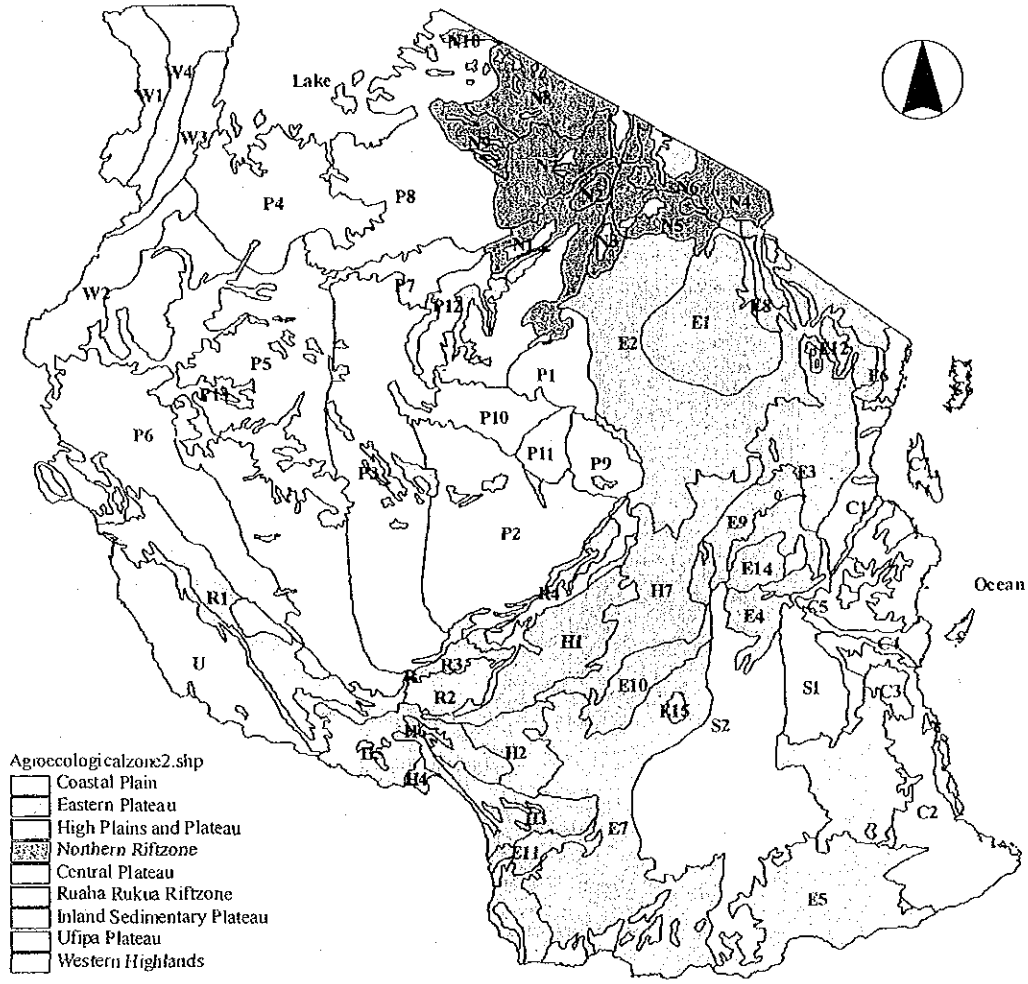
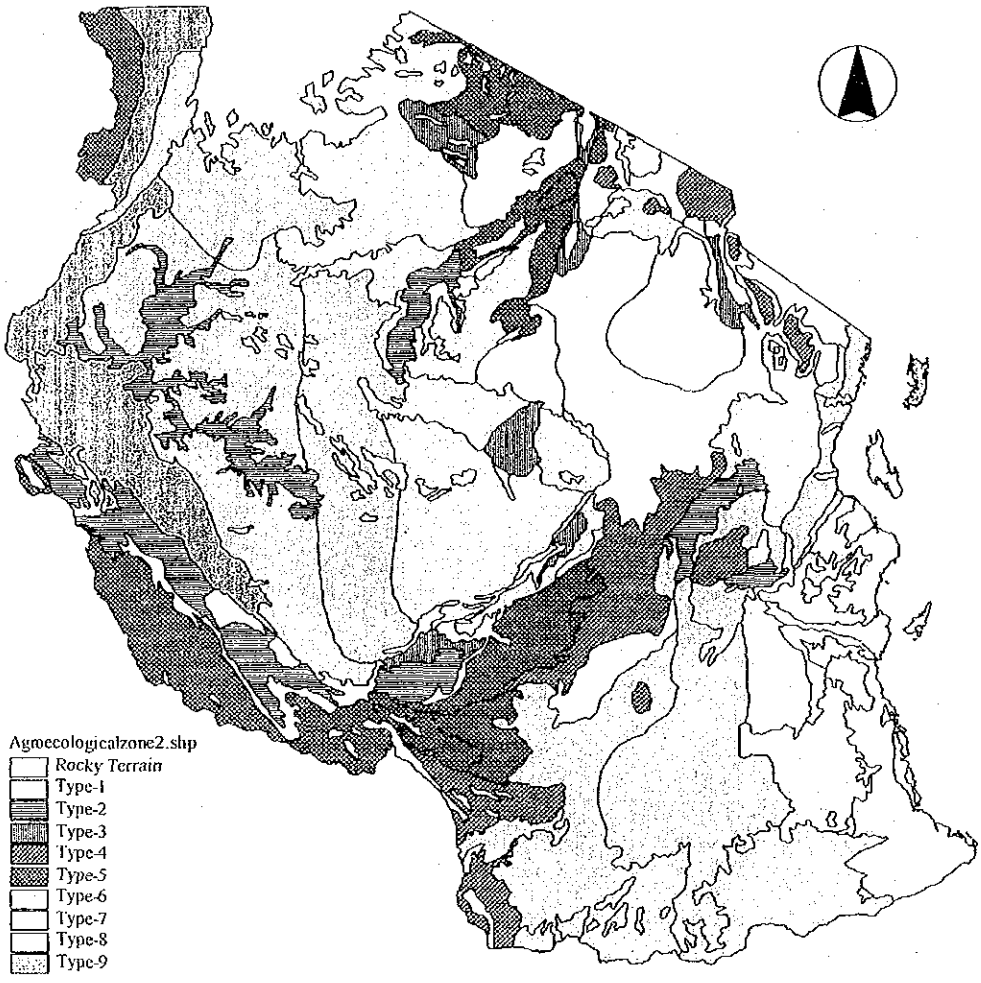
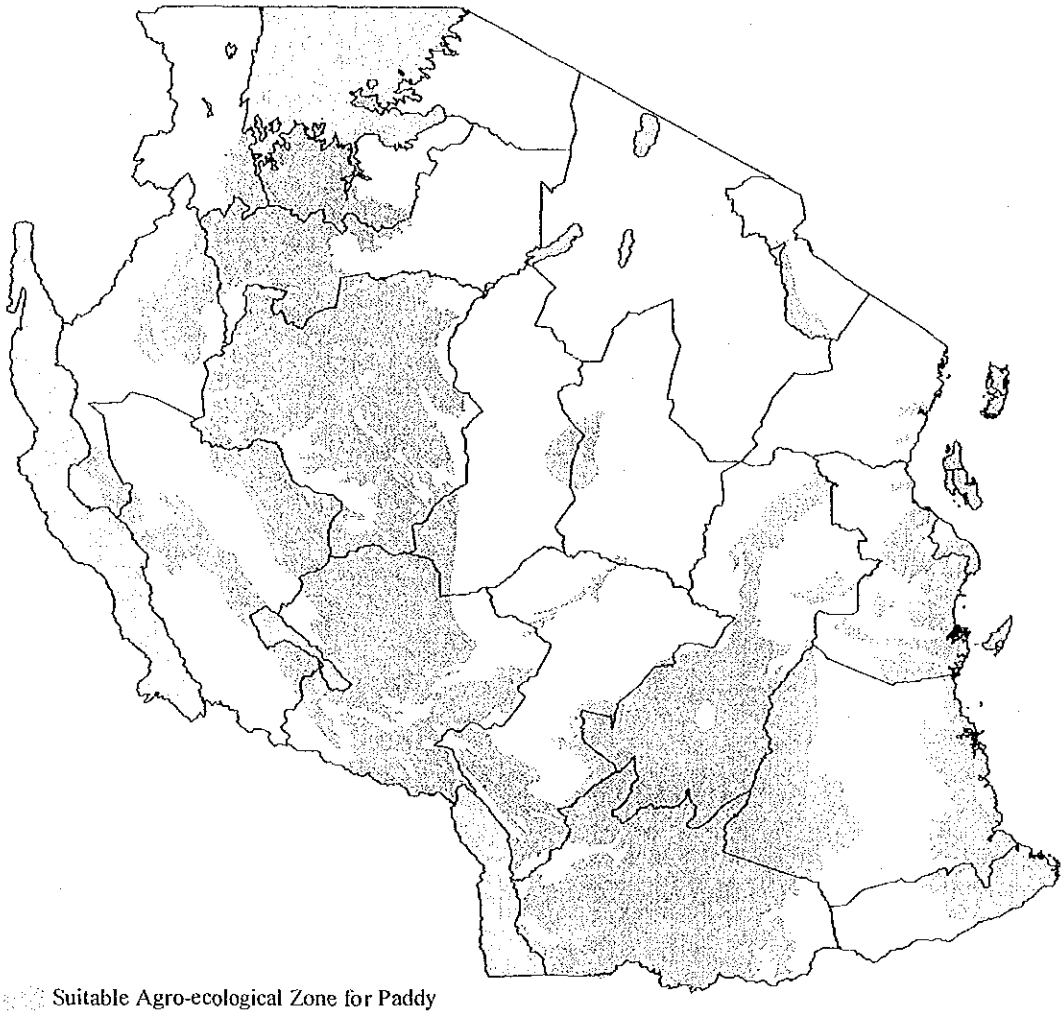
Figure



The Study on the National Irrigation Master Plan in the United Republic of Tanzania	**Figure 2.2.1 Agro-ecological Zone Map**
Japan International Cooperation Agency	

