JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DEPARTMENT OF IRRIGATION
MINISTRY OF WATER RESOURCES
HIS MAJESTY'S GOVERNMENT OF NEPAL

THE FEASIBILITY STUDY ON THE SUNSARI RIVER IRRIGATION PROJECT IN THE KINGDOM OF NEPAL

FINAL REPORT
MAIN REPORT

January, 2003

SANYU CONSULTANTS INC.

AFA
JR
03-04

CURRENCY EQUIVALENTS (as of August, 2002)

1 Nepalese Rupee (Rs)	=	0.0128 US$
1 Nepalese Rupee (Rs)	=	1.53 Japanese Yen
Rs 78	=	1 US$
Rs 0.655	=	1 Japanese Yen

PREFACE

In response to the request from His Majesty's Government of Nepal, the Government of Japan decided to conduct a Feasibility Study on the Sunsari River Irrigation Project in the Kingdom of Nepal and entrusted the Study to the Japan International Cooperation Agency (JICA).

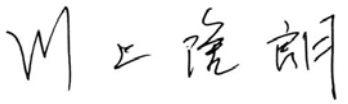
JICA sent to Nepal a study team headed by Mr. Kosei HASHIGUCHI, Sanyu Consultants Inc., five times between April 2001 and November 2002.

The Team held discussions with the officials concerned of His Majesty's Government of Nepal, and conducted field surveys at the Study Area. After the Team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relation between our two countries.

I wish to express my sincere appreciation to the officials concerned of His Majesty's Government of Nepal for their close cooperation extended to the Team.

January 2003



Takao Kawakami
President
Japan International Cooperation Agency

January 2003

Mr. Takao Kawakami
President,
Japan International Cooperation Agency (JICA)
Tokyo, Japan

Dear Mr. Kawakami,

Letter of Transmittal

We are pleased to submit to you the Feasibility Study Report on the Sunsari River Irrigation Project in the Kingdom of Nepal. The Report presents the Irrigation Development Plan formulated with the advices and suggestions of the authorities concerned of the Government of Japan and your Agency. Also included were comments made by the Department of Irrigation (DOI), Ministry of Water Resources, of the Kingdom of Nepal during the technical discussions on the draft final report which were held at Kathmandu in November 2002.

The overall objective of this Study is to improve the living standard of the local people in the Study area based primarily upon irrigated agriculture development. The development plan has been prepared in partnership with and by guidance from the DOI, and incorporated the views of the beneficiaries and other stakeholders such as Department of Agriculture, local authorities, international funding agencies, NGOs, etc. The process of this Study centered on the following which themselves were the objectives of the Study:

- To conduct a feasibility study on the Sunsari River Irrigation System, basic concept of which is to formulate an efficient water use plan aiming at agriculture development, and
- To carry out technology transfer to Nepalese counterparts through the course of the Study.

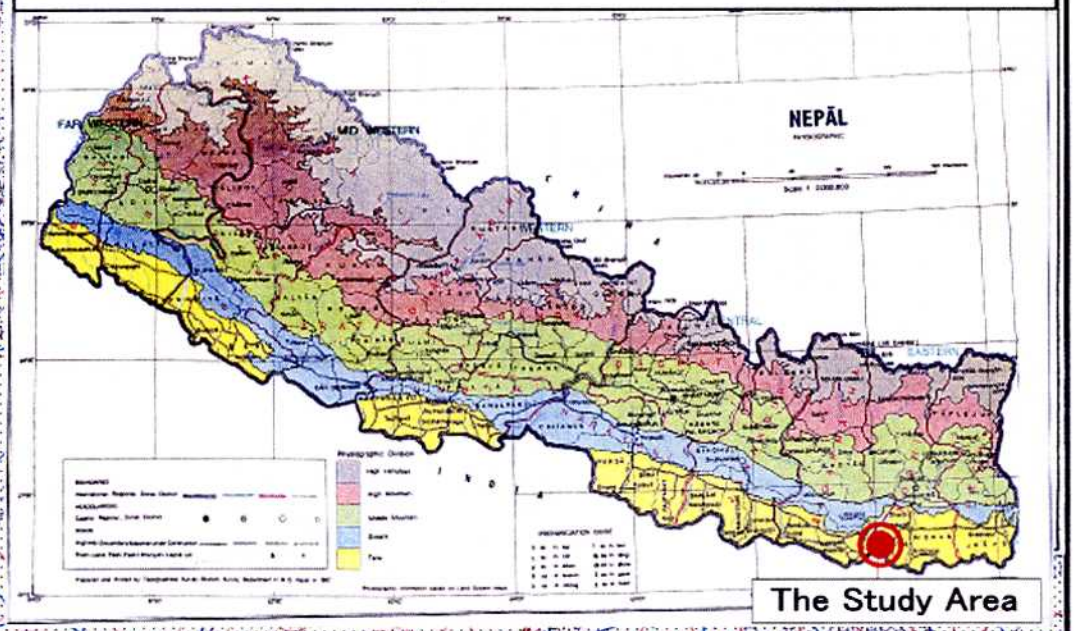
To attain the above objectives, the Study has been carried out in a phasing manner; Phase 1 dealing mainly with situation analysis as well as formulating provisional development plan and Phase 2 undertaking so called feasibility study. The Phase 1 study started at the mid of April 2001 and completed at the end of March in 2002, and the Phase 2 started at the mid of June 2002 and lasted to January 2003, producing this Final Report as the output.

We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs, Ministry of Agriculture, Forestry and Fisheries of the Government of Japan. We also wish to express our deep gratitude to DOI, the counterpart agency, in the Kingdom of Nepal for the close cooperation and assistances extended to us during our investigation and study.

Very truly yours,

Kosei HASHIGUCHI
Team Leader of the Study Team

Location Map of the Study Area



Intake of Sunsari-Morang Project

Chatara Main Canal

Sunsari District

Morang District

E-W Highway

Inaruwa

Biratnagar

Sunsari River

INDIA

SAPTAKOSHI RIVER

Chatara Canal

Budhi River

Lohandra K.

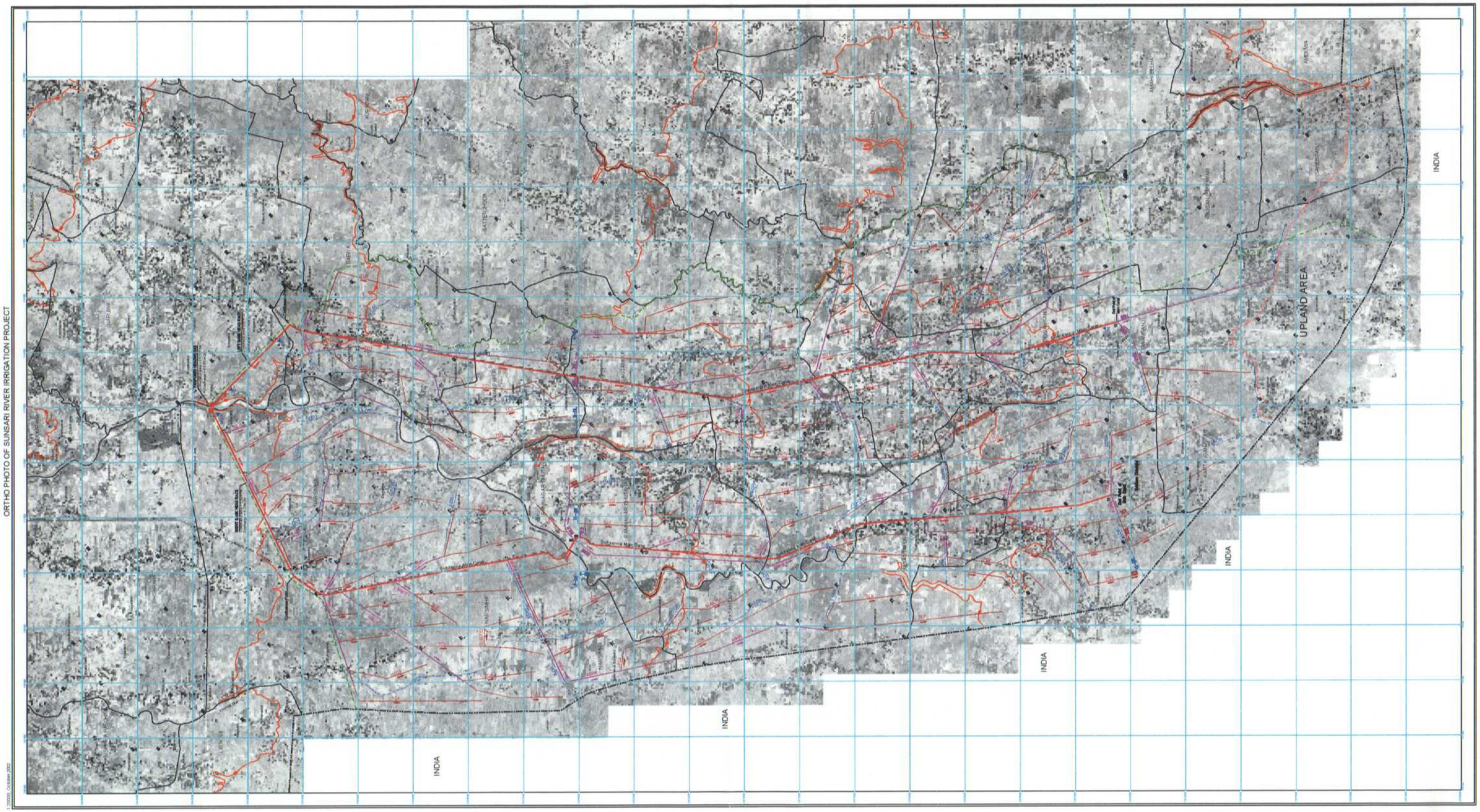
Koshi Tappu Wildlife Reserve

LEGEND			
National Boundary		Sunsari-Moran Project Area	
District Boundary		The Study Area	
Highway		River	
Secondary Road		Airport	
Seasonal Road		National Park	

0 10 20 30 40

Scale 1 : 500,000

Irrigation and Drainage Network



The Sunsari River at the intersection with the East-West Highway. This is the starting point of the Study area 16,800ha heading toward downstream. The proposed headwork site is located at about 600m downstream.

