419,268	
Jul.	1st.	10	23,852	895	11,780	12	5,305	17,992	5,860	425,128	
	2nd.	10	20,719	895	6,494	10	5,305	12,704	8,015	433,144	
	3rd.	11	19,405	984	6,894	10	5,831	13,719	5,685	438,829	
Aug.	1st.	10	13,923	12,943	5,678	7	5,302	23,930	-10,007	428,822	
	2nd.	10	10,887	12,943	7,620	5	5,302	25,869	-14,982	413,840	
	3rd.	11	13,692	14,237	14,043	7	5,837	34,124	-20,432	393,408	
Sep.	1st.	10	9,935	30,117	22,498	5	6,567	59,187	-49,252	344,157	
	2nd.	10	9,271	30,117	31,455	5	6,567	68,144	-58,873	285,284	
	3rd.	10	8,307	30,117	24,345	4	6,567	61,033	-52,726	232,558	
Oct.	1st.	10	7,701	965	13,890	4	1,991	16,850	-9,149	223,409	
	2nd.	10	11,698	965	11,682	6	1,991	14,644	-2,946	220,463	
	3rd.	11	9,480	1,061	16,769	5	2,182	20,017	-10,537	**209,926**	**Min.**
Nov.	1st.	10	11,612	665	6,310	6	-2,289	4,692	6,920	216,847	
	2nd.	10	10,690	665	8	5	-2,289	-1,611	12,302	229,148	
	3rd.	10	10,935	665	0	5	-2,289	-1,619	12,554	241,702	
Dec.	1st.	10	15,099	455	0	8	-2,428	-1,965	17,065	258,767	
	2nd.	10	17,035	455	0	9	-2,428	-1,964	19,000	277,767	
	3rd.	11	28,172	500	180	14	-2,684	-1,990	30,161	307,928	
Total			**893,767**	168,299	356,235	450	60,855	**585,839**	307,928	-	-
									Max. - Min. =	**230,089**	

Notes

*1) Seepage loss from dam body of 0.05 % of storage volume is assumed.

*2) Evaporation from water surface is estimated based on balance of rainfall and evaporation with kc of 1.1 from FAO Irrigation and Drainage Paper No.24.
(See Table "Evaporation from Water Surface of Reservoir, Ngoma 22" for reference.)

*3) Water Supply for Rice Paddy — 168,299 m3/yr.

*4) Cumu. Storage Volume : Start at DWS.1,386.50m — 0 m3 (Effective Dam Storage Volume)

表 4-1-1-28 水収支シミュレーション結果（Water Balance Study）

Case-3：灌水面積率（Wet Area Coefficient）= 60%

Cropping Acreage

Crop		Area	
Rice Paddy		35 ha	13 %
Upland Cropping	Maize+Beans	140 ha	51 %
	Vegitable-1	20 ha	7 %
	Vegetable-2	40 ha	15 %
	Vegetable-3	20 ha	7 %
	Coffee	20 ha	7 %
	Sub-total	240 ha	87 %
Total		275 ha	100 %

Efficiencies

Description		Coefficient	Remarks
Irrigation Efficiency	Rice Paddy	100 %	
	Upland Cropping	85 %	= 95% (Conveyance: Lined Canal) * 90% (Field Application: Drip)
Wetting Area	Rice Paddy	100 %	"Suface Irrigation"
	Upland Cropping	**60 %**	"Micro Irrigation"

Reservoir

Description	EL & Volume	Remarks
Full Water Surface	EL. 1,390.60 m	FWS (Water Surface Area: 14.96 ha)
Dead Water Surface	EL. 1,386.50 m	DWS (Water Surface Area: 8.15 ha)
Bottom of Reservoir	EL. 1,380.00 m	ELbttm
Active Storage Capacity	450,000 m3	between FWS and DWS (H=4.10m)
Dead Water Volume	250,000 m3	between DWS and ELbttm (H=6.50m)