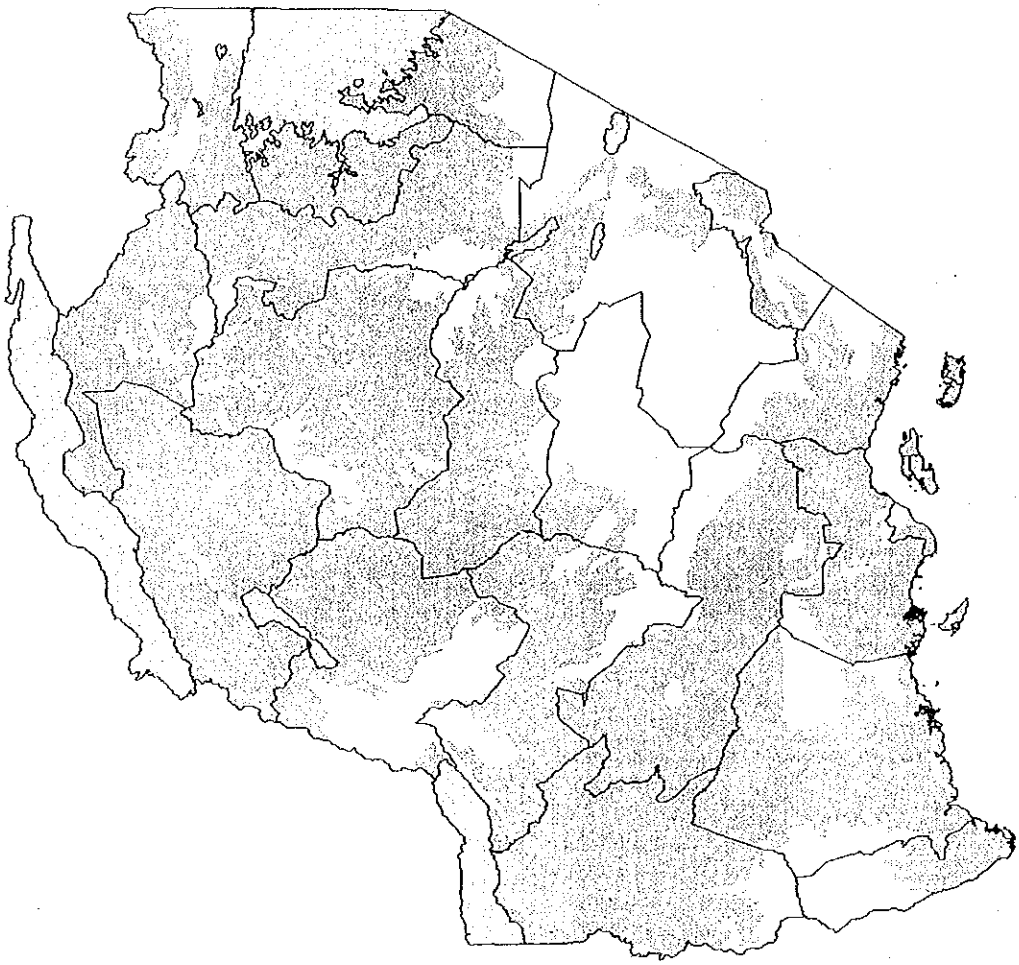


The Study on the National Irrigation Master Plan in the United Republic of Tanzania	**Figure 2.2.2 Major Physiographic Type of Agro-ecological Zone Map**
Japan International Cooperation Agency	



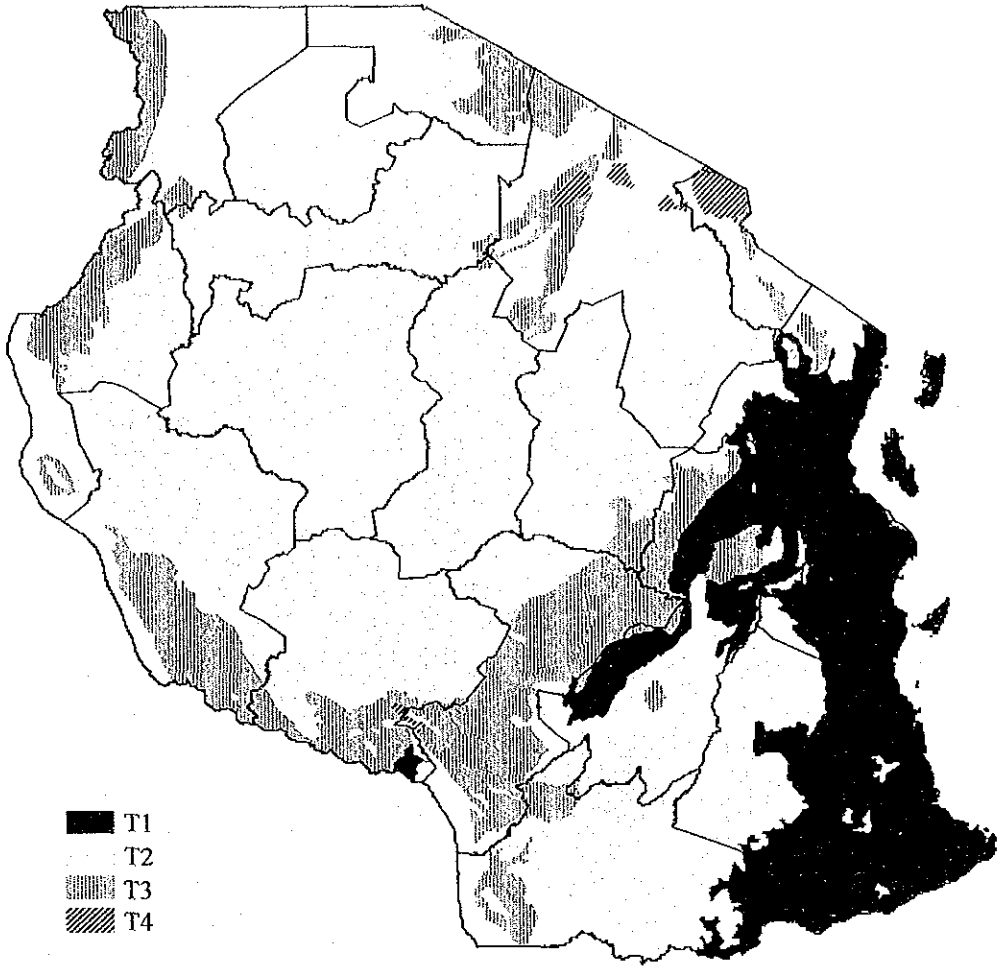
Suitable Agro-ecological Zone for Paddy

The Study on the National Irrigation Master Plan in the United Republic of Tanzania	**Figure 2.2.3** **Distribution of Suitable Agro-ecological Zone for Paddy**
Japan International Cooperation Agency	



Suitable Agro-ecological Zone for Maize

The Study on the National Irrigation Master Plan in the United Republic of Tanzania	**Figure 2.2.4** **Distribution of Suitable Agro-ecological Zone for Maize**
Japan International Cooperation Agency	

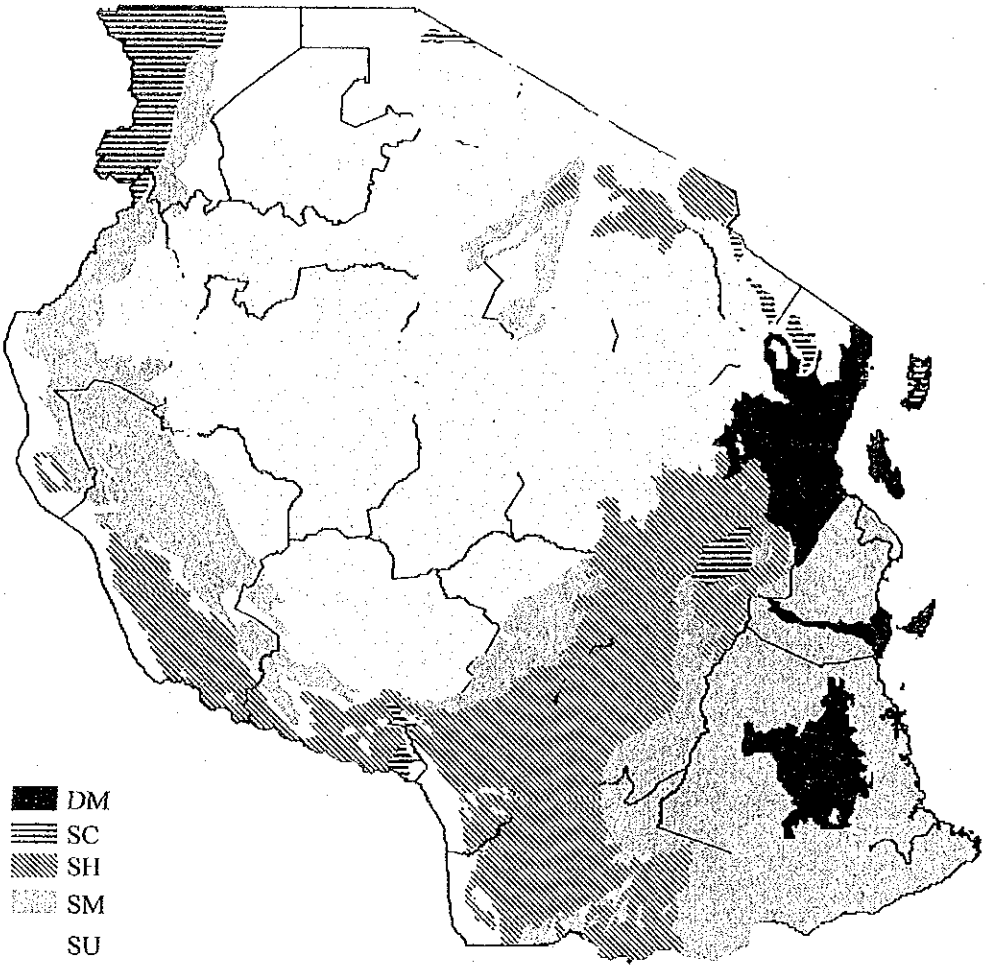


Temperature regime	Altitude range	Temperature range			Major crops
		Mean annual max.	Mean annual min.	Range	
T1	0-750	29-31	19-23	9	cotton, rice, sugarcane, groundnuts, cowpeas, cassava, Bananas, citrus, soya, sisal, maize, sorghum, sweet potatoes, millet
T2	750-1,500	27-30	15-18	12	cotton, rice, sugarcane, sesame, groundnuts, cowpeas, cassava, bananas, pineapple, citrus, soya, sisal, sorghum, beans, coffee, maize, millet, wheat, sweet potatoes
T3	1,500-2,300	22-25	10-15	11	maize, millet, wheat, pyrethrum, apples, peaches, plums, grapes, potatoes, sweet potatoes, beans
T4	2,300-	16-19	5-10	10	apples, plums, peaches, grapes, apricots, potatoes, pyrethum