The Sunsari river at the Sukumbasi village in Ghuski VDC, which is the southern most location bordered with India. The river gracefully flows down toward Indian side in the sunset.

Suksena Canal at the location of siphon crossing the Sunsari River. The irrigation water usually reaches up to this point and irrigate the nearby areas along the canal though it is not enough.

Shankarpur Canal at a mid-stream part. The condition is better than Suksena Canal since it was once rehabilitated under Stage I of SMIP. However, the water delivered is not enough to cover the planned area due to sandy soil prevailing in the Study area.

Paddy crop occupying 68% of the total farmland area is the most important crop in rainy season in the Study area. The present yield is however only 2.3 ton/ha which is far lower than the expected yield of 4.2 ton/ha under irrigation.

Wheat is the major crop in winter season in the Study area. The planted area occupies about 60 % of the farmland in Study area. The yield is 2.0 ton/ha at present and expected to increase to 3.5 ton/ha under well managed irrigation..

A consultation workshop held outside. A counterpart is explaining the proposed project to the farmers and has obtained their opinions which were incorporated in the development plan.

An in-house consultation workshop. A counterpart is explaining the background of the project and then the canal network. More than fifty people participated this workshop.

EXECUTIVE SUMMARY

INTRODUCTION

The Terai plain used to be a tropic jungle up until late 19th century. Resettlement into this Terai area started at early 20th century, and since then many people have been coming in. Heavy reclamation machineries, available since around mid 20th century, have greatly helped to open the area, thus the Terai area has turned to be a granary of Nepal nowadays. Once it was a dense forest, but now it supplies huge amount of cereals and other agricultural products not only for the people in the Terai but also for the nation.

The Study area falls in an eastern part of the Terai. The administrative district wherein the Study area is located is the Sunsari. The area is well known for a large national irrigation system called Sunsari-Morang Irrigation Project (SMIP), the source of which is Sapta Koshi river. The SMIP, which started the commissioning in as early as 1975, is the biggest irrigation system as of today in Nepal. The irrigation system, however, has a difficulty to supply enough water all over the irrigable area of 68,000 ha.

The Study area occupies a south-western part of the SMIP, starting at E-W highway at its northern most part and running down to the international border with India. Running through the Study area is a perennial river called Sunsari originating in Siwalik mountain range. The Sunsari river is quite small as compared to the Koshi river. However, if the Sunsari river could well be developed for irrigation, the Study area would enjoy irrigated agriculture, for which the local people have long been waiting.

With the Sunsari river developed, how much area can enjoy irrigated agriculture? How should the outlook of the Study area be? How much benefit would be brought upon the local people? Is the project feasible in terms of technology, finance, economy, institution, etc., and what are the environmental implications if any? If negative environmental impacts were foreseen, what could the mitigation measures be? This Study attempts, as a feasibility study, to answer these questions.

This Study was initiated by a request from His Majesty's Government of Nepal (HMGN) that the Government of Japan (GOJ) send a study mission to carry out the feasibility study. The GOJ sent the Scope of Work mission of Japan International Cooperation Agency (JICA) in November 2000. The Scope of Work was agreed and signed on November 29, 2000 between the two governments, and Sanyu Consultants Inc. of Japan was then contracted by JICA to carry out the Study. The Study Team first showed up in Kathmandu on April 17, 2001 and proceeded to the subsequent field survey, and has now completed all the surveys and studies, presenting this Final Report.

CHALLENGES IN NEPAL'S IRRIGATION DEVELOPMENT TODAY

Water Resources Act (2049) was promulgated in 1992, to make arrangements for the rational utilization, conservation, management and development of the water resources. Provisions 5 and 6 of the Act clearly recognize a Water Users Association (WUA) as a legal entity with perpetual succession. Provision 22 of the Act mentions about turning over of irrigation system constructed by HMGN to a duly organized farmers association. These provisions

together endorse that a WUA is duly established as a legal entity and can participate in irrigation O & M even with the project ownership over the facilities.

Irrigation Regulation was firstly promulgated in 1993 soon after the Water Resources Act was enacted, and amended in 2000. Provision 10 rules that a project developed by HMGN or a canal, secondary canal, sub-secondary canal, tertiary or watercourse of such project may be transferred to WUA. As for a big project, a joint management is also envisaged. The provision states that big projects, which cannot be fully transferred to the WUA, may be operated jointly by the two parties based on agreed service charge, share percentage of WUA and arrangement for maintenance.

Irrigation Policy was formulated in 1992 and is amended every three years. The Irrigation Policy raises six objectives, of which the 3rd objective states the future direction of the government involvement in irrigation development as: to decrease the government's involvement in the construction, maintenance and operation of irrigation scheme by gradually increasing the participation of organized users without having adverse impact on effectiveness of the different stages of implementation of irrigation development.

Until the middle of 1980s, irrigation development by the government had focused largely on the construction of physical infrastructure of canals and structures, and little attention was paid to the effective management of the completed systems. Attention began to be paid to the improved management of the government managed irrigation systems from 1985 onwards. This is reflected in the above act, regulation and policies and also in the implementation of a number of management-oriented projects since 1985. Those projects have specifically emphasized participatory approaches.

Aside from users' participation, self-financial sustainability of irrigation systems is also very much concerned. Nepal Irrigation Sector Project undertakes 2 policy relevant studies. A study finds that the current recovery of O & M cost from the irrigation service fee, presently set at 60 Rs/crop/ha to 200 Rs/ha/year, ranges from 0.1 % to 15 % only, leaving the irrigation systems very much dependent on heavy government support actually by a form of subsidy.

Another study presents a very ambitious irrigation policy in terms of beneficiaries' burden in both capital investment and O & M. The study is concluding that the beneficiaries could bear as high as 79 % of the capital cost in case of large irrigation systems in the Terai and 85 % in case of medium irrigation systems in the Terai aside from the full recovery of O & M cost which is same as the one presented in the above study.

Though the implication given by the two studies may seem somewhat too beyond what the actual practices are taking place on the ground, the direction in irrigation development is now very clear. The direction is that the government involvement in irrigation sector be minimized and in return the beneficiaries participate not only in a form of labor contribution but also through all the process of planning, construction, operation and maintenance as well as for financial due.

THE STUDY AREA

Demography:

The Study area is located southern most part of Sunsari district bounded by Indian border to the south and west. Total area of the Study area covers 168.2km^2, occupying about 13% of the district and agricultural area is estimated at about 125.7km^2, 74% of the total Study area. Total population of the Study area according to year 2001 Census is 97,700, about 16% of the population in Sunsari district live in the Study area. The population density counts 581people per km^2 , higher than the density of Sunsari district, which is 498.

The annual average population growth rate from 1991 to 2001 is 2.5%, slower growth to the district of 3.0%. Although the population growth of Sunsari district is relatively rapid due to migration from the hill area, as one of the factors, it seems that the migration movement has not reached influentially to the Study area due to the location furthest from the hill side. Instead, the migrant work has got its movement to India as well as Arabic countries. According to interviews to farmers in the Study area, some 10% of the villagers in a VDC are going to India or Arabic countries to work.

In the vicinity of the Study area, there are two significant cities, which are Inarwa, the nearest Municipality to the Study area and Biratnagar, the second biggest city in Nepal. Total populations of Inarwa and Biratnagar in 2001 are 23,200 and 161,000 respectively. These cities are the major link of economy with the Study area in the people's selling agriculture products or buying daily stuff.

People's Livelihood:

Most of the people in the Study area are engaged in agriculture. Those who earn from agriculture are categorized into landowners, tenants and farm laborers. Women are mostly engaged in agricultural labor. Livestock rearing is also considerable income source. Fishery in rivers and fishponds is a common occupation, especially for those who are landless and who have only meager lands of several khatas (one khata equivalent to 0.03 ha).

Agriculture:

Main crops in the Study area are monsoon paddy, wheat, potato, oilseeds (mustard, sunflower and linseed etc.), pulses (lentil, soybean and local varieties etc.), vegetables (cauliflower, cabbage, eggplant, onion and tomato etc.), sugarcane and jute. Cropping season is divided into three categories, namely spring, monsoon and winter. Farmers rotate the cultivation with paddy in monsoon season and wheat, potato, oilseeds, pulses, vegetables and/or fallow in winter season. Paddy and jute cultivation in the spring season are limited.

Based on the Rural Socio-economic Survey conducted by the Study Team in July 2002, cropping intensities of paddy in monsoon and wheat in winter are estimated at 68 % and 59 % respectively. The Study area is also well known for vegetable production area, particularly for potato and early cauliflower. Although there are some commercial vegetable growers in the Study area, cropping intensity of vegetables is not more than 2 %. Sugarcane and jute are the most important cash crops as well as potato and vegetables. Jute occupies almost 20 % of the overall agricultural land during spring/monsoon season. However, jute and sugarcane suffer from sharp fluctuations in price as compared with vegetables. The overall

cropping intensity of the Study area is estimated at 164 %.