Results of Water Balance Study

Month	Decade	days	Inflow (m^3) ①	Outflow (m^3): Rice Supply Water ②	Outflow (m^3): Upland Crop Irrigation Water Requirement ③	Outflow (m^3): Seepage Loss ④	Outflow (m^3): Evaporation from W. Surface ⑤	Outflow (m^3): Total ⑥=Σ②-⑤	Balance between In & Outflow (m^3) ⑦=①-⑥	**Cumulative Storage Volume of Reservoir (m^3)** ⑧	Remarks
										0	
Jan.	1st.	10	21,595	469	0	11	-2,485	-2,005	23,600	23,600	
	2nd.	10	43,927	469	0	22	-2,485	-1,994	45,921	69,522	
	3rd.	11	44,143	516	3,840	22	-2,735	1,643	42,501	112,022	
Feb.	1st.	10	37,257	6,228	5,148	19	3,134	14,529	22,728	134,750	
	2nd.	10	40,417	6,228	8,579	20	3,134	17,961	22,456	157,206	
	3rd.	8	28,559	4,982	3,195	14	2,513	10,705	17,854	175,060	
Mar.	1st.	10	31,307	854	5,398	16	2,033	8,301	23,006	198,066	
	2nd.	10	29,033	854	7,016	15	2,033	9,918	19,114	217,181	
	3rd.	11	37,139	939	10,122	19	2,248	13,329	23,810	240,991	
Apr.	1st.	10	33,398	658	3,200	17	-2,045	1,830	31,568	272,559	
	2nd.	10	33,160	658	0	17	-2,045	-1,370	34,530	307,088	
	3rd.	10	36,144	658	3,506	18	-2,045	2,137	34,007	341,096	
May	1st.	10	48,003	468	8,052	24	219	8,763	39,239	380,335	
	2nd.	10	45,660	468	10,466	23	219	11,176	34,484	414,819	
	3rd.	11	40,077	515	30,635	20	236	31,407	8,670	**423,489**	**Max.**
Jun.	1st.	10	33,656	1,232	46,160	17	4,862	52,271	-18,615	404,874	
	2nd.	10	30,742	1,232	41,002	15	4,862	47,111	-16,369	388,505	
	3rd.	10	27,139	1,232	25,586	14	4,862	31,694	-4,554	383,951	
Jul.	1st.	10	23,852	895	14,136	12	5,305	20,348	3,504	387,455	
	2nd.	10	20,719	895	7,793	10	5,305	14,003	6,717	394,171	
	3rd.	11	19,405	984	8,273	10	5,831	15,098	4,307	398,478	
Aug.	1st.	10	13,923	12,943	6,814	7	5,302	25,066	-11,143	387,335	
	2nd.	10	10,887	12,943	9,144	5	5,302	27,393	-16,506	370,829	
	3rd.	11	13,692	14,237	16,852	7	5,837	36,933	-23,241	347,589	
Sep.	1st.	10	9,935	30,117	26,998	5	6,567	63,686	-53,751	293,837	
	2nd.	10	9,271	30,117	37,746	5	6,567	74,435	-65,164	228,673	
	3rd.	10	8,307	30,117	29,214	4	6,567	65,902	-57,595	171,079	
Oct.	1st.	10	7,701	965	16,668	4	1,991	19,628	-11,927	159,152	
	2nd.	10	11,698	965	14,019	6	1,991	16,980	-5,283	153,869	
	3rd.	11	9,480	1,061	20,122	5	2,182	23,370	-13,890	**139,979**	**Min.**
Nov.	1st.	10	11,612	665	7,572	6	-2,289	5,954	5,658	145,637	
	2nd.	10	10,690	665	9	5	-2,289	-1,610	12,300	157,937	
	3rd.	10	10,935	665	0	5	-2,289	-1,619	12,554	170,491	
Dec.	1st.	10	15,099	455	0	8	-2,428	-1,965	17,065	187,556	
	2nd.	10	17,035	455	0	9	-2,428	-1,964	19,000	206,556	
	3rd.	11	28,172	500	216	14	-2,684	-1,954	30,125	236,681	
Total			**893,767**	168,299	427,482	450	60,855	**657,086**	236,681	-	-
									Max. - Min. =	**283,510**	

Notes

*1) Seepage loss from dam body of 0.05 % of storage volume is assumed.