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

Japan International Cooperation Agency

Figure 2.2.5
Distribution of Temperature Regime



Moisture Zones	Growing period characteristics
DM	Areas with double cropping period
SC	Areas with single, often continuous growing period
SH	Areas with single growing period, highly responsive to moisture storage capacity
SM	Areas with single growing period, moderately responsive to moisture storage capacity
SU	Areas with single growing period, unresponsive to moisture storage capacity

The Study on the National Irrigation Master Plan in the United Republic of Tanzania	**Figure 2.2.6 Distribution of Moisture Zones**
Japan International Cooperation Agency	

Appendix D

Irrigation and Water Management

THE STUDY
ON
THE NATIONAL IRRIGATION MASTER PLAN
IN
THE UNITED REPUBLIC OF TANZANIA

MASTER PLAN

APPENDIX D

IRRIGATION AND WATER MANAGEMENT

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APPENDIX D

IRRIGATION AND WATER MANAGEMENT

CHAPTER 1 PRESENT CONDITIONS AND CONSTRAINTS IN IRRIGATION DEVELOPMENT

1.1 Irrigation Water Use under the Country's New Water Policy

In general, it is compulsory for irrigation water uses to acquire a water right in Tanzania. It is prescribed by the Water Utilization Act as describing, "The law prescribes that any person who intends to use the water of river shall obtain a water right, and the law also requires that any parson who wants discharge effluent and waste water in a water body shall obtain the water right". The issue of granting water rights is dealt with in accordance with the section 15 of the act No.45 of 1974 and also the regulations of 1997 made under section 38 (2) of the Act.

Nevertheless, work of authorization of water right has progressed at a slow pace. For the Pagan River Basin which is a most advanced river basin in authorization of water rights, 730 water rights have been granted among recognized 1,883 water abstractions which are mainly for irrigation water supply purpose at 2.2 lit/sec of averaged discharge. In the case of the Rufiji River Basin, 914 water rights have been granted among recognized 1,446 water abstractions. So far, customary water use by the traditional irrigation schemes have been consecrated, and granted water rights easily as far as adequate application is prepared and submitted. However, outside pressures for irrigation water use will become more strong, judging from the recent establishment of new policy of "National Water Policy".

National Water Policy was finally drafted on December 2001, and would be soon authorized. Presently effective "Water Utilization Act" shall be revised in accordance with the philosophy stated in the new Policy. Basic structure of the new Policy is as follows:

Basic Structure of National Water Policy

National Water Policy	
Objectives of the policy	Sections of the policy
(1) develop a comprehensive framework for sustainable development and management of the Nation's water resources, including putting in place an effective legal and institutional framework for its implementation	I. Water Resources Management

(2) institute cost sharing and beneficiary participation in planning, construction, operation and maintenance of community based domestic water supply schemes	II. Rural Water Supply
(3) implement an integrated approach to water resources management and for water and sanitation service delivery	III. Urban Water Supply

Source: National Water Policy (Draft), 2001

The Policy attaches greater importance to "comprehensive framework for sustainable development and management of the Nation's water resources" and "participatory implementation of water supply scheme". The formalized new policy on water resources development and management is supposed to have a drastic influence on water use for the irrigation sector.

The Policy says that water resources development and management shall be dealt with in effective manners in line with an idea of "Water as a common use resource". As described concretely, "water for basic human needs in adequate quantity and acceptable quality will receive highest priority, and other uses will be subject to social, economic and environmental criteria". Furthermore, it is clearly regulated that "all water abstractions and effluent discharges shall be subject to the *water use permit* or *discharge permit* to be issued for a specific duration". These two aspects must be great threats for irrigation water supply. One threat is the restrain on new irrigation water resources development in competition with other water uses of industrial sectors in a single viewpoint of economic superiority. Another threat is hindrance on continuous use of water for irrigation water as the supply depend upon the water using condition of the right holder or need of water for new users at the time being.

These new currents in water resources development and management, were already incorporated in the ongoing project of RBMSIIP which has been successful in river basin management in Pangani and Rufiji River Basin. The RBMSIIP is under a basic development concept that no allocation of water is given to new irrigation water use, on the basis of the result of economic evaluation which shows water use for hydro-power generating is much superior to the same for irrigated agriculture in viewpoint of economy.

Subsequently, new direction of irrigation development has been proposed so that saved amount of water through improvement of present worse irrigation efficiency shall be appropriated for the development of irrigated agriculture.

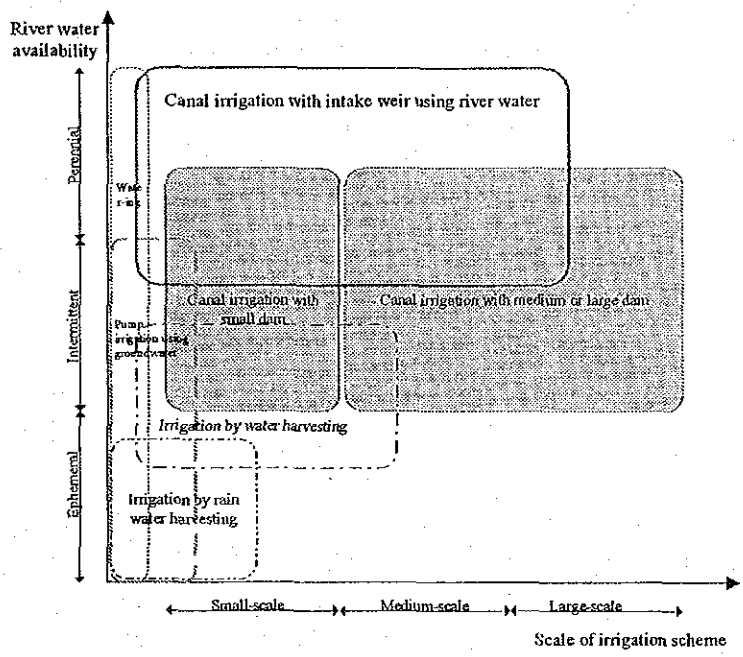
The basic concept of the National Water Policy is an extension of the similar idea in the RBMSIIP. Some counterarguments against the assertion of "water for only economic growth's sake" have been heard. It is required to identify actual

contribution of irrigation in Tanzania, and clarify the position of irrigated agriculture in the country.

1.2 Type of Irrigation Development in Tanzania

Irrigation practices in Tanzania are categorized into several patterns by scheme size, availability of water sources and so on, as shown in the following figure: A system of canal irrigation with intake weir having water sources of perennial river is the most prominent irrigation system in the Mainland. Traditional water harvesting practice diverting flood water into fields is performed widely in the marginal areas in Central Tanzania. Twenty-one(21) dams for irrigation water supply were constructed in 1970s, while almost all reservoirs excluding seven (7) sites are not functional due to being silted up. Furthermore, watering by hand or by simple manual pump from a source of spring and impounding so called as "*kisima*", is practiced by individual farmers or by small groups of them in all over of the country.

Classification of Irrigation Practices in Tanzania



Applicability of the irrigation practices differs in general, depending upon natural conditions, sociological condition and size of the targeted site. However, it is important to identify advantageous of those irrigation practices against specified constraints. Advantages of those irrigation practices are summarized in following table:

Advantages of the Irrigation Practices

Classification	Advantages against below constraints				Remarks
	Instability and intermittency of available water	Lower elevation of available water	Low reliability and safety in taking water	Hazards by debris content in water	
Canal irrigation with intake weir	(-) Basically, it is applied for perennial flow.	(effective) Off-taking elevation can be risen by the weir.	(effective) Reliability can be given by solid facilities.	(effective) Those hazards can be alleviated with appropriate designing of weir.	Applied in many schemes in common. It highly depends upon availability and stability of river water.
Canal irrigation with dam	(effective) Natural fluctuation of water can be regulated by water storage.	(effective) Off-taking elevation can be risen by the dam.	(effective) Reliability can be given by solid facilities.	(effective) Those hazards can be alleviated with appropriate designing of intake.	Not many schemes implemented in Tanzania. High reliability and well operability can be given.
Pump irrigation	(effective) Instability of available water can be improved using groundwater.	(effective) Providing water elevation can be lifted by the pump.	(effective) Reliability can be given by solid facilities.	(effective) Those hazards can be alleviated with appropriate designing of well.	Few schemes implemented in Tanzania due to high cost in operation. It is adoptable for smaller and intensive agriculture.
Irrigation by water harvesting (by flood diversion weir)	(Not effective) No regulation for fluctuation of water is given.	(effective) Off-taking elevation can be risen by the weir.	(effective) The safety can be given by solid facilities.	(Not effective) Very little effect is expected due to a characteristic of ephemeral rivers having enormous sediment load.	Practiced in SDPMA/PIDP and SPFS. Permanent weir structure seems to be out of step with the site condition. High sediment load with flood shall bury the facility shortly.
Irrigation by rain-water harvesting	(effective) Short-term regulation of rain fluctuation can be given.	(effective) Some effects can be given depend upon location of harvesting pond.	(effective) Some reliability can be given by the facilities.	(Not effective) No effect can be expected due to a characteristic of ephemeral rivers having enormous sediment load.	Some attempts are done, for instance in SPFS. It is adoptable for smaller and extensive agriculture.
Watering	(-) Basically, it is applied for spotted area having an impounding as such.	(effective) Water can be delivered in higher fields by hand.	(Not effective) Little reliability can be given due to no solid facilities.	(effective) Those hazards are avoidable due to hand watering.	Applied in Tanzania widely in individual farmers level. It requires serious laborious work for farmers.