Cropping intensity of monsoon paddy in the Study area is lower than that of other SMIP command areas; overall command area of SMIP resulted in 97.1 % of cropping intensity of paddy in the year 2001/2002. The Study area has difficulty to achieve high cropping intensity of paddy due to insufficient irrigation water and dominant sandy soil. However, intention to cultivate paddy is very strong among the farmers in the Study area. According to the Rural Socio-economic Survey, 84 % of the sample households gave the first priority to cultivate paddy because of necessity for self-consumption. Also, 85% of the sample households answered that they would cultivate paddy even if irrigation water was insufficient.

Yields of paddy and wheat in the Study area are estimated at 2.3 MT/ha and 2.0 MT/ha respectively. These yields are below the district average level; paddy and wheat have 40 % and 20 % lower yield respectively as compared with those of the district average, resulting in around 70 kg per capita deficit of food grains at present in the Study area. This is mainly due to the shortfall of irrigation water in the area. On the other hand, potato and vegetables that fit to cultivate in sandy soil nearly come up to their potential yield.

Land Holding:

The result of 2001 Population Census reveals that the number of household having no farmland reaches to 38% of the total households in the Study area. Also a baseline survey, which covered all the households of Kaptanganj VDC carried out in 2001 by LGP, supports the reliability of the census, giving the data about 40% of the households are landless engaged either in sharecropping or farm labor or other jobs. Considering the total area (taxable area), total households and adopting share of 38% for landless, average land holding size per landowner in the Study area is estimated at 1.24ha, (or 0.77ha/HH including landless).

Land holding size per household ranges from less than 0.5 ha to 20ha in the Study area, but the majority of the owners are small-scale farmers. The baseline survey in Kaptanganj VDC shows that 63% of the households are either landless (42%) or own less than 0.5 ha (21%) and 86% of households fall in the category of less than 2 ha. Households who own more than 5 ha only occupy 3% of the total households in Kaptanganj VDC. According to a series of field interviews with farmers, the situation in other VDCs in the Study area would be more or less the same.

Land tenant is prevailing in the Study area. Major tenant system in the Study area is share cropping. Landowner and the tenant share the output by 50: 50. According to the field survey, landowners in the Study area normally share the input as well with 50: 50 except for labor, of which the tenant takes care. There are also some landowners who do not share the inputs but loan them to the tenant. According to the sample Census of Agriculture in 1991/92, 29% of households in Sunsari district are engaged in renting lands.

Food Security:

According to another household survey carried out in 1998 by LGP, 53% of households in the Study area answered that they live with inadequate food for more than nine months. The word “Inadequate” in this survey is defined that household who cannot support their food from their own farmland. So the meaning of inadequate rather indicates self-sufficiency at

household level.

As given the position in the fertile granary of the Terai plain, the Study area can be also considered to be a piece of the granary of the region. However, the above sample household survey shows that the Study area is, nevertheless, placed in a spot of food shortage due to mainly the shortfall of irrigation water, though the Koshi river water was supposed to wet the Study area through the two branch canals of SMIP, Shankarpur and Sukusena. It is envisaged that the development in the Study area, as a spot left behind the natural blessing of the Terai, should cope with the food insufficiency primarily.

Household Income and Expenditure:
Aforementioned Rural Socio-economic Survey by the Study Team, in which the sample households were selected from the ones having own land and distributed as equal number as possible according to the farm size, would indicate the structural difference of household economy by farm size. But the samples selected were rather better-off households, since the amount of other income per household obtained by the survey is considerably high and the landless households were not included in the samples.

Having in mind the condition of the samples, it is estimated that average household net incomes including self-consumption of agricultural produce for the households with 0.03-0.4ha, 0.45-0.9ha, 0.9-1.8ha, 1.8-3.0ha and 3.0-14.0ha are estimated at 56,700Rs (9,500Rs/capita), 48,000Rs (8,100Rs/capita), 66,300Rs (10,300Rs/capita), 78,800Rs (11,300Rs/capita) and 149,800Rs (21,400Rs/capita), of which the shares of income from agriculture are 22%, 42%, 49%, 51% and 62% respectively. Self-consumption of agriculture products is around 60 % of the total production in the households having less than 3.0 ha.

As indicated above, the households who own less farmland are getting more income from other income sources including farm labor. As well as relying on other income source, the households with small farmland cultivate their lands more intensively than the large-scale farm households, as the farm size gets smaller, the cropping intensity shows increasing tendency. Accordingly the agricultural productivity measured in gross value of outputs is higher in the small-scale farm households.

As for expenditure, food expenditure including self-consumption occupies the highest share in the total expenditure and the share is higher for the smaller-scale farm households. The shares of food expenditure for 0.03-0.4ha, 0.45-0.9ha, 0.9-1.8ha, 1.8-3.0ha and 3.0-14.0ha are 58%, 55%, 50%, 42%, and 39% respectively. Expenditure for clothes occupies the second highest share for most of the class with 12 to 13%. Larger-scale farm households have tendency to get higher amount of credit or it could be said that they could have better access to credit than the small-scale farm households. Education expenditure is spent much more in the larger-scale farm households, as well.

People's Norm and Social Network:
Social network in the rural society is quite wide in the Study area regardless of the diversity of caste, religion and their origin. For example, marriage is usually arranged by parents or relatives and they sometimes seek the future spouse of their sons even to other districts or beyond the international border, for avoiding consanguineous marriage. According to the

interview to farmers, the proportion of marriage with people from India is 40-50% especially in the VDCs along the international border.

According to the field survey, farmers do never rely on public agriculture extension service and mostly exchanging information among them. The most common medium of information is, "see and talk among farmers". As it could be seen, the most reliable information source for farmers is "farmers". They are mostly neighbors in a same Ward or VDC.

Gender:
Culture in the Study area is generally male-dominated culture, in terms of decision-making, access to control toward economic activities, education, and so forth due to patriarchy social system. Activities done by outside of the house mostly are regarded as male job, even if female cooperate with them. Presence of women, therefore, tends to be concealed in public, but they are actually the greater contributors to agriculture activities. It is also observed that women seem to get more opportunities to participate in communal activities under facilitation of external agencies like health care and micro-credit programs.

Present Irrigation Practice:
It is confirmed by the field survey that the farmlands well irrigated from Shankarpur and Suksena canals are only 55 ha (Babiya, Jalpaur, Gautampur VDCs), and 25ha (Narsimha VDC) as of August 2001 respectively. Therefore, most of the farmers in the Study area are relying on rainfall or otherwise pumping shallow groundwater for irrigation. Pump irrigation by shallow tubewell is prevalent especially in the southern parts of the Study area. However, the groundwater is not usually used for paddy irrigation except during acute water shortage but used for winter season's crops because paddy usually cannot bear the pumping cost (diesel).

Marketing Conditions:
Farm products are brought to the local market by individual farmers or through local assemblers. They use bicycle, cattle cart and tractor. There are also middlemen coming in for purchasing the produce. Collective marketing activity is not observed active. Retail price nearby markets varies in wide range by season, especially price fluctuation of perishables is sharp between on-season and off-season. In case of cabbage, there could reach around four times difference of the price between the two seasons.

Road condition in the north side, east side and of course along the trunk road running at the center of the Study area is fairly good and there is no major difficulties to transport agriculture produce on this road network. However, the western parts of the Study area like Basantapur and Ghuski VDCs are in poor road condition. These areas are dominated by sandy soil, making it difficult to keep the road condition tough enough to transport agricultural produce.

Development Constraints:
1) Soil Unsuitable for Paddy Production
According to the Land Resource Mapping Project (LRMP) conducted by the Canadian International Development Agency (CIDA), area suitable for paddy production is limited only to around 10% of the Study area located in Ghuski, Rajganj Sinuwari, Madhay Harsahi and

Gautampur VDCs. Sandy soil prevalent in the Study area with little capacity to hold moisture and nutrients is a limiting factor for paddy production that requires much irrigation water. Yet farmers who prefer to eat rice tend to plant paddy no matter if it will be harvested or not. This fact shows there is a gap between rational land use in theory and farmers' intention of farming.

2) Poor Access to Quality Farm Inputs

The second concern following irrigation water among farmers is how to access quality farm inputs, particularly fertilizer. The country completely depends on imported fertilizer mainly from India. After the liberalization of farm input supply, fertilizer without certification of nutrient contents is imported illegally in large quantity. Poor quality of fertilizer causes not only ineffectiveness in production increase but also growth injury such as salt injury.

3) Poor Access and Quality of Extension Services

One ASC and three SCs staffed with 8 technicians (JT/JTA) in total are responsible for provision of extension services in the Study area. This fact shows that one technician should cover around two thousand households. In case of Japan, it is common that one extension worker takes care of around 300 households. Limited manpower makes extension system practically defunct, even though a group approach has been tried for efficient services. Many farmers also point out the quality problem of the extension services.

4) Flood and Inundation

On the contrary of the shortfall of irrigation water, a rush of flood sometimes occurs in every monsoon season causing inundation in some part of the Study area. Based on the interviews to the local farmers from April to May 2001 and after a big flood that occurred in July 2002, there are eight areas of inundation in the Study area. These areas are concentrated in a nearly level valley floor, southern part of the Study area, although a few flood areas show up in the north and northeast. These areas are limited in the active flood plains in the Study area, meaning that most of the cases the inundation takes place due to flood coming from nearby rivers such as Sunsari and Budhi and also replenished by rainfall.