*2) Evaporation from water surface is estimated based on balance of rainfall and evaporation with kc of 1.1 from FAO Irrigation and Drainage Paper No.24.
(See Table "Evaporation from Water Surface of Reservoir, Ngoma 22" for reference.)

*3) Water Supply for Rice Paddy 168,299 m3/yr.

*4) Cumu. Storage Volume : Start at DWS.1,386.50m 0 m3 (Effective Dam Storage Volume)

表 4-1-1-29 水収支シミュレーション結果 (Water Balance Study)

Case-4：灌水面積率 (Wet Area Coefficient) = 70%

Cropping Acreage

Crop		Area	
Rice Paddy		35 ha	13 %
Upland Cropping	Maize+Beans	140 ha	51 %
	Vegitable-1	20 ha	7 %
	Vegetable-2	40 ha	15 %
	Vegetable-3	20 ha	7 %
	Coffee	20 ha	7 %
	Sub-total	240 ha	87 %
Total		275 ha	100 %

Efficiencies

Description		Coefficient	Remarks
Irrigation Efficiency	Rice Paddy	100 %	
	Upland Cropping	85 %	= 95% (Conveyance: Lined Canal) * 90% (Field Application: Drip)
Wetting Area	Rice Paddy	100 %	"Surface Irrigation"
	Upland Cropping	**70 %**	"Micro Irrigation"

Reservoir

Description	EL & Volume	Remarks
Full Water Surface	EL. 1,390.60 m	FWS (Water Surface Area: 14.96 ha)
Dead Water Surface	EL. 1,386.50 m	DWS (Water Surface Area: 8.15 ha)
Bottom of Reservoir	EL. 1,380.00 m	ELbttm
Active Storage Capacity	450,000 m3	between FWS and DWS (H=4.10m)
Dead Water Volume	250,000 m3	between DWS and ELbttm (H=6.50m)