Remarks: Studied by JICA Study Team

Closely speaking, a flood diversion weir applied in the previous projects e.g. SDPMA can not be put in the same category of water harvesting technology, because it is without any storage or delay action against flood. It is a makeshift for irrigation improvement in the marginal area where dam reservoir is practically required so as to regulate ephemeral river flow. Moreover, pump irrigation is not always applicable everywhere and for any irrigated agriculture. It can be introduced for intensive agriculture in which high expenses in pump operation expenditures can be borne.

Selection of type of irrigation facilities or determination of dimensions of facilities shall be subject to the optimality of the site conditions. However, general irrigation type may be selected among above mentioned irrigation practices, in consideration with general regional characteristics of the location of the schemes.

CHAPTER 2 PROBLEM ANALYSIS ON SELECTED EXISTING IRRIGATION SCHEMES

2.1 Objectives and Methods of Problem Analysis

The Irrigation Master Plan, which is a theme of the Study, must be a comprehensive and overall development plan so as to essentially contribute to national irrigation development in Tanzania. Needs for re-consideration could be identified in some subjects in terms of implementation and execution system proposed in the NIDP. On the other hand, there is a room to be made better in the contents and components of the NIDP. These requirements of improvement in NIDP seem to be caused not only by the current circumstances change related to irrigation development in Tanzania, but also by the some overlooks when the NIDP was formulated. In order to identify such important subjects, during this field survey of the Study, a problem analysis was carried out.

Present long depression in irrigation development in Tanzania arises from the incorporated constraints compounding problems in each competent source, such as beneficiaries, Irrigation Section, donors, and private sectors. It is difficult to catch the incorporated constraints by means of examination in each competent source independently. It should put into consideration the overall constraints in irrigation development, instead of problems in each sector alone. For this purpose, in this Study, an analysis method is adopted to examine existing irrigation projects in consonance with project procedures from initial commencing stage to O&M stage of the project.

In this Study, an original form for project analysis was designed. The form is designed so as to pursue problems, stage by stage in project implementation, and grading appraisal according to five ranks which can be obtained in each stage of the project. Adopting the form for project analysis shown in Figure 2.1.1, Problem Analysis has been carried out for some projects, which were selected as mentioned in the next paragraph. The problem analysis has been undertaken with the following outlook:

- to finalize analysis form and schedule of the work
- to select projects to be examined
- to deliver the forms (analysis form and project sheet) to personnel concerned in the project through the counterpart giving adequate guidance
- to collect entered forms through the counterpart

- to review the reply on the form
- to inquire the personnel concerned with the project to give details, if necessary
- to analyze the results in consideration with other information for the projects available, and findings obtained through project site inspection

2.2 Scheme Selection for Problem Analysis

It is judged that projects implemented in old days were not appropriate for this analysis because circumstances surrounding irrigation implementation in those days have changed. Furthermore, peculiar projects are also inappropriate for the target project due to lack of generality of problems found on the projects. Based upon these understanding, projects which have progressed under the NIDP, or have been conformable to the development concept of the NIDP, were selected. Projects implemented just before and after the establishment of the NIDP, are listed in the following table:

Target Projects for Problem Analysis

No.	Name of Programme/Project	Implementation	Present Status
1	Pawaga Irrigation Project	1993 - 1995	Under operation
2	Madibira Agricultural Smallholder Development Rice Project	1995 - 2000	Under operation
3	Rehabilitation of Kilimanjaro Traditional Irrigation Schemes	1987 -	Under implementation
4	Smallholder Development Project for Marginal Area (SDPMA)	1992 – 1999	Under operation
5	Participatory Irrigation Development Programme (PIDP)	2000 -	Under implementation
6	River Basin Management and Smallholder Irrigation Improvement Project(RBM-SIIP)	1996 -	Under implementation
7	Agricultural Sector Programme Support – Irrigation Component (ASPS-IC)	1998 -	Under study – on course of implementation
8	Special Programme for Food Security (SPFS)	1995 -	Under implementation
9	Mwega Smallholder Irrigation Project	2000 -	Under implementation
10	Traditional Irrigation Programme (TIP)	1987 -	Under implementation

Source: Internal information in the Irrigation Section

Basically, all projects listed above were selected as the target projects of the problem analysis, however, a few projects were excluded because of difficulties and/or delay of collection of significant reply.

2.3 Problem Analysis

Consequences of the problem analysis are shown in Attachment 1, and salient features of the projects are summarized in a project sheet including in the Attachment 2. Projects of, Rehabilitation of Kilimanjaro Traditional Irrigation Schemes and Traditional Irrigation Programme (TIP), could not be collected entered forms due to some reasons. And, Special Programme for Food Security (SPFS) was kept out because the project has not included substantial irrigation development components. As to Participatory Irrigation Development Programme (PIDP), it was judged that SDPMA can cover PIDP since the PIDP is an expanded phase of SDPMA.

The main points of the answered projects are summarized as follows:

Main Points of the Target Projects for problem Analysis

Programme/projects	Overall assessment
Pawaga Irrigation Project	This is the implementation of first phase in the development program proposed in the F/S, mainly constructing intake weir. As 2nd and 3rd phases are at a standstill for lack of funds, present irrigation system could not always be expected to have full-scale effects. Although advocating "simple and low-cost technology", lack of basic technical considerations was identified in the design, which has not made a sense of adoption of the applied simple technology. The failure in designing wasted the efforts during construction, and imposing a trouble in O&M on farmers.
Madibira Agricultural Smallholder Development Rice Project	This is a novel attempt in large-scale irrigation development for the sake of smallholder. The project has just entered operation stage. Forward performance of the project is worth of remark. Serious problems could not find in every procedures of the project implementation.
SDPMA	This is a useful challenge for irrigation development in the marginal areas which hold limited water availability. Attaching great importance to farmers' participation, good participation of farmers has been generally seen. Water harvesting technology is under developing process in Tanzania. Some constructed diversion weirs were designed with less consideration of river morphologic characteristics as ephemeral river.
RBM-SIIP	RBM-SIIP has carried out a large number of activities related to irrigation improvement in combination with supporting river basin management. SIIP component has made slow progress because of some reasons. As far as assessing present stage of project implementation, lack of experiences and insufficiency of management system could be recognized in planning, designing and supervising. Furthermore, lack of adequate contractors for irrigation projects are keenly recognized.
ASPS-IC	The project has progressed taking legitimate and appropriate procedures, in scheme identification, scheme selection, and conducting study and formulating development plan with applying participatory approach. The project punctiliously follows NIDP's concept of "in small-scale, for smallholder, by simple and low-cost technology". It is still not yet started construction. The project seems to worry too much about lowering costs so that project cost is about US$ 2,000 per ha. or less.
Mwega Smallholder Irrigation Project	*The project is under construction, hopefully it will be completed by March 2002.* Taking facilities' reliability in O &M in any situation into account, relatively high cost design rather than other irrigation projects was adopted. Even taking consideration so as to reduce burden of farmers during O&M, still anxiety for improper farmers' management exist.

Source: Internal information in the IS

2.4 Outcomes on Problem Analysis

General viewing the entered analysis forms of the answered projects, it was understood that each procedure of the project plays important part on overall success of the project. Identified importance and required attention in each procedure in project implementation are summarized by project procedure as follows:

Identified Importance and Required Attention for Each Project Procedure

Identification of Present Conditions:	Planning:	Designing:	Construction:	Operation and Maintenance:
Accurate identification of present conditions is indispensable for project success. Large effort is required for necessary data and information collection due to improper arrangement of agencies concerned. LGA's support and cooperation can be hardly expected due to inadequacy of organization and personnel capability. Conditions in social and environmental aspect are rather difficult to handle than natural conditions.	It is rare to contradict the overall policy or strategies. However, logical consistency or concreteness is difficult to be given. Consistency of logic in project plan is also uncertain. And project assumptions are not taken into consideration, or ignored in many cases. Degree of farmers' participation can be highly influenced interventions to farmers in beginning stages of the project.	Designing is quite different by project in modality and level, due to lack of authorized guidelines. In many cases, actual conditions are not reflected in designing adequately, because of little and easy observation for the site. Ground of designing is generally unclear. Management plan in operation and maintenance is not always examined sufficiently.	Process of contractor selection is varied in project by project, depending upon situation and convenience of the projects. Failures and delay in construction work occur remarkably due to lack of capability and experience of contractors. Supervision of construction work is done improperly by not well-defined system, without proper number of participants. Even encouragement for farmers' participation is done while no proper care system exists in post implementation of projects.	Mistakes accrued during planning, designing and construction are put off to post implementation, and becoming a burden in O&M. The likely blames and failures are put on responsibility of O &M. Improper support system for farmers' activities in O&M exists. As monitoring of the operating project is not carried out timely and properly, project-cycle is difficult to sustain.

Others:
Log-frame was not prepared in every projects so far, and soundness in logic of planning was paid little attention.
Recent days, PRA is frequently held. The method is effective for encouraging farmers participation, however, it is a heavy load for farmers.
Every project prepare own technical guidelines for planning, designing and construction, quoting from existing international guidelines optionally.
Capability of LGA in irrigation development is far below expectation, and following negative trend.
Irrigation Section make effort as thoroughly as possible, however, it is difficult to keep adequate initiative in project implementation due to depressed conditions.
Donors sometimes occupy a dominant position in supported project implementation rather than Irrigation Section.

Source: Studied by the JICA Study Tram

Furthermore, important points concluded from the problem analysis in irrigation development are summarized and enumerated as follows:

- As to encouragement of farmers' participation, adoption of several participatory approaches such as PRA is much effective as evidenced in the results of this study. However, deep farmers' participation is not adequate, though it is necessary assumption for the success of project. There are instances in which farmers were highly encouraged for their participation into project, however, the project has not succeeded in its operation due to constraints in other fields. It is misleading to attach a special importance to promotion of participation only.

- Logical structure of every project is generally not always sound. Especially, when important assumptions are not appropriately considered, these factors left off from previous consideration influence project's success or failure after all. Also, linkage between the project purpose and projects outputs is generally weak. In some cases, despite declaring a project purpose to contribute as a pilot model in irrigation development, a replicability of the project is not examined, or no approaches to expand the effects of the pilot model effectively are provided.