Development Potentials:

1) Effect of Irrigation Observed in SMIP

The cropping pattern in the upper stream reaches of SMIP, where the farmers enjoy more than 4 t/ha of paddy yield, is very different from the one in the Study area. Cropping pattern in winter season in the Study area is seen as mainly wheat crop. Whereas, the cropping pattern in the upper stream reaches of SMIP in winter season is dominated by vegetables or pulses crop. As some interviews to farmers revealed, majority of farmers in the Study area are growing wheat during winter season for their cereal consumption, due to low yield of paddy. If the paddy yield in monsoon season increases by irrigation development, farmers in the Study area will be able to have options of growing profitable vegetable crop other than wheat as practiced in SMIP area.

2) Soil Suitable for Diversified Crop Production

Sandy soil prevalent in the Study area turns to advantage in terms of promoting upland crops, particularly wheat and vegetables that are weak to wet injury or root rot. Fortunately, vegetables have been already familiar to the farmers as a secondary crop after monsoon paddy

in the Study area. There are some commercial vegetables growers who have already established production procedure based on their experiences. For this reason, it is expected that existing commercial vegetable growers play a role of the core farmer to distribute their skills to the new commercial vegetable growers. With effective extension services, the vegetable crop in the area can be expanded.

3) Geographically Advantageous Position for Marketing

The Study area is located at geographically advantageous position for agricultural marketing. There are several urban areas that have large numbers of consumers; Biratnagar (population; 161,036 in 2001), Inaruwa (23,200 in 2001), Ithahari (41,210 in 2001) and Darhan (95,332 in 2001). The trunk road that runs from north to south connects to East-West highway so that it is possible to transport perishables to Kathmandu within the same day, as well. Supposed that marketing system including regulations, infrastructures and fair-trading is developed properly, there should be every possibility for the Study area to be the center of vegetable production. In the future, there is also a possibility of being a major supplier of agricultural products to Indian markets near the border, if the quality and price of the growers in Nepal become competitive with Indian growers.

4) Community Feature and Possibility to Change

It is observed that the social strata in the Study area has been in transition period. The size of landholding is not related to caste and the opportunity to improve living standard has been open regardless of labor division determined by tradition. It means that they can improve their lives more, if they really wish or once farmers can feel confidence that they can change their lives by themselves. Their wish could be further developed if there is appropriate external support.

On gender issue, any decision-making is mostly managed by male. This tendency is remarkable in relatively large-scale landholder class. On the other hand, though women in lower class are less educated, they have lauder voice since they are earning money through farm labor, whose workload is quite same or sometime heavier than male. This kind of cultural change observed among women in relatively lower class implies that the change in culture is possible depending on the social circumstances.

WATER RESOURCES ASSESSMENT

The prospective water resources that this Study should focus on are; 1) Sunsari river, 2) groundwater either shallow or deep, 3) water release from SMIP, and 4) other rivers such as Budhi and its tributaries. The last one, Budhi river, has been already provided a diversion weir which commands about 1,800 ha, indicating very little possibility to further develop the river. Therefore, this Study undertakes Sunsari river as the first development priority source and the groundwater as the supplemental water source.

Surface Water Development:

Sunsari river has a catchment area of 300 km^2 at the prospective headworks site which is 600 m downstream from E-W highway bridge point. Sunsari river originates in a mountainous area called Siwalik Range that is located in the northern part of Sunsari district. The river flows from the north to south in meandering and has perennial flow. The river is obviously

recharged by seepage from the Sapta Koshi river and by irrigation water from SMIP. As Chatra main canal of SMIP starts carrying certain amount of irrigation water, runoff in the Sunsari river correspondingly increases to some extent.

This Study carried out a runoff analysis to estimate how much water is available in the Sunsari river for irrigation development. The analysis should deal with runoffs of not only in monsoon season but also in winter season, so that a model called Tank Model has been employed. The model is composed of four tanks. The first tank from the top represents surface runoff and second tank represents subsurface runoff. Likewise, the third and fourth tanks represent the base flow by groundwater. The tanks have side runoff outlets and are combined vertically.

On the basis of the results of 29 years simulation (1973 - 2001), the availability of water was examined correspondent to reliability (probability). The reliability was examined at probability 50 %, 60 %, 70 %, 80 % and 90 %. Available water with 80 % reliability is about 4 m^3/s during winter season and becomes much during monsoon season reaching to as high as 35 m^3/s, and 388 MCM, 321 MCM and 67 MCM for annum, monsoon season from May to October and winter season from November to April respectively.

Groundwater Development:
Based on the monitoring records of existing tube-wells, groundwater in and around the Study area is found widespread and exists in a relatively shallow subsurface. Groundwater flows approximately from northwest to southeast along the landform in the Study area. The groundwater is composed of confined aquifer and unconfined aquifer. Confined aquifer exists deeper than about 50 m below the ground surface, while unconfined aquifer is limited to a depth of about 50 m.

Unconfined aquifer is subject to fluctuations according to the season and local irrigation practices. Also, a monitoring of groundwater level in the Study area indicates that groundwater table in unconsolidated aquifer varies seasonally, very often in response to annual climatic variations. This condition is almost same as on deep tube-wells. Groundwater level rises from May to August and decreases during September to April. The fluctuation range is about 3 – 5 m.

In Sunsari district, 17 observation STWs were drilled in 1989 and further sixteen observation DTWs were drilled in 1996 by GWRDP. In addition, this Study constructed a test DTW in Kaptanganj VDC with a depth of 120m. These wells show that the discharge ranges from 2 to as much as 24 l/s and from 30 to about 40 l/s for STW and DTW respectively. Shallow aquifer shows us very promising groundwater potential. Though the discharges of deep tubewells were not much attractive, this was due to the pump capacity. Taking into account the aquifer condition, the discharge from a DTW can be increased to even more than 100 l/s

Possibility of Water Release from SMIP:
This Study has examined if SMIP has any extra water that can be used for the Study area. The approach to examine is divided into two steps; namely, 1) examination of Chatra intake capacity according to the water level in Koshi river, and 2) within which, how much water SMIP can release or otherwise how much water the Sunsari River Irrigation Project (SRIP)

should be entitled to receive.

On the course of examining the Chatra intake capacity, this Study found out a trend of Koshi water level continuously getting down. Should the lowering trend continue, the Chatra intake would become unable to withdraw water during winter season at around year 2005 to 2008. This situation would not take place after May 10, meaning that the Chatra intake remains functional to withdraw as much water as the designed volume after May 10 even if the lowering trend would continue in a long run.

Faced with the continuous lowering trend of water level of Koshi river, this Study takes a position that no supplemental water should be taken into account in planning irrigation development of the Sunsari river during lean period, say up to May 10. After May 10, there is a possibility that the Chatra MC could provide water reaching to the capacity of the Vortex tubes, say 5 cum/s.

OVERALL DEVELOPMENT STRATEGY AND FRAMEWORK

Having seen the present situation of the local population yet suffering from food shortage, the Project should aim at raising the living standard of the people primarily by means of agriculture development. Therefore, this Study sets as its development goal "to improve living standard in the Study area based primarily upon irrigated agriculture development". The development framework starts with the development goal and covers down to all the project components.

To realize the development goal, 6 development approaches are presented; 1) develop irrigation and drainage system, 2) promote irrigated agriculture, 3) develop basic rural infrastructure such as road, 4) mitigate flood and inundation, 5) mitigate environmental negative impact if any, and 6) improve irrigation policy. The first and second approaches are the main scope for this Study, though others should not be underrated. The 6th approach is not a direct approach toward the development goal, but presented as a by-product through this Study.

Time Framework should also be defined, composed as it is of short, medium and long terms, when preparing any development plan. A focal or urgent project is placed within the short-term development with high priority. In this sense, Sunsari river development aiming at irrigated agriculture promotion is of course placed in the short development term. This Study adopts such time frame as: 1st to 5th Year for Short Term, 6th to 10th Year for Medium Term, and 11th to 20th Year for Long Term.

THE DEVELOPMENT PLAN

Agriculture Development:
Referring to the result of Land Resource Mapping Project (LRMP), most of the Study area is classified into the areas suitable for diversified crop due to the sandy soils except for limited spots scattered in Ghuski, Rajganj Sinuwari, Madhya Harsahi and Gautampur VDCs. The limited spots are suitable for paddy crop, and estimated less than 10 % of the Study area. However, the present land utilization in the Study area during monsoon season is mostly

represented by paddy crop.

This fact shows that there is a gap between rational land use in theory and farmers' intention of farming. Farmers who prefer to eat rice tend to grow paddy in monsoon season whether it can be well harvested or not. Paddy crop requires a considerable bulk of water and the sandy soils stimulate the water requirement for paddy. Under this situation, it would be difficult to formulate a land use plan or cropping pattern according to the farmers' full intention, unless otherwise the available water in Sunsari river were found abundant.

Whether the sandy soil is a constraint or potential for agriculture development is similar to both sides of a coin. Sandy soil is suitable for upland crops, which do not require much water for their growth. The sandy soil having less moisture holding ability does not cause wet injury or root rot, which are serious limiting factors for growth of upland crops. Fortunately, vegetables as secondary crop after monsoon paddy have already been familiar to the farmers in the Study area.

The Study area is located at advantageous position for marketing. Biratnagar, the second biggest city in Nepal, as well as Inaruwa, Jumka and Itahari are nearby cities with high demand for agricultural products. These cities will be targeted as the destination of the products. In the future, there is also some possibility for the farmers in the Study area to be a main supplier of agricultural products to Indian towns near the border as the quality and price of the products become competitive with Indian perishable growers.