Results of Water Balance Study

Month	Decade	days	Inflow (m^3) ①	Outflow (m^3): Rice Supply Water ②	Outflow (m^3): Upland Crop Irrigation Water Requirement ③	Outflow (m^3): Seepage Loss ④	Outflow (m^3): Evaporation from W. Surface ⑤	Outflow (m^3): Total ⑥=Σ②-⑤	Balance between In & Outflow (m^3) ⑦=①-⑥	**Cumulative Storage Volume of Reservoir (m^3)** ⑧	Remarks
										0	
Jan.	1st.	10	21,595	469	0	11	-2,485	-2,005	23,600	23,600	
	2nd.	10	43,927	469	0	22	-2,485	-1,994	45,921	69,522	
	3rd.	11	44,143	516	4,480	22	-2,735	2,283	41,861	111,382	
Feb.	1st.	10	37,257	6,228	6,006	19	3,134	15,387	21,870	133,252	
	2nd.	10	40,417	6,228	10,009	20	3,134	19,390	21,026	154,278	
	3rd.	8	28,559	4,982	3,728	14	2,513	11,237	17,321	171,600	
Mar.	1st.	10	31,307	854	6,297	16	2,033	9,200	22,107	193,706	
	2nd.	10	29,033	854	8,186	15	2,033	11,088	17,945	211,651	
	3rd.	11	37,139	939	11,809	19	2,248	15,016	22,123	233,775	
Apr.	1st.	10	33,398	658	3,733	17	-2,045	2,363	31,034	264,809	
	2nd.	10	33,160	658	0	17	-2,045	-1,370	34,530	299,338	
	3rd.	10	36,144	658	4,090	18	-2,045	2,721	33,423	332,762	
May	1st.	10	48,003	468	9,394	24	219	10,105	37,897	370,659	
	2nd.	10	45,660	468	12,210	23	219	12,921	32,739	403,398	
	3rd.	11	40,077	515	35,741	20	236	36,512	3,564	**406,963**	**Max.**
Jun.	1st.	10	33,656	1,232	53,853	17	4,862	59,964	-26,309	380,654	
	2nd.	10	30,742	1,232	47,836	15	4,862	53,945	-23,203	357,452	
	3rd.	10	27,139	1,232	29,850	14	4,862	35,958	-8,819	348,633	
Jul.	1st.	10	23,852	895	16,493	12	5,305	22,704	1,148	349,781	
	2nd.	10	20,719	895	9,092	10	5,305	15,302	5,418	355,199	
	3rd.	11	19,405	984	9,652	10	5,831	16,477	2,928	358,126	
Aug.	1st.	10	13,923	12,943	7,950	7	5,302	26,201	-12,278	345,848	
	2nd.	10	10,887	12,943	10,667	5	5,302	28,917	-18,030	327,818	
	3rd.	11	13,692	14,237	19,660	7	5,837	39,741	-26,049	301,769	
Sep.	1st.	10	9,935	30,117	31,497	5	6,567	68,186	-58,251	243,518	
	2nd.	10	9,271	30,117	44,037	5	6,567	80,726	-71,455	172,063	
	3rd.	10	8,307	30,117	34,083	4	6,567	70,771	-62,464	109,599	
Oct.	1st.	10	7,701	965	19,446	4	1,991	22,406	-14,705	94,895	
	2nd.	10	11,698	965	16,355	6	1,991	19,317	-7,619	87,275	
	3rd.	11	9,480	1,061	23,476	5	2,182	26,724	-17,244	**70,031**	**Min.**
Nov.	1st.	10	11,612	665	8,834	6	-2,289	7,216	4,396	74,428	
	2nd.	10	10,690	665	11	5	-2,289	-1,608	12,298	86,726	
	3rd.	10	10,935	665	0	5	-2,289	-1,619	12,554	99,280	
Dec.	1st.	10	15,099	455	0	8	-2,428	-1,965	17,065	116,345	
	2nd.	10	17,035	455	0	9	-2,428	-1,964	19,000	135,345	
	3rd.	11	28,172	500	253	14	-2,684	-1,917	30,089	165,434	
Total			**893,767**	168,299	498,729	450	60,855	728,333	165,434	-	-
									Max. - Min. =	**336,931**	

Notes

*1) Seepage loss from dam body of 0.05 % of storage volume is assumed.

*2) Evaporation from water surface is estimated based on balance of rainfall and evaporation with kc of 1.1 from FAO Irrigation and Drainage Paper No.24.
(See Table "Evaporation from Water Surface of Reservoir, Ngoma 22" for reference.)

*3) Water Supply for Rice Paddy 168,299 m3/yr.

*4) Cumu. Storage Volume : Start at DWS.1,386.50m 0 m3 (Effective Dam Storage Volume)

表 4-1-1-30 設計取水量 (Design Discharge Volume)

Cropping Acreage

Crop		Area	
Rice Paddy		35	13%
Upland Cropping	Maize+Beans	140	51%
	Vegitable-1	20	7%
	Vegetable-2	40	15%
	Vegetable-3	20	7%
	Coffee	20	7%
	Sub-total	240	87%
Total		275	100%

Operation Hours

Crop	Operation Hours	Remarks
Rice Paddy	24 hrs	
Upland Cropping	8.5 hrs	

Efficiencies

Description		Coefficient	Remarks
Irrigation Efficiency	Rice Paddy	100 %	-
	Upland Cropping	85 %	-
Wetting Area Coefficient	Rice Paddy	100 %	"Suface Irrigation"
	Upland Cropping	70 %	"Micro Irrigation"