- A concept of "in Small-scale, for Smallholder, by Simple and low-cost technology" is a main stream in irrigation development. It is definitely agreeable in general, in consideration with present circumstances in Tanzania surrounding irrigation development. However, definition of "simple and

low-cost" is sometimes an apt to be misunderstood as "easy and no concern of technical knowledge and aspect". There are many cases in which most fundamental views in river morphology and river sediment transportation are neglected or unconcerned about. Then, it suffers shortening the life of projects, or requiring much effort to remove sediment deposit.

- Relating with the above aspect, presently IS works in general planning and project management much exclusively. Basic technology in irrigation which must be a foundation of such planning and management techniques, are apt to be looked down on. These movements seem to be a hotbed building unrealistic project formulation.

- Overlooking the selected projects in chronological order, it is notable not to reflect previous failures into the next projects. Backstopping system to accumulate lessons learnt and reflect the experiences to others does not exist in Irrigation Section. Accumulation of technical experiences is made light of, too much thinking about a management.

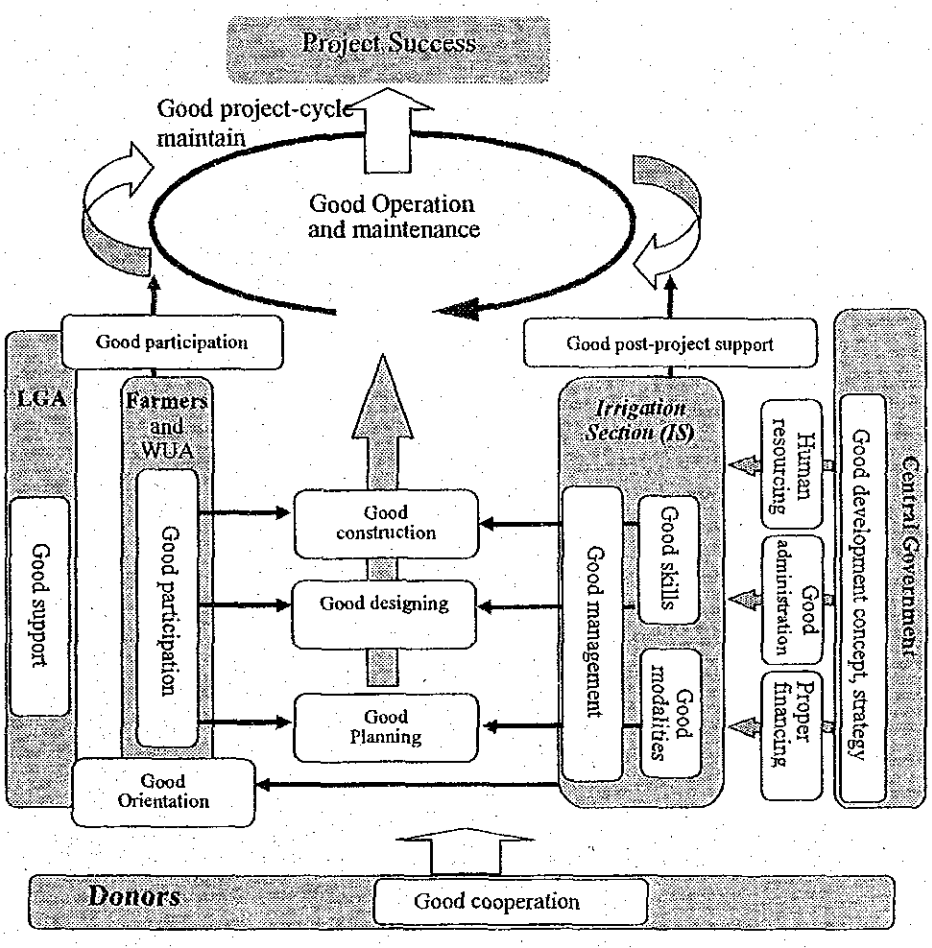
- Technical references such as guidelines and manuals, are not adequately prepared and missing. Although some technical references were prepared under previous programmes/projects, those were not systematized and generalized for common use. This has not only caused misappropriation of the contents of the prepared references, but also brought about by inadequacy of information management system.

- Besides the inadequate preparations in contract system and supervising, capability and experiences of contractors are definitely below expectation. Substantial measures for improvement of contractors' capacity should be taken immediately. Provisional alternatives in order to successful construction work in irrigation schemes should be considered.

- WUA must act an important role in operation and maintenance of irrigation scheme. Besides encouraging WUA's effort on their duties, supporting system for the WUA's activities is essential during post implementation of irrigation scheme.

- LGA plays a significant part for the success of irrigation development. At present, function of office and personnel concerned in irrigated agriculture is still powerless in every district. Adequate participation to meet their present status should be thought.

Above points identified through the problem analysis seem to be related with not only implementation methodology or plan, but also other circuitous sub-sectors. Project shall succeed by having good performances in whole circumstances surrounding irrigation development if implemented according to the following schematic figure: The results of problem analysis were reflected in formulation of master plan components so as to improve every faulty sub-sectors in the system shown in the figure.



Required Good performances in Whole Circumstances Surrounding Irrigation Project Success

CHAPTER 3 STUDY ON IRRIGATION DEVELOPMENT LEVEL

3.1 Needs for Benchmarking of Irrigation Development Level

As it was identified in the results of the Problem Analysis, irrigation development in Tanzania has been executed without certain authorized guidelines prescribing for irrigation development level. From the outset, it is difficult to contain great variation in natural condition and social situation in Tanzania to simply unified criterion. In such sense, to set a unified figure in irrigation development level and to compulsion the criteria seem to be out of place for Tanzania.

However, the differences in technical aspects among implemented projects are too conspicuous even taking variation of characteristics in regional conditions into consideration. The big differences in irrigation development level may bring about; (i) ineffective utilization of limited resources to be appropriated to irrigation development, (ii) complain of farmers concerned to the irrigation schemes being in depleted level, (iii) confusion in expansion of model effects to other areas, and (iv) complexity in supervising and monitoring irrigation schemes together with others which are under different development levels.

In Tanzania, an original criterion on irrigation development level which is elastic or widely accommodating for the variation of conditions of concerned project is required to be fixed.

3.2 Previous Guidelines and Criteria

Irrigation development level is a basic assumption or a fundamental condition of the technical standards in irrigation planning, designing and construction. So far, several technical guidelines were prepared in relation to the specified projects. Following table shows general views of the technical guidelines already prepared:

Existing Technical Guidelines in Irrigation Development

Name of Project	Prepared term	Manual Title	General Status
ISID	1991 - 1994	Project Planning manual	The manual consisting of several volumes, covers all technical fields related to irrigation. The manual has been hardly utilized by every concerned personnel.
ASMP	1996 -	Technical Manual for Planning and Design of Irrigation Systems, Construction Manual for irrigation Works, Technical Manual for Operation & Maintenance of Irrigation Systems	The manual is intended to provide technical and procedural guidance to all personnel involved in the planning, designing, implementation and operation &maintenance of irrigation system in the country. Though a draft of the manual was prepared, it has not been finalized or not made public.

RBM-SIIP	1999 - 2000	Irrigation Design Manual	A design manual for irrigation system was prepared which consisted of two volumes of Guidelines and Drawings. It is a well-organized outcome. It is expected to be utilized in common, with giving some improvements in the contents.
PIDP	2000 - 2001	Rainwater Harvesting Design Manual for Irrigated Agriculture in Marginal Areas	A design manual was prepared consisting of eleven chapters. Many parts of the manual were introduced design methods for conventional irrigation system, few special modalities for water harvesting scheme design are presented.
ASPS-IC	2001 -	Irrigation Water Management Field Handbook for Extension Staff	The handbook consisting of one volume with about 180 pages, is not yet finalized. The handbook will provide information on irrigation water management to extension field personnel as a quick reference manual.

Source: Internal information in the IS

Existing technical guidelines and manuals are not utilized in irrigation development widely and effectively. Although it is caused by inadequacy of knowledge management system or failure of information delivering and circulating arrangement in Irrigation Section, contents of the existing references might have a room to be improved. The existing technical guidelines and manuals composes of introduction and explanation for technical subject item-by-item diverting from international technical guidelines, such as "Irrigation and Drainage Paper, FAO".

Those existing technical references scarcely mentioned the aspect on irrigation development level. In Tanzania, irrigation development should be promoted in various manners corresponding to the variations of projects' sites, from now on. Pursuing optimum irrigation development for each target area which has its own constraints and locality, argument on irrigation development level must be attentive.

As a basic irrigation development concept, "low-cost technology" was advocated since the NIDP establishment. Then, lower investment cost per hectare became an object of argument. However, the argument has been done in viewpoint of affordability, rather than suitability or optimality of the project. Irrigation development level should be decided upon to clarify the suitability or optimality of project in Tanzania.

3.3 Basic Concept for Study on Irrigation Development Level

Appropriate approach should be corresponding to the natural and social conditions in the concerned project area. As explained in the Inception Report, many options could be conceived in irrigation improvement in general. In such cases, same agricultural productivity is ensured by different ways of irrigation practice, one is to realize by means of systematic irrigation operation with solid facilities in

hardware as an initial investment, another is to achieve by simple facilities with close human cares in software as a post-implementation effort. Concept of the combination between in hardware (initial investment) and software (cares in post-project implementation) component by several typical irrigation systems are illustrated in the Figure 3.3.1.

From these understandings in irrigation improvement, objectives of the study on irrigation development level are to provide conceivable options of irrigation development having appropriate combinations in hardware and software, which meet any unusual characteristics of concerned project area. Some specific features of inputs in hardware and software will be also proposed in corresponding to the establishment of standards on the irrigation development level.

3.4 Study Result

In the course of the Study, preparatory investigation including project cost analysis on the selected on-going irrigation projects were carried out taking the above-mentioned basic concept for the study on irrigation development level into consideration. Following two major tasks were conducted during this term:

a) Project cost at per ha in several projects appears significant gaps outwardly. However, most of the differences could be justified by the reasons of differences in project assumption and/or project condition. First task was to adjust the apparent project cost to the modified cost so as to offset differences in project assumptions, then, to compare with each modified project cost of selected on-going projects.