Combining the blessed sandy soil with geographical advantage, summer vegetables promotion must have potentials to some extent. During monsoon season, vegetables come to short of supply and few varieties in any markets around the area. The price of vegetables varies in wide range, for example the price of cabbages in summer season becomes four times of the rock-bottom price in springtime. If the vegetable crop and marketing in monsoon season are realized, farmers will be able to get great benefits. In consideration of the present conditions, a stratagem for agricultural development with following time frame is proposed;

- **Short-term Strategy**

  Food security in the Study area has not been established yet; there are 7,000 MT (equivalent to 70 kg per capita) deficits of food grains in the year 2001/2002. With this setback in mind, establishment of food security is given the first priority as the short-term strategy. Cereal requirement for the population in the Study area will be met by paddy and wheat. The year 2012 (assumed at 5 years after the commencement of the operation) is targeted to reach the goal of short-term strategy.

- **2) Mid & Long-term Strategy**

  Not only is the Study area located at a position geographically advantageous for marketing activity, but also does the Study area have favorable agricultural environment particularly for vegetable production that fits to the sandy soil as well as temperate climate throughout the year. Vegetable production will be promoted in order to improve the farmers' economy as the mid & long-term strategy. The year 2017, assumed at 10 years after the operation commencement, is targeted to reach the goal of the mid-term strategy.

Proposed crops under the Project are basically same as the present crops in the Study area; there is no idea to introduce new crops that the farmers may fail to well cultivate without well functional extension services. The difference between the present and proposed cropping patterns is the cropping intensity and also the area coverage of each crop. Proposed cropping pattern is considered from the point of view of cereal food security as well as the strategy of vegetable production promotion.

This Study proposes that the cereal sufficiency should be met by both wheat and paddy production. Required cropping intensity of paddy under project condition will be calculated back based on the present production of wheat (2.0 t/ha). As the result of the calculation, required cropping intensity of paddy in order for achieving cereal sufficiency is estimated at 59.0 %, thereby 60% of paddy crop intensity is programmed in the cropping pattern.

Consideration for proposing other crops are: 1) cropping intensity of jute will be reduced to 15 % from the present 20 % according to the recent trend that synthetic fiber is taking the place of jute, 2) vegetable production will be promoted aggressively according to the mid & long term development strategy, say 10% during monsoon and 10% during winter, and 3) cropping intensity of other crops will be set more or less on the same level as compared with the present condition or be increased slightly. Total proposed cropping intensity is estimated at 180 % as a whole.

This Study, as supporting program, proposes two programs; 1) Extension Program for Vegetable Production, and 2) Promotion Program for Vegetable Marketing. The former program is almost same as conventional extension services but centering on vegetable promotion. The extension workers will make contact with WUAs as their entry point. Same manner as group approach being undertaken by DAO applies to this program. The program undertakes pilot fields devoted for proper utilization of fertilizer and chemicals.

The latter program, Promotion Program for Vegetable Marketing, undertakes mainly information dissemination for which the vegetable produced in the Project area will be advertised by way of local newspaper, local gazettes, radio, etc. The program also invites prospective private venders, retailers, wholesalers to the Project area. Inviting the businessmen will also motivate the farmers to produce high qualitative vegetables.

Irrigation Development:

This Study deals with 13 VDCs, total gross land area of which is 16,800 ha. Some parts of the are cannot be covered by a diversion barrage to be constructed in the Sunsari river simply because of: 1) some areas like northern tip of the Study area are located out of the canal network, 2) topographic condition does not allow the gravity distribution, etc. Taking into account such areas to be excluded, the net irrigable area which can be covered by the Sunsari river is now 10,147 ha.

This Study employs two methods of estimating draft crop water requirement; 1) Modified Penman method and 2) preventive irrigation method. Net required irrigation water is estimated by undertaking an amount of effective rainfall. The effective rainfall is referred to the data from Biratnagar Airport between 1971 to 2000. The net irrigation water will then be converted into gross requirement taking into consideration the efficiency in delivering,

distributing and applying the water to the crops. The overall efficiencies that the Study refers are 65% for paddy irrigation and 50% for upland field irrigation.

As per paddy, additional water such as peroration should be considered. A total of 42 field tests of water depth measurement (percolation test) has been carried out in 2001 and 2002. The results range from 9.9 mm/day to as much as 38.7 mm/day. No test has shown the percolation less than or close to the SMIP design peroration that is 3.00 mm/day in Suksena area. Dividing the Study area into three parts; northern, mid and southern, those average percolations are 14.4 mm/day, 17.0 mm/day and 20.8 mm/day from the north to south respectively (overall average is 17.26 mm/day).

A case study was carried out on water balance on the Sunsari river with different paddy area and different system reliability. One thing very clear from the Study is that the water available in the Sunsari river cannot support full 10,147 ha of paddy, leading to a discussion; whether the project area should be reduced or less water consumptive crops like upland crops should be promoted or otherwise the system reliability should be lowered.

There is a disparity between the northern part and southern part within the Study area. The southern part is relatively poor than the northern part. Should the local people living in the southern part be excluded from the project, the disparity would increase and also they might feel segregated from ordinary Nepalese. This leads us to an idea of not reducing the project area but either lowering system reliability or promoting upland crops or otherwise undertaking the both.

There may be difficulties to rapidly change the present dominant paddy to vegetables. In this regard, an option could be a case that paddy should be allowed as much as possible even with lower system reliability at least for some time. On the other hand, the Study area is dominated by sandy soil which is not suitable for paddy cultivation but for vegetable promotion. In this sense, future development vision should undertake vegetable promotion to some extent. These two contradictory issues give us the following term-wise development strategy:

- As to short term development, 80 % of paddy area can be tried with system reliability of 50 % and the remaining 20 % could serve upland crop promotion. According to the case study, the case of 80% paddy with 50% reliability leaves meager surplus of 0.7 m^3/s at the leanest period. Except the leanest period, there are about more than 2 cum/s surplus, which can be used for upland crop promotion.
- As for mid and long term development, paddy area should be reduced to 60 % and the remaining 40 % should serve upland crop cultivation. This case gives 80 % system reliability to the irrigation system. The case of 60% for paddy crop with 80% reliability leaves about 0.79 m^3/s surplus at the leanest period.
- Design discharge for the short-term development is bigger than the one for the mid and long term development. Referring to the case study, about 20 m^3/s and 17 m^3/s are required for short term and mid & long terms developments respectively. However, canal design should not necessarily be made based on the bigger amount of 20 cum/s since there is free board section in all the canals, accommodating the difference.

During winter season, many water shortages take place in supporting the wheat and winter vegetables. The water available in Sunsari river becomes small during winter season to as little as less than 4 m^3/s. Even if whole amount of water is extracted for the Project, the water cannot support full area of 10,147 ha during winter. The area that the available water can support is 6,600ha in case all water extracted and 3,500ha in case 1.8 cum/s (50% of minimum P80%) released to downstream. Therefore, measures to cope with the water deficit should be sought.

Preventive irrigation has been carried out in countries where vast cultivable land is available while water resources are so limited that the irrigation water cannot cover whole the prospective land. No formula has been established to estimate preventive irrigation requirement, but we can refer to actual examples practiced in the field. The example is STW irrigation. The farmers apply minimum amount of water to save the diesel cost. The amount counts to about 60 % of the one estimated by Penman method, and this can be regarded as the water requirement for preventive irrigation.

Winter irrigation should also consider the regulatory downstream release. How much water the Project should release to downstream is very much dependent on how the paper mills located just downstream of the proposed headworks site proceed in terms of establishing an effluent treatment plant (ETP). Since the present water quality has already been deteriorated by the mills' effluent, this Study considers no water extraction during winter season as the base case.

Though it is very difficult to forecast how much the paper mills can deal with, this Study considers 50% downstream release, 1.8 cum/s release, as expecting case 1, still requiring the factories to establish ETP that reduces the effluent by 80% (at present DANIDA intervention is on-going). Then, 20% release, 0.7 cum/s, is also considered as expecting case 2 on condition that the factories meet the Nepalese Industry Effluent Standard and also fishermen's compensation is met. Based on this, this Study proposes the following irrigation development:

Monsoon: Proposed cropping pattern; namely, 60% paddy and upland crops

Winter: Base case: No river water is extracted (downstream release is 100% as present). Irrigation in winter is carried out with STW as the present situation.

Winter: Expecting case 1: proposed cropping pattern under rotational irrigation between Suksena and Shankarpur by year with preventive irrigation (downstream release is minimum 1.8 cum/s, 50% of minimum P80% flow)

Winter: Expecting case 2: proposed cropping pattern under rotational irrigation between Suksena and Shankarpur by year with conventional irrigation, requirement of which is estimated by Penman method (downstream release is minimum 0.7 cum/s, 20% of minimum P80% flow)

Irrigation Facilities:

The siting of the headworks is proposed at 600 m downstream from the E-W highway. Though Sunsari river flows in meandering almost all the way, there is a straight and stable reach starting at about 100 m downstream from the E-W Highway. The stable reach is about

700 m and at a downstream mid of the stable reach is designed for siting the headworks. The site set on the straight reach can well divert the Sunsari river water into both east and west conveyance canals leading to Shankarpur and Suksena canals.