Design Discharge

Month	Decade	Days	Rice Paddy Supply Water (m^3/dec)	Rice Paddy Discharge Volume (m^3/sec)	Upland Cropping GIWR (m^3/dec)	Upland Cropping Discharge Volume (m^3/sec)	Grand Total GIWR (m^3/dec)	Grand Total Discharge Volume (m^3/sec)	Remarks
Jan.	1st.	10	469	0.0005	0	0.0000	469	0.0005	
	2nd.	10	469	0.0005	0	0.0000	469	0.0005	
	3rd.	11	516	0.0005	4,480	0.0133	4,996	0.0139	
Feb.	1st.	10	6,228	0.0072	6,006	0.0196	12,234	0.0268	
	2nd.	10	6,228	0.0072	10,009	0.0327	16,236	0.0399	
	3rd.	8	4,982	0.0072	3,728	0.0152	8,710	0.0224	
Mar.	1st.	10	854	0.0010	6,297	0.0206	7,151	0.0216	
	2nd.	10	854	0.0010	8,186	0.0268	9,040	0.0277	
	3rd.	11	939	0.0010	11,809	0.0351	12,749	0.0361	
Apr.	1st.	10	658	0.0008	3,733	0.0122	4,391	0.0130	
	2nd.	10	658	0.0008	0	0.0000	658	0.0008	
	3rd.	10	658	0.0008	4,090	0.0134	4,748	0.0141	
May	1st.	10	468	0.0005	9,394	0.0307	9,862	0.0312	
	2nd.	10	468	0.0005	12,210	0.0399	12,679	0.0404	
	3rd.	11	515	0.0005	35,741	0.1062	36,256	0.1067	
Jun.	1st.	10	1,232	0.0014	53,853	**0.1760**	55,085	0.1774	
	2nd.	10	1,232	0.0014	47,836	0.1563	49,068	0.1578	
	3rd.	10	1,232	0.0014	29,850	0.0975	31,082	0.0990	
Jul.	1st.	10	895	0.0010	16,493	0.0539	17,387	0.0549	
	2nd.	10	895	0.0010	9,092	0.0297	9,987	0.0307	
	3rd.	11	984	0.0010	9,652	0.0287	10,636	0.0297	
Aug.	1st.	10	12,943	0.0150	7,950	0.0260	20,892	0.0410	
	2nd.	10	12,943	0.0150	10,667	0.0349	23,610	0.0498	
	3rd.	11	14,237	0.0150	19,660	0.0584	33,897	0.0734	
Sep.	1st.	10	30,117	**0.0349**	31,497	0.1029	61,614	0.1378	
	2nd.	10	30,117	0.0349	44,037	0.1439	74,154	**0.1788**	
	3rd.	10	30,117	0.0349	34,083	0.1114	64,200	0.1462	
Oct.	1st.	10	965	0.0011	19,446	0.0635	20,411	0.0647	
	2nd.	10	965	0.0011	16,355	0.0534	17,320	0.0546	
	3rd.	11	1,061	0.0011	23,476	0.0697	24,537	0.0709	
Nov.	1st.	10	665	0.0008	8,834	0.0289	9,499	0.0296	
	2nd.	10	665	0.0008	11	0.0000	676	0.0008	
	3rd.	10	665	0.0008	0	0.0000	665	0.0008	
Dec.	1st.	10	455	0.0005	0	0.0000	455	0.0005	
	2nd.	10	455	0.0005	0	0.0000	455	0.0005	
	3rd.	11	500	0.0005	253	0.0008	753	0.0013	
Annual			*168,299.0*	-	*498,729.4*	-	*667,028.4*	-	-
Maximum			*30,116.7*	***0.0349***	*53,853.3*	***0.1760***	*74,153.5*	***0.1788***	-

Notes

*1) GIWR (m^3/dec) : Gross Irrigation Water Requirement

*2) Discharge Volume (m^3/sec) = GIWR (m^3/dec) / dec (days) / (3,600 (sec/hr) * Operation Hours (hrs))