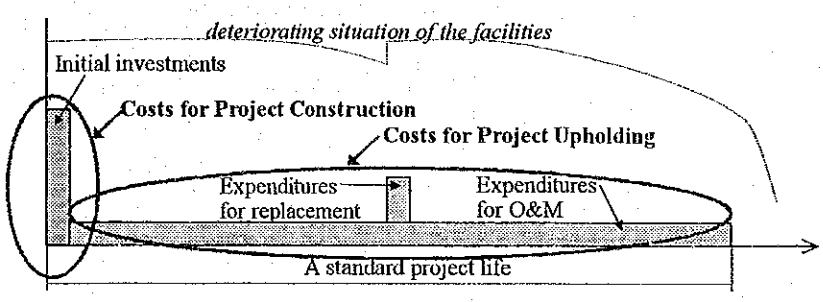
b) Second task was to examine a relation between project assumptions and cost balance of the two categorized investments, and to roughly classify irrigation development type in consideration with the result of the above task.

(1) *Investigation on Project Investment*

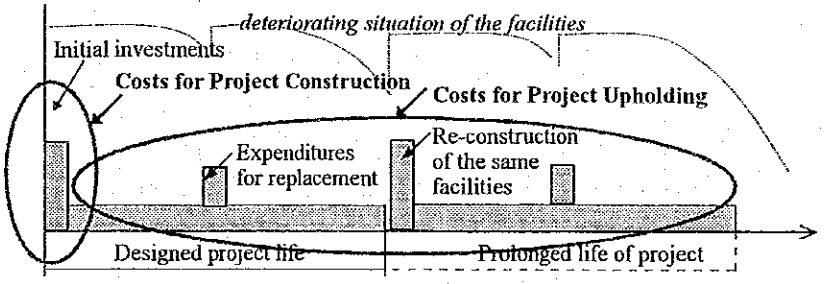
For the selected projects, project cost was adjusted taking differences in project assumptions into consideration. As the on-going projects for this investigation, the same projects selected in the Problem Analysis, were applied. Features of the selected projects are shown in Attachment 2. Apparent project costs of them vary from about US$ 1,000 /ha. to about US$ 11,000 /ha. Nevertheless, project

conditions and assumptions, such as cost estimated year, design reliability against drought occurrence, project life and so on, differ in each other. For instance, difference of project life gives large difference of development level of facilities and also the required cost for them. For the project showing low apparent cost, it is not always a low-cost project if it has shorter life of project.

Following two figures schematically show dissimilarity of projects which have different project life. Providing that the upper project has a standard project life, the lower project which has a shorter project life can work within a shorter period rather than the standard life span. In order to expand the project duration of the lower project so as to be as same as the standard years, an additional input or effort is required. As these additional efforts are put in same category as operation and maintenance, a post-project implementation investment including cost for project up-holding such as additional efforts and O&M cost and so on may be considered. The post-project implementation investment could correspond to the expenditures in software, while the initial investment for facilities' construction may correspond to the expenditures in hardware.



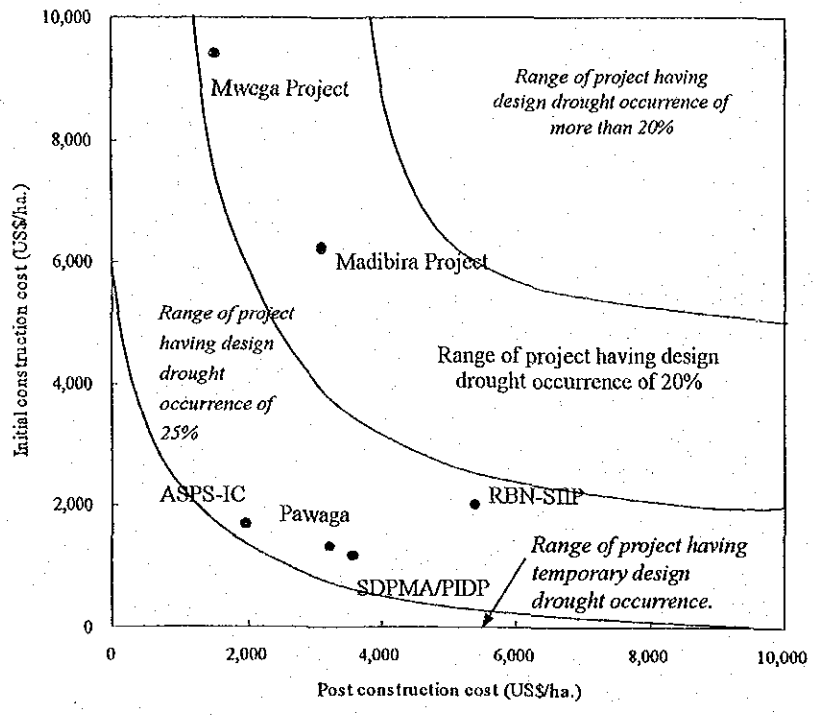
Conceptual Explanation of Input Provision for a Standard-lived Project



Conceptual Explanation of Input Provision for a Short-lived Project

Arranging as the same manner, adjusted project costs of the selected projects were obtained, and the result is shown in Table 3.4.1. Converting the costs at US$/ha., the result is shown in following figure indicating two axis of the initial

construction cost and the post-project implementation cost.

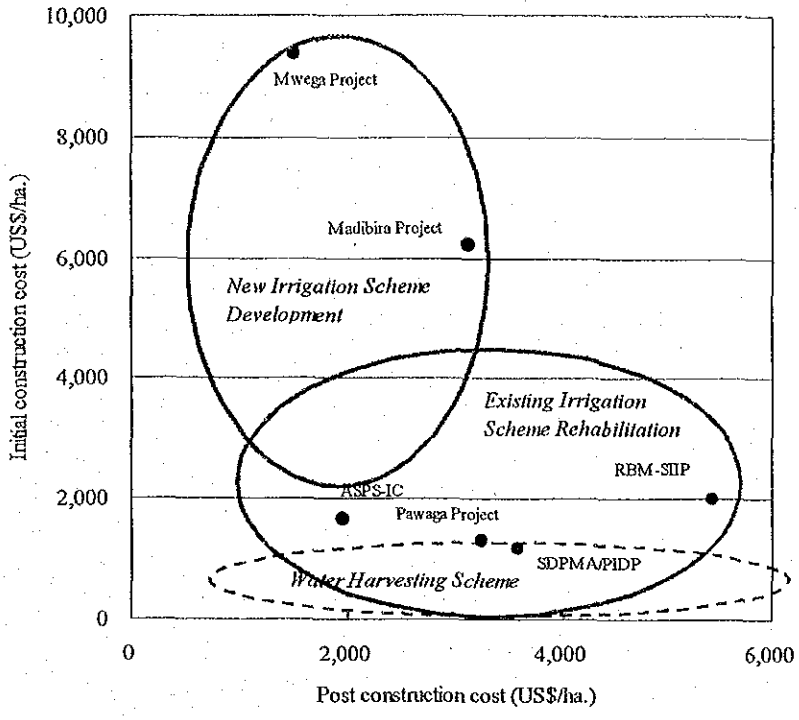


Result of Arrangement of Project Cost

According to the result of arrangement of project cost, every selected project appears in the same stage for comparison. As designing higher reliability of project, the initial construction still more exceeds the post-project implementation cost. Even for the projects having same design reliability, diversified balance of both costs could be taken corresponding to the farmers capability for project operation and local conditions.

(2) Provisional Classification of Irrigation Development

For the time being, irrigation development could be divided into three (3) types, namely, new irrigation development scheme, rehabilitation irrigation scheme and water harvesting scheme. Utilizing the above-obtained result, the irrigation development classifications can be drawn within the two-axis graph as follows:



Provisional Classification of Irrigation Development

For the new irrigation development scheme, rather higher-cost facilities are required so as to substitute farmers' shortcoming of experiences and knowledge in water management which causes from poor irrigation practices. On the contrary, for the rehabilitation scheme, the post construction cost surpasses the other attributing to the advantages in farmers performance. Furthermore, many efforts of farmers are required in water harvesting development.

For the water harvesting to be adopted in marginal areas, low-cost technology is essentially suitable having shorter project life. One reason for this is economic feasibility, and other reason is characteristic of natural condition. Ephemeral rivers for water harvesting generally changes watercourse. Once watercourse of the ephemeral river changes in short term, investment of solid facilities having long life is of no use.

3.5 Guideline of Irrigation Development Level

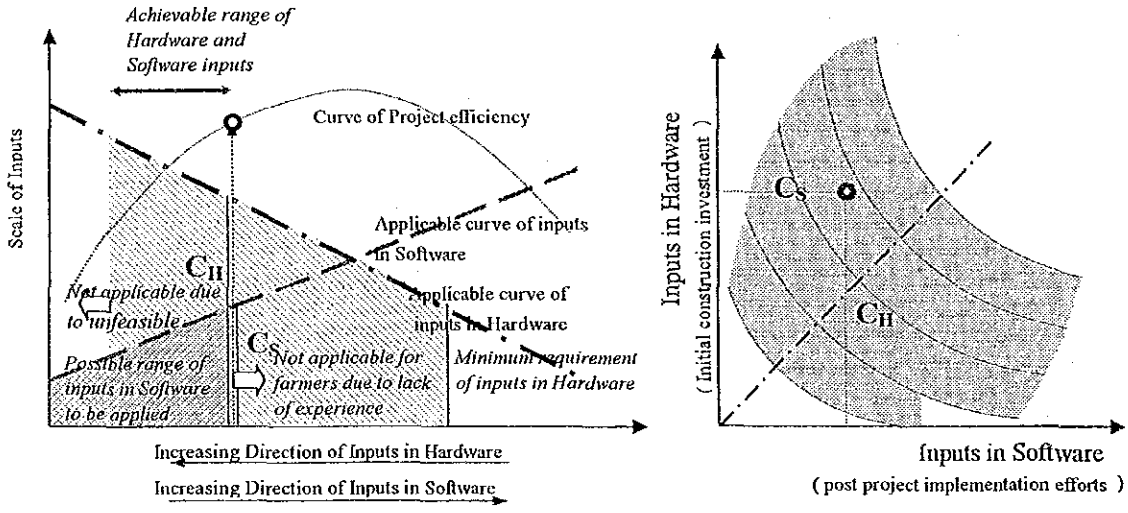
A Guideline of Irrigation Development Level was prepared in Attachment 3. The guideline for irrigation development level is intended to show a possible and most suitable modality of irrigation development by irrigation development pattern on the basis of recognition of potentiality and limitation of irrigation

development of the relevant area. Sometimes, it may be given broad interpretation flexibly depending upon peculiar conditions of scheme site.