The site can also evade from the industrial effluent by the two paper factories. There are two paper factories located right beside Sunsari river at about 700 m downstream from E-W highway, discharging effluent into Sunsari river. The headwork site is so designed that the effluent cannot enter the irrigation network. The dimensions of the proposed headworks are as follows:

- Position of headworks — 600m downstream from E-W High Way
- Type of headworks — Barrage (fully movable manual gate type)
- Catchment Area — 300 km^2
- Design High Flood Discharge — 650 m^3/sec
- Width of headworks — 72 m
- No. of Spillways — 5 Nos.
- No. of Under Sluices — 4Nos. (on both sides of the headworks)
- Size of Under Sluice Gates — 6.2m x 3.85m
- Size of Spillway Gates — 6.2m x 3.60m
- Design Water Intake Discharge — 16.93 m^3/sec
- River Maintenance Flow — about 1.8 m^3/s (50% of minimum P80%)
- Related Structure — Fish Pass (on both sides of the headworks)

Canal design refers to the SMIP experiences and the existing conditions of the present canal network in the Study area. To meet with the present cross section of the canals, the new design section basically follows the existing cross section so that additional excavation/embankment as well as land acquisition can be minimized. Though the present canals are all unlined, the main canals of Suksena and Shankarpur plus the biggest secondary of 4SRR are to be concrete-lined since the embankment material available around the site is very much sandy dominated.

SMIP standardized length from the beginning point of secondary to the end of tertiary to be limited at about 5 km from the viewpoint of proper water distribution. This Study follows this standard, thereby no canal longer than 5 km is allowed. The canal network follows the present irrigation network, taking into account the 5 km limit, so as to minimize the land acquisition. In case the density of canal network is found not enough from the viewpoint of system management and equal water distribution or a canal is longer than 5 km limit, some additional canals are arranged.

As per watercourse, this Study designs much shorter unit than SMIP. SMIP standard limits the length to about 1.2 km covering 28 ha each. This Study envisages all the watercourse should be constructed by the concerned farmers as their contribution to the Project. Also, taking into account is the sandy soil. The soil will shorten the durability of such small canal, asking the farmers frequent maintenance and repair. Once a portion of the canal is breached, the longer the watercourse is, the more difficulty the farmers will face. Therefore, this Study proposes about 300 m length as the limit of the watercourse together with about 20 ha

command area.

As per distribution system, while main canal adapts conventional check regulating system together with drops as required according to the topographic condition, distribution once after the water gets into secondary canal block is designed to be proportionally and free. No gated regulation within secondary canal block wherever is applied. This concept has been well verified in SMIP. Though the distribution system requires almost full water level even during lean period, the system lowers the construction cost and maintenance cost, and eliminates manipulation by delinquent users.

As per system management, this Study proposes that the diversion headworks and main canals of Shankarpur and Suksena should be managed by the Department of Irrigation (DOI), and secondary canals and below thereof be managed by the relevant WUAs. The WUAs will basically be organized in conformity with any branch canal with a certain limit from the viewpoint of social solidarity. If a secondary canal so designed following the present canal alignment as much as possible goes beyond farmers manageability, the secondary is divided into blocks or otherwise DOI goes down to a point in the secondary canal. The latter case takes place on 4SRR which is the biggest secondary.

Operation and Maintenance:
To operate and maintain the SRIP, there should be engineers, overseers, institutional development officer, association organizer, administrative and assistant staff, etc. The staffing proposed here basically refers to the structure of the forthcoming division office but has new staff alignment that is not allocated under the present structure. New staff alignment is for: 1) institutional development officer, 2) association organizer (some project offices already have), 3) agriculture engineer, and 4) strengthening of accounting section.

The proposed organizational set-up is to have a total of 15 staff serving not only for SRIP but also for whole divisional office. The staff exclusively devoted for SRIP operation and maintenance will be total 22 including 14 gate keepers, and the proposed organization consists of two sub-sections; namely, institutional section devoted for WUAs and technical sections. The technical section has one engineer under whom there are four overseers composed of two civil, one mechanical and one electrical.

One civil overseer takes case of one of the main canals together with 7 gatekeepers. Out of the total 14 gate keepers, 6 gate keepers are posted at the headwork site since there have to be 24 hours stand-by under 3-shift a day (2 gate keepers x 3 sifts a day). Along the main canal, this Study proposes minimum number of gate keepers; namely 4 each (about 5 km reach per gate keeper).

Water Users Association:
In this Study, hydraulically decentralized WUAs is proposed in conformity with any head gate or check regulator that controls the flow into their irrigation area. This is so made by establishing a WUA consistent with each head gate or check regulating gate of secondary canal. The WUAs is stratified, starting in all the cases with on-farm water users group, called WUG, whose irrigation area is commanded by a watercourse. After firming up WUGs along a secondary canal, a responsible organization for the canal will be established as the

Water Users Committee (WUC).

Referring to the canal network, there will be a total of 44 WUCs; 18 for Suksena area and 26 for Shankarpur area. The area coverage by a WUC ranges from 115 to 402 ha with an average of 231 ha. Number of WUGs per WUC ranges from as small as 6 to 20 with an average of 12. As all WUCs are to have joint management contract with the DOI project office, the head gate will be the responsible demarcation between the project and the WUCs; namely, above which the DOI project office will be the responsible and below which the WUCs will be the responsible for operation and maintenance.

Rural Infrastructure Development (Road):
As observed in the field, the road conditions in the western part of the Study area is poor and that may have also caused the current little interventions in the areas. Therefore, the improvement of road network condition in the western part of the Study area will be put in high priority from the viewpoint of public equity. To improve current road network situation, connection of village roads and canal maintenance roads constructed simultaneously with the canal network is proposed to establish a road network for effective transportation in the areas.

To establish effective road network in the western part of the Study area, three sections of existing village roads will be necessary to improve. These sections are: 1) Dewanganj – Ghuski, the length of 5 km, 2) Harinagara – Basantapur with the length of 1.3 km, and 3) Ghuski – Basantapur with the length of 5.5 km. If these roads are improved, the people in Basantapur and Ghuski can more easily access to Dewanganj and Harinagara to connect to Inaruwa and Biratnagar and there is also vegetable collection center at the right south of Dewanganj.

Flood Mitigation:
This Study proposes bank strengthening of canals running along the Sunsari river, so that flood would not spill over to the mid and southern part of the Project area. The strengthening consists of 1 m width additional embankment almost all the reaches after the siphon point of Suksena and a part of gabion protection. This arrangement would mitigate the severest inundation taking place in Basantapur, Ghuskis and Kaptanganji VDCs.

Aside from the strengthening of canal embankment, no protection works are planned in this Study since additional civil works for flood mitigation would not be justified from the economic point of view. Rather, smooth draining of flood is planned. As many farmers raised concerns, canal network sometimes hinders smooth flood recession, causing lasting submergence. This situation in worst cases results in breaching the canal intentionally by the local villagers to run the retarding water away. To mitigate this situation, this Study designs drainage siphons crossing canal networks as required.

COST RECOVERY AND FINANCIAL MANAGEMENT

Irrigation Service Fee (ISF):
In principle as a self-supporting account, all the O & M cost of the irrigation system ought to be covered by the Irrigation Service Fee (ISF), so that the system can be financially viable. The O & M cost should include salaries of the government staff, honorarium for committee

members of the Water Users' Committee, and fund for replacement, as well as the physical operation and maintenance expenses. On condition that, it is estimated for the Sunsari River Irrigation System that the total annual O & M cost will be 10.1 million Rs or 998 Rs/ha (maintenance possibly contributed by labor is expressed in cash).

To set ISF rate of the irrigation system as a service industry, there arises another principle, namely payment according to the service rendered. Therefore, it is proposed to set the ISF rate by crop season and those who do not receive irrigation water during winter season should be exempted from ISF payment. ISF rate for SRIP is proposed in a case of the distribution of surface water into 100 % of the irrigable area in monsoon season and only 50% of the irrigable area in winter season due to the water availability in Sunsari River.

Assuming that 10% of exemption (introduced in this Study) would take place during a year, the necessary cost for SRIP will arrive at 1,100Rs/ha. Because effectiveness of the irrigation is much more visible during winter season due to the meager rain, farmers would pay ISF more willingly in winter than monsoon season. The ISF rate is, therefore, proposed to set higher amount in winter season, but lower than the cost of STW enough for farmers to willingly use the surface irrigation water. In conclusion, the proposed ISF rate is set to be 600 Rs/ha in monsoon season and 1,000 Rs/ha in winter season.

The proposed rate is very high comparing with the current rate of SMIP (200 Rs/ha/year). In case the government administration recurrent cost will be supported by the central treasury as current condition, the necessary O & M cost of the irrigation system including 10% of exemption is estimated at 790 Rs/ha/year. In this case, ISF rates would be proposed at 430 Rs/ha in monsoon season and 720 Rs/ha in winter season.

The rates proposed may be ambitious referring to the current ISF collection efficiency on the ground. Taking into consideration the situation, it is proposed to apply for a temporary legislation prior to the enforcement of the proposed ISF, namely ISF would be partially collected like only for the cost of desilting of the main canal, adjusting to be the same ISF rate of current SMIP until the expected crop yields with project situation are realized. The duration of the legislation will be 5 years for monsoon crop (paddy) and 10 years for winter crop (vegetables).

It is also proposed that even after the enforcement of the proposed ISF rates, approval of exemption should be set according to the crop yield to secure the social justice. For example, if the yield of paddy is less than the current yield of 2.5 t/ha, 100% of the exemption will be approved and if the yield is 2.5t/ha to 3.5t/ha, 50% of ISF will be exempted and if the yield reaches more than 3.5t/ha, no exemption will be considered.