3.6 Additional Explanation for the Balance of Hardware and Software

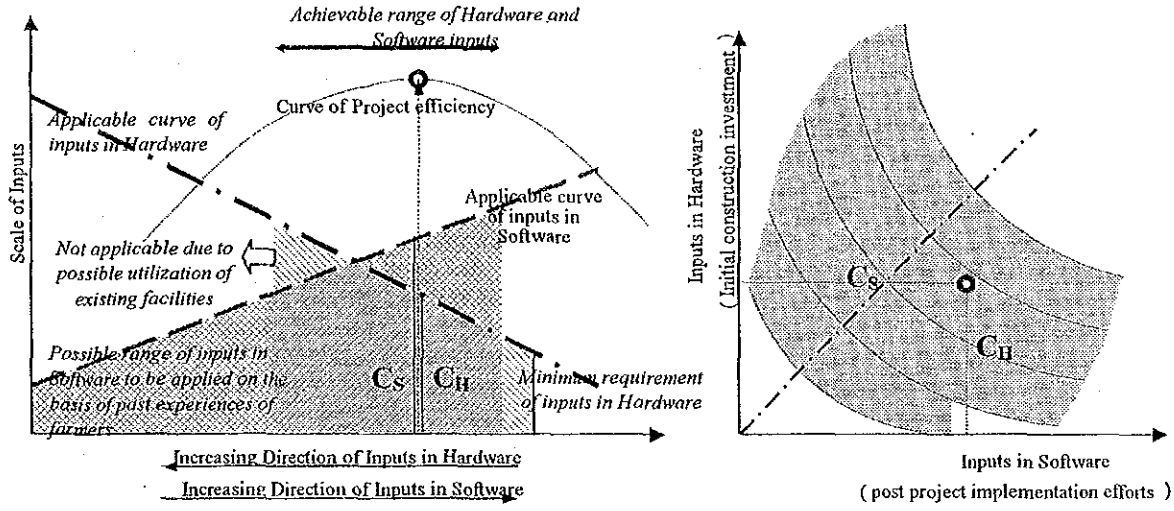
As shown in the guideline of irrigation development level, every types of irrigation development are not similar in their balanced position between hardware and software. The guideline shows that "New Irrigation Scheme" has a tendency to be balanced at a position with combination of higher hardware investment and lower software efforts. On the contrary, "Water Harvesting Scheme" is to be balanced at a position with combination of lower hardware investment and higher software efforts. And "Rehabilitation for Existing Scheme" takes a moderate of the both. In this clause, additional explanation on these matters is given.

For the case of "New Irrigation Scheme", software on the scheme operation is not expectable much because beneficiaries have little experience in irrigation to meet the requirement of such modern scheme. However, appropriate investment cost for the scheme is generally rather than higher because the scheme is sited in advantageous areas with more cost-effective planning applying modern technology. "New Irrigation Scheme" generally demands rather light-maintenance facilities, thus, it could be affordable because of higher feasibility of the scheme implementation. The situation is illustrated as follows:



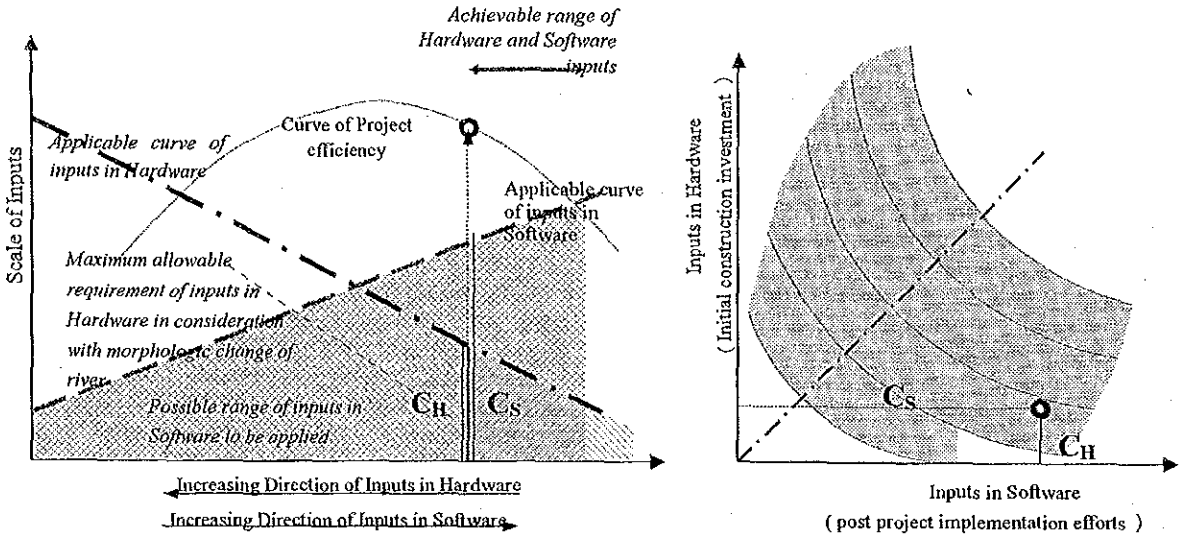
Schematic Explanation of Optimum Point of Balance Between Hardware and Software
(New Irrigation Scheme)

For the case of "Rehabilitation Irrigation Scheme", software on the scheme operation is rather expectable because beneficiaries have practiced irrigation for many years at the same site of the scheme. Appropriate investment cost for the scheme is moderate because the scheme implementation is not always drastically changed because it is a rehabilitation work. Therefore, "Rehabilitation Irrigation Scheme" could generally provide experienced maintenance and operation, and, it is moderately affordable for initial investment. The situation is illustrated as follows:



Schematic Explanation of Optimum Point of Balance Between Hardware and Software (Rehabilitation Irrigation Scheme)

For the case of "Water Harvesting Scheme", appropriate investment cost for the scheme is fairly limited because the scheme implementation gives limited gains and still has unreliability for water supply as same as before. Software on the scheme operation is expectable to be given because beneficiaries have practiced harvesting water for many years. Instead of that, software like farmers' efforts in operation and maintenance is essential for the scheme implementation, otherwise, the scheme would be failed. That is to say, "Water Harvesting Scheme" could provide much intensified efforts in software with lowest initial investment. The situation is illustrated as follows:



Schematic Explanation of Optimum Point of Balance Between Hardware and Software (Water Harvesting Scheme)

3.7 Large-Scale Irrigation Development

Possible medium and large-scale irrigation schemes were also identified within the Inventory Survey as well as small-scale schemes. Besides the identified schemes within the inventory, there were several large-scale irrigation development projects which have been wanting to be developed. There areas are easily reviewed in terms of present situation.

So far some large-scale irrigation development projects were planned in Tanzania, mainly in 1980'. Almost all projects have not been implemented. Furthermore, presently, large-scale irrigation development seems to be hardly favorable because of not only difficulties in financial availability but also scarce linkage with the recent government's development policy like poverty reduction etc. However, no one say the day dose not come when large-scale irrigation projects are strongly urged to be implemented. Within this Study, as a land potential data covering all country was satisfactorily prepared, pre-identified large-scale irrigation development sites would be easily re-assessed utilizing the land potential data and information on the recent situation. The salient features of the assessment for large-scale irrigation development are summarized as follows:

Salient Features of Assessment for Large-Scale Irrigation Development

River Basin	Area/	Pre-identified Irrigable	Present status	Identified area in Land	Future Prospect for large-scale development

	Catchment *	Area (ha)**		potential map (ha)***	
Rufiji River Basin	Usangu Plains	217,000	According to the RBM Study, farmlands of 47,000ha is irrigated.	305,000	(Not promising) Not recommended because of environmental issues
	Kilombero Valley	330,000	Plenty fertile land remains without irrigation.	508,000	**(Promising)** High altitude lands are more beneficial, otherwise, flood control measures are important.
	Lower Rufiji	80,000	In 1982, F/S was carried out in which STIEGLER's Gorge Dam construction was proposed.	190,000	**(Promising)** Phasing development is also feasible.
Ruvu River Basin	Mgeta plain	30,000	JICA Master plan for Ruve River-Basin Development was carried out.	533,000	(-) It is not hopeless, but construction of several dams is indispensable.
	Middle/ Lower Ruvu	30,000			
Wami River Basin	Mkata Plains	14,000	Some numbers of small scheme were implemented.	178,000	(-) Irrigation development by a series of small-scale schemes are much practical rather than large-scale development.
	Wami Coastal Plain	37,000	Not yet developed.		
Wembero River Basin	Manonga/ Wembero Plain	112,220	Some numbers of water harvesting scheme have been implemented.	406,000	(Not promising) Large-scale development is unfeasible because the river is ephemeral.
Lake Victoria	Mara Valley	90,000	Some numbers of water harvesting scheme have been implemented.	110,000	(-) Irrigation development by a series of small-scale schemes are much practical rather than large-scale development.

* : These areas were regarded as a potential area for large-scale irrigation development covering more than 10,000 ha according to the following data source.

** : Data source for these figures is "Rapid Water Resources Assessment" Feb. 1995

*** : These are areas of arable land in sizable scale identified on the Land Potential Map which was prepared within this Study. The figures are considerably large rather than the pre-identified ones, because these were considered land potential only.

According to the above table, at least two projects, namely, "Lower Rufiji Valley Irrigation Development Project" and "Kilombero Irrigation Development Project" are to be warming over. Rufiji River-Basin Development Authority (RUBADA) intends to implement the both projects within the RUBADA's medium development period.

Tables

Table 3.4.1 Cost Analysis of Selected Projects

Analyzed Projects	Command area (ha.)	Planned project life (year)	Year of the cost estimated	Inicial investiment cost (million Tsh.)		Post Project Implementation Cost														Total equivalent cost (million Tsh.)
						Annual O & M cost during each project life			Replacement and repair during each project life			Additional construction cost untill standard project life		Additional O&M cost untill standard project life		Additional replacement and repair untill std.Pro.life		Others		
				Project base*	Escalated ***	Project base*	Adjusted **	Escalated ***	Project base*	Adjusted **	Escalated ***	Adjusted **	Escalated ***	Adjusted **	Escalated ***	Adjusted **	Escalated ***	Adjusted **	Escalated ***	
Madibira Agricultural Smallholder Development Rice Project	3,000	50	1995	10,634	14,935	95	4,270	5,997	532	532	747	-	-	-	-	-	-	-	-	6,743
Rehubilitation of Kilimanjaro Traditional irrigation Schemes	(no information available)																			
Smallholder Development Project for Marginal Areas (SDPMA)	4,300	25	1999	3,957	4,025	161	3,699	3,763	386	386	393	3,957	4,025	3,699	3,763	386	393	-	-	12,337
Participatory Irrigation Development Programme for Marginal Areas (PIDP)	(no information available)																			
River Basin Management and Smallholder Irrigation Improvement Project (RBMSIIP)	220	25	1999	347	#REF!	13	294	299	-	-	-	347	353	294	299	-	-	-	-	952
Agricultural Sector Programme Support-Irrigation Component (ASPS-IC)	1,008	50	2001	1,353	1,353	27	1,272	1,272	150	300	300	-	-	-	-	-	-	-	-	1,572
Pwaga Irrigation Project	2,000	20	1991	357	1,063	0	2	5	9	9	26	536	1,594	3	8	18	53	-	907	2,594
Special Programme for Food Security (SPFS)	(no information available)																			
Mwaga Smallholder Irrigation	580	50	1997	3,978	4,362	9	452	496	182	182	200	-	-	-	-	-	-	-	-	695
Traditional Irrigation Programme	(no information available)																			

Note:

Cost data were given in Attachment 2 "Project Sheet". Standard Project Life is assumed at 50 years. If planned project life of the Project is shorter than the standard life, some additional cost were added within the Post Project Implementation Cost to retain project effect during the standard life.

*: Actual construction cost was quoted from the Completion Reports if there was significant difference between the costs in the study report and completion report. Actual O&M and replacement costs were obtained by means of interview when no data were available in the existing reports.

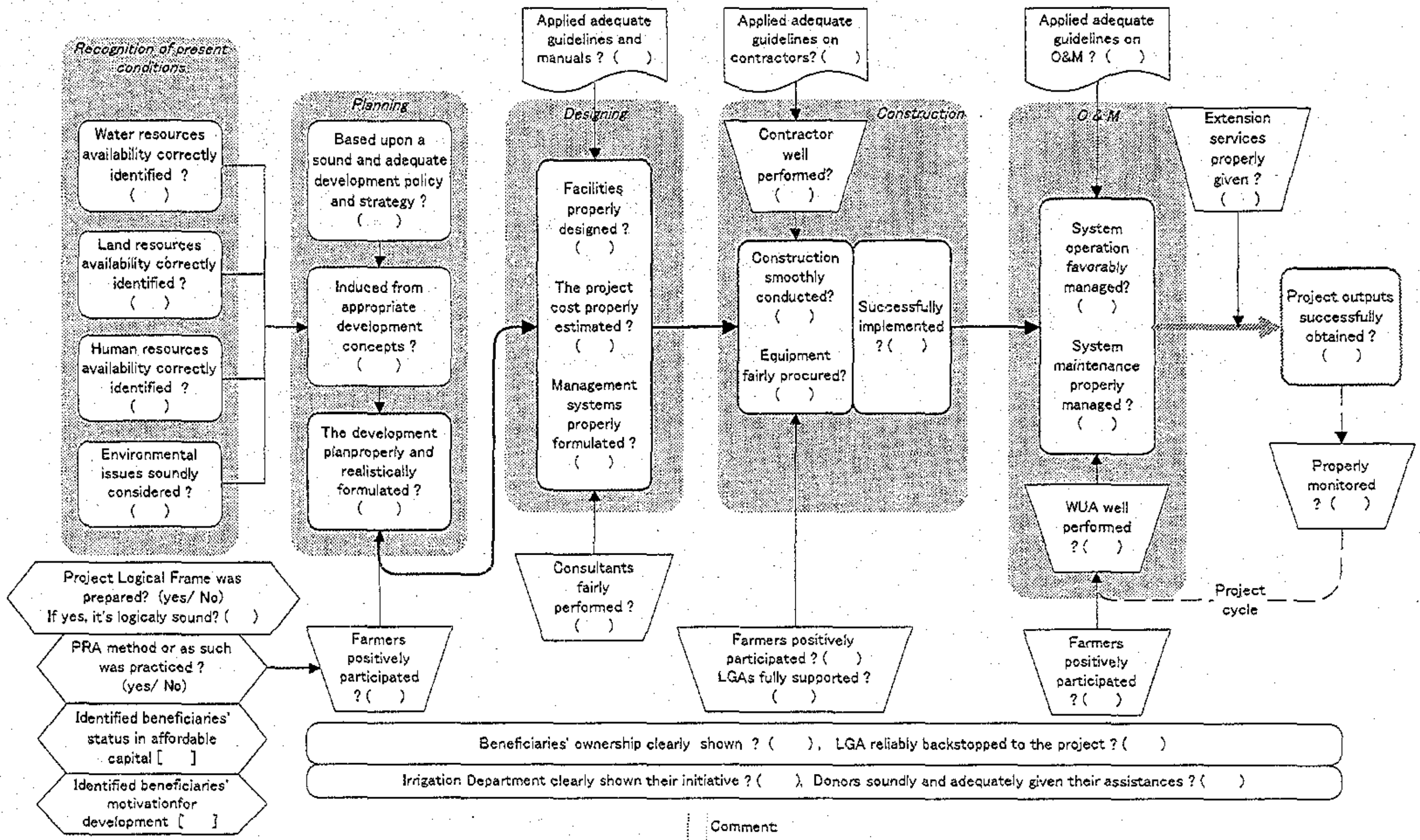
** : adjusted to cover the whole project life period

***: escalated to the standard year (2000) from the different years for estimation

Figures

Project Sheet for the Problem Analysis Project title: Name of Scheme: surveyed in 2001. .

Present stage of the Project: (Completed the study, Under construction, Completed construction, Operating, Under rehabilitation)



Comment:

Note: ( ): Fill out the Project's situation as; A:Good B:Fair C:Normal D:Poor E:Bad
S:In the case of special condition

[ ]: Put down the lebel of A to E

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Figure 2.1.1 Form of Project Analysis

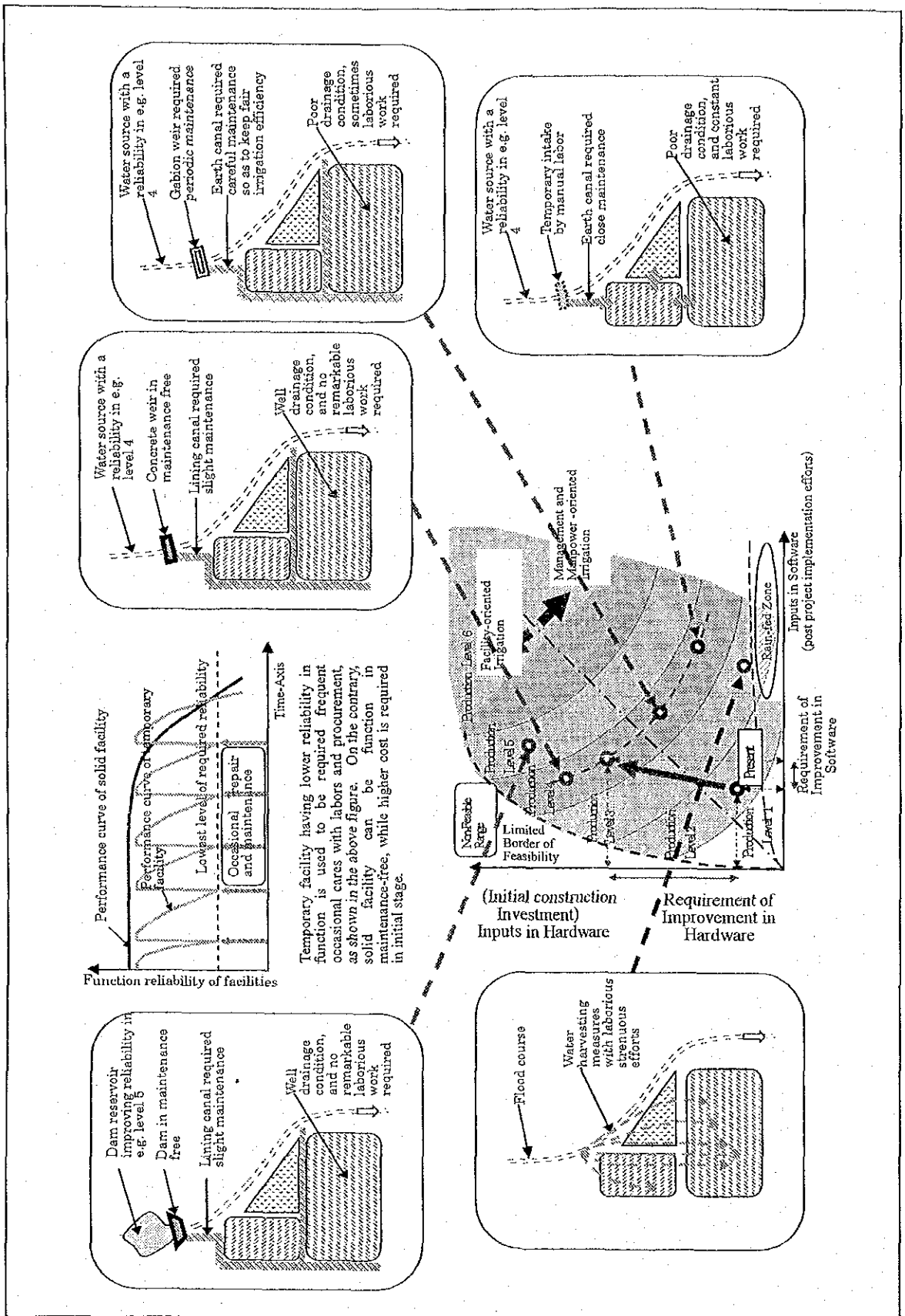

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Figure 3.3.1
Variations of Irrigation Development Level by Typical Pattern of Irrigation System