Relevance of the proposed ISF rate is to be discussed hereunder from the viewpoints of farmers' affordability and willingness. In conclusion, it can be said that the proposed ISF rates in monsoon and winter seasons are affordable for farmers, but rather debatable in terms of farmers' willingness. All the same, it is proved that the surface irrigation water is still advantageous to STW in terms of cost. It is, therefore, evaluated that the proposed ISF rates in both monsoon and winter seasons are relevant in operating and maintaining the Sunsari River Irrigation System.

This Study proposes that the ISF share between the government and WUC in SRIP is estimated in proportion to its managerial responsibilities enough to cover the necessary O&M cost for both parties. From this approach of defining ISF rate and the share between the government and WUC, the cost recovery will be attained as far as ISF is collected properly from the farmer members of the WUC. As the result of the O & M cost estimation for both the government and WUC, it is proposed that ISF sharing ratio between the government and WUC will be 50% and 50%. This sharing ratio has to be stipulated in a contract of joint system management between the government and WUC.

Irrigation Service Fee Collection System:
Under the joint system management, sharing of ISF collected between the government and WUC and ISF collection by WUC will be the basis of establishing the basic flow of ISF collection. In this concept, WUC will bill and collect ISF from farmer members through the respective WUGs. Record keeping of individual ISF payment performance, so called Irrigation Fee Register (IFR), will be kept and maintained by the WUC, as well. This IFR will be the basis of the financial management of WUC. The government, under the joint system management, only bills to WUC and collect its share of ISF from WUC.

The billing procedure should be done by the WUG deputized personnel with farmer members in every planting season prior to ISF collection. It is the only way of assessing the irrigated area accurate to work with the farmer members who actually receive the irrigation water. Although it seems that enforcement of exemption has not been in practice very much on the ground, this could be applied for securing the social justice and fairness within WUC. During the crop season, if the calamity causes the damage of the crop seemingly resulting in very low yield, the farmer member in question could have right to request exemption.

THE PROJECTS AND THE IMPLEMENTATION ARRANGEMENT

The Proposed Projects:
Referring to the development plan formulated, this Study proposes six projects, which are the Sunsari River Irrigation Project (SRIP), Supporting Infrastructure Project, Agriculture Supporting Project, Environmental Mitigation, Drainage Re-use Project, and Groundwater Development Project. The SRIP, the core project, is to construct a headworks in the Sunsari river together with extensive canal networks and on-farm development. Of the construction components, the on-farm development, basically 20 ha watercourse command area, is to be undertaken by concerned WUG and no government budgetary assistance is foreseen in the construction. The Government is to construct up to tertiary canal level to which organized WUCs can participate through labor contract with the contractor concerned.

Implementation Schedule:
The implementation of SRIP is divided into two stages; namely, Stage 1 covers the construction of the headworks to the main canals of Suksena and Shankarpur. Then, Stage II will cover the construction of secondary to the tertiary canals inclusive of on-farm development. The Stage I requires a total of 4 years, one for detail design/tendering and the rest three years for construction. The Stage II requires same 4 years with same arrangement but the first year will be placed at the fourth year of the Stage I. Thus, a total of seven years

will be required to complete the SRIP.

The SRIP will start diverting the Sunsari water at year 5 upon completion of the Stage I though it will irrigate only the areas along main and existing secondary canals. The area to be irrigated by the main and existing secondary canals is estimated at about 20 to 30 percent of the whole 10,147 ha according to the existing canal network. The irrigated area by Stage I may be enlarged with additional 10 – 20 percent area taking into account plot-to-plot irrigation. Full operation will come at the year 8 upon Stage II completion.

Together with the SRIP implementation, other components such as supporting infrastructure should also be implemented in order to bear the expected full benefit. Most infrastructure components are to complete by year 7 together with SRIP except the drainage re-use. Drainage re-use intends to divert the drainage water coming into Old Sunsari river into a sub secondary canal of Suksena area. The drainage re-use is to be implemented in years 10 and 11 after confirming how much drainage water is actually coming into the river.

Agriculture supporting program requires longer duration than infrastructure construction. This Study proposes 5 years duration for the both extension and vegetable promotion programs. Both programs are to start at year 5 upon completion of SRIP Stage I. Inland fisheries promotion which is a compensation for 180 fishermen dependent on Sunsari river should start at an early stage of the project implementation, say year 2, and complete until the year 7 before the SRIP start full operation. Environmental monitoring and auditing will start with the project commencement and proceed to project operation period.

Project Cost:

The project costs are totaled at around 1.41 billion Rs or 18.1 million US$, of which SRIP, supporting infrastructures, agriculture supporting, environmental mitigation, groundwater development, and others (drainae re-use) are respectively estimated at 1.27 billion Rs (16.3 million US$), 23.3 million Rs (300 thousand US$), 42.5 million Rs (540 thousand US$), 45.8 million Rs (590 thousand US$), 11.7 million Rs (150 thousand US$), and 14.3 million Rs (180 thousand US$). SRIP is proposed to implement in two stages and the costs of Stage I and Stage II are estimated at 783 million Rs (10 million US$) and 492 million Rs (6.3 million US$) respectively.

Summary of Project Costs

Description		Total Cost (Rs)	Contents		Remarks
			Construction (Rs)	Land Acquisition (Rs)	
1. Sunsari River Irriggation Project (SRIP)		1,275,183,000	1,161,375,000	113,808,000	
1.1 Stage I		(783,181,000)	(774,394,000)	(8,787,000)	
1.2 Stage II		(492,002,000)	(386,981,000)	(105,021,000)	
2. Supporting Infrastructures		23,318,000	23,083,000	235,000	
3. Agriculture Supporting		42,465,000	42,465,000	0	
4. Environmental Mitigation Measures		45,874,000	40,884,000	4,990,000	
5. Others (Drainage Development)		14,273,000	13,743,000	530,000	
6. Groundwater Development		11,699,000	11,699,000	0	
Grand Total	Rs	1,412,812,000	1,293,249,000	119,563,000	
	US$	18,084,000	16,554,000	1,530,000	

Implementation Responsibilities:
It is proposed that the DOI will be the main executing and implementing agency for the investment of the proposed SRIP. There are to be three levels of implementation functions and responsibilities:

- The Project Steering Committee (PSC) responsible for project monitoring and supervision as well as interagency coordination. It is to be chaired by DOI's Director General. The PSC will include representatives of all relevant participating agencies to meet in Kathmandu once every quarter to ensure effective coordination and implementation.
- The Project Co-ordination Office (PCO) to be established within DOI's Surface Water Division in Kathmandu responsible for overall project coordination, provision of technical support to the Project Management Office (PMO), and liaison with selected NGOs to implement procedures and practices to facilitate effective participation of users in decision making, WUC capacity building and transfer of irrigation systems to self reliant WUCs for sustained operation and maintenance.
- The Project Management Office (PMO) to be established in the project site proposed that the Director of the Eastern Regional Irrigation Directorate will act concurrently as the Project Manager reporting to the Project Coordinator. The PMO is to manage the implementation of SRIP.

Technical Assistance:
Aside from the Consultants to be employed in implementing the SRIP, this Study proposes that a technical assistance team should be assigned to the project. The technical assistance team will be in charge of achieving the full benefit from the project and composed of the team leader fully assigned and such experts as water management, irrigated agriculture development inclusive of vegetable marketing promotion, financial management, and institutional development. The team is expected to start the assignment at year 5 and the duration requires at least 5 years.

PROJECT JUSTIFICATION

Economic Evaluation:
Economic evaluation is principally conducted with the major projects, which target on the realization of irrigated agriculture by Sunsari river water. Of the six projects proposed in this Study, the said major projects include four projects, which are SRIP as the core, supporting infrastructures, agriculture supporting and environmental mitigation. Integration of these four projects will enhance the realization of the expected project benefit, thus they should be implemented in close relation.

The primary benefit of the project accrues from the increase of agricultural production, namely increase of yields and cropping intensity, and also introduction of diversified crops will bring the increase of the profit. Total economic benefit at Base Case (described hereunder) is estimated at 354.8 million Rs. Another expected benefit of the project is a saving of STW operation cost. In the Base Case defined hereafter, saving of the operation cost of STW is estimated at 15.7 million Rs for winter crops.

EIRR calculation is carried out for the following assumed four cases and the EIRRs from Case 0, 1, 2, and 3 come up at 15.6 %, 16.1 %, 18.9 % and 20.2 % respectively. EIRRs of all the cases are over the opportunity cost of capital in Nepal, which is 12 %. It is, therefore, evaluated that the Project is economically feasible in each case as well as the Base Case. NPV of the Base Case is estimated at 343 million Rs or 4.4 million US dollar.

In monsoon season, all cases would execute Surface Water Irrigation (SWI) for the whole command area, and achieve to full yield expected by the Project. In Case 0,the Base Case, the Sunsari river water would not be diverted at all during winter season in order to maintain the current volume of the river flow at lean period, considering the adverse affect to the fishery in the river. The entire area during winter season would be covered by Tube Well Irrigation (TWI) as practiced at present. Therefore, the yields of winter crop would not change by the Project.

In Case 1, the river water is distributed into about a half of the command area during winter season, through either Suksena or Shankarpur canal by every year rotation. However, the amount of water extracted from the river is 50 %, only to be the level of enabling preventive irrigation to meet the requirement of the downstream river water quality, according to the degree of reduction of the effluent from the paper factories and the compensation to the fishermen whose occupation will be affected by the project. This case would not allow the increase of the crop yields from the present level but only saving the pumping cost of shallow tube well by alternating the source of water.

As for Case 2, the command area covered by the SWI would be same as the Case 1, namely about a half of the area would be irrigated by the rotational irrigation. But the system can extract 80 % of the river water and provide the water onto the farm by the level of conventional irrigation, assuming the establishment of treatment plant in the paper factories and agreement of compensation to the concerned fishermen. In this case, the increase of yields at full extent can be realized by the Project.

For Case 3, though it may be unlikely to happen, the case assumes that the irrigation water from SMIP through Sukusena and Shakarpur canals could serve the command area in winter season with 3.8 to 5.0 cum/s. In this case, all the command area would be serviced by the surface water and therefore, no rotational irrigation is required. Every year, all the command area could enjoy the sufficient surface irrigation water accruing the full extent of crop yield increase and saving of the pumping cost.

Farm Budget Analysis:

On farm budget analysis, it is evaluated that incremental net income per hectare in the Base Case will be at; Marginal (below 0.4ha) = 13 thousand Rs, Medium (0.9 – 1.8ha) = 17 thousand Rs, Large (3.0 ha and above) = 29 thousand Rs, namely, the bigger the farm size is, the higher the incremental net income per hectare becomes, because the marginal-scale farmer is already practicing high crop intensity even at present (191 %), there are less surpluses for expansion of cropping area, but large-scale farmer has low crop intensity at present (156 %), so that irrigation water can make a big raise in agricultural income.

Major Indirect and Intangible Benefit:

1) Increase in Employment Opportunity

In a short term, a large number of farmers will be involved in construction works, which are spread over seven years. Average annual employment for construction labor will be about 630 man-year in the hard ware of the main component alone. They are equivalent to about 10 % of landless population in the Study area, supposing the number of landless household is 6,640.

Increase of crop production creates job opportunities for harvesting labor and crop diversification proposed in this Study as well contributes to creating opportunities for farm labor. Other way of job creation with the proposed project is a canal maintenance work. Canal maintenance works such as desilting and grass cutting in some canals can be done by hired labor and the source of wage could be born to ISF. The major projects will generate incremental annual farm employment of about 400 man-years for the Base Case, as agriculture production will increase in the command area, and about 570 man-year for the Case 2. Even desilting and grass cutting under WUC's jurisdiction need about 14 thousand man-day every year.

2) Improvement of Transportation

The western part of the Study area due to the poor access have got little attention from development support agencies like UNDP and Plan International tackling poverty alleviation. The proposed road network improvement in the western part of the Study area will contribute to attracting these agencies as well as improving the marketing condition of the area.

3) Increase in Land Value

Financial value of farmland and residential land will be increased by the major projects implementation. This means the value of land assets as a mortgage and the larger class farmers will have more monetary power in the future. On the contrary, the condition of tenant and marginal class farmers will be hard to acquire own farm land due to increase in land prices.

ENVIRONMENT

Water Quality:

The Team has conducted a series of water quality check in years of 2001 and 2002 for both monsoon and winter seasons. 6 points from surface water and 5 points from groundwater (2 from shallow tubewells and 3 from deep tubewells) had been sampled for the water quality check. Judging from the test, it can be said that the water qualities of the Sunsari river and groundwater in the Study area are suitable for irrigation except for the water of the Sunsari river after it receives industrial effluent from 2 paper factories (headworks site is located upstream from the factories' discharge points).

Paper Factories:

The wastewater from the two paper factories, located near the headworks site, contains high-level values of TSS, BOD, COD, etc. Micro fiber, mineral, saccharide, alcohol, lignine and its decomposition materials made in the process of paper production bring about the increase of these values. The particulars beyond the standards of "Tolerance Limits for

Industrial Effluents Discharge into Inland Surface Waters", Nepal Bureau of Standards and Metrology (NBSM) are TSS, Ammonia, Chloride, Lead (Pb), Chromium (Cr), COD and BOD (Chloride was referred to a German standard because no standard in Nepal).

There is a possibility that the factories construct an Effluent Treatment Plant (EPT) under assistance from DANIDA. This ETP, however, is not supposed to run up to the level at which Nepal Standard is satisfied but to reduce the effluent by 80% from the present (with the 80% reduction, COD will be about 600 mg/l against the standard of 250 mg/l in case of Baba factory). Also, Baba factory would probably increase the production to as much as four times owing to the already constructed new production lines (current 10 t/day to 40 t/day).

As the present situation is not already permissible, the Sunsari River Irrigation Project (SRIP) may not be allowed to take any water during lean period unless otherwise the factories take any kind of measures of reducing the effluent. Though the factories are already violating a law in Nepal, the practice on the ground might continue. Faced with this situation, impact assessment on Sunsari river water quality has been done from the view point of how further deterioration of the river water can be avoided upon the SRIP coming into operation. The summary of the assessment is:

- The factories should reduce the effluent with assistance from DANIDA or otherwise by their own responsibility. If the present situation prevails, the SRIP should not take any water during lean period since the present situation is already beyond the permissible level.
- On condition that the factories install an ETP reducing the effluent to 20%, the SRIP may take Sunsari water up to 50 %. However, if Baba factory runs the production line with the full capacity, the situation would become a little worse than the present situation (up to three times more production is within the present condition). Therefore, 50% water diversion during lean period should accompany careful monitoring of both paper production and the river water quality.
- If the SRIP intends 80% water diversion, the Government should enforce the factories to comply with the Nepal Standard. Unless otherwise the factories abide by the Nepal Standard, the SRIP should not proceed to the 80% water diversion. Compensation for fisheries should also be fully considered in case that the SRIP diverts 80% water.

Bio-diversity in Sunsari River:
Should complete dewatering below the headworks for a stretch of about 26 km in Sunsari river take place, serious impacts will take place on micro flora and aquatic invertebrates. Mainly 3 groups of fauna, Plecoptera, Ephemeroptera and Tricoptera will get more affected if most amount of water is diverted and the river becomes half-dried. These faunal groups have a narrow range of tolerance to changes in environmental factors such as temperature, dissolved oxygen, pH and carbon dioxide levels.

The fish species which have ecologically adapted to a flowing conditions will find the new condition in the Sunsari river untenable, while species which in the river system are restricted to pools would adapt to the new conditions. Changes in the composition and abundance of both the planktonic and benthic communities resulting from the reservoir formation would

also affect the food supply of many species of fish, some adversely, some favorably. This factor will eventually influence the species composition in the fish population.

Taking into account above, after the headworks starts operating, at least 20% of the probability 80% flow in winter season should be released, which is double percentage of 10% usually practiced in Nepal. Two fish paths will also be provided to the planned headworks to conserve the fish species; one in each side. Unless the industrial effluent from the paper factories can meet the Nepal Standard, the SRIP will have to release 50% water with condition still requiring the factories to reduce the effluent to 20% of the present. The 20% regulatory downstream release is 0.7cum/s, and 50% is 1.8 cum/s.

Fisheries in Sunsari River:
Mallah people who are sometimes called Gudhi have been traditionally engaged in fishery depending on Sunsari river, Old Sunsari river (Mariya Dhar), and other rivers. Their communities lie in such VDCs as Ghuski, Ramnagar Bhutaha and Narusimha. Total number of their household is estimated at around 180 according to interviews to the fishermen, of whom only 17 are part time fishermen and the rest are all fully engaged in fishing.

Though the headworks will release a regulatory flow to downstream to keep the biodiversity in the Sunsari river, there may be adverse effect on the fisheries due to the decrease of flow. In reality, the 2 paper factories have already affected the fisheries to certain extent. Taking into account the present situation already deteriorating and also their social status, the Project should actively undertake a measure to promote fish culture for the fishermen.

As for lands for fishponds, utilization of Mariya Dhar (old Sunsari) should be firstly considered for the fish culture promotion. However, while fishing in Mariya Dhar at present, many people claim the land within the Dhar as private. Referring to the fishermen's opinion, resolution of the ownership problem and then a weir/bund for ponding about one meter depth of water in Dhar would be the most appropriate alternative to them as a compensation for diverting water from Sunsari river.

This Study is proposing 50% diversion during winter season upon the paper factories reducing the effluent to 20%. Though one may say fish culture promotion, as compensation, may not be necessary in case of 50% diversion, this Study recommends to promote the fish culture even in case of 50% diversion. This early promotion of fish culture would well prepare the fishermen to operate full fish culture in lieu of fishing in Sunsari river at the time the SRIP start diverting 80% of water.

CONCLUSION AND RECOMMENDATIONS

Conclusion:
The Sunsari River Irrigation Project (SRIP), once implemented, will realize the people's long lasting dream to come true; that is agriculture development well supported by irrigation water. The proposed SRIP will improve the living standard of the local people through the irrigated agriculture. For instance, if the SRIP operates only during the monsoon season, (existing STWs will irrigate the land during winter season) even as the base case, the incremental agricultural income for marginal, small, medium and large-scale farm households will be

13,000 Rs/ha/yr, 11,000 Rs/ha/yr, 17,000 Rs/ha/yr and 29,000 Rs/ha/yr respectively. In case SRIP diverts 80% of the river water into farmlands during winter season, the incremental income of the above-mentioned farm households will be 21,000 Rs/ha/yr, 26,000 Rs/ha/yr, 34,000 Rs/ha/yr and 44,000 Rs/ha/yr respectively.

The SRIP, from the viewpoint of national development, gives EIRR 16 % higher than the opportunity cost of capital of 12 % in Nepal even at the base case. It is expected with the SRIP that the unit yield of paddy will increase to 4.2 t/ha from the current 2.3 t/ha and gross production in the Study area, at the base case, will add 7,600 tons of paddy, 17,700 tons of summer vegetables etc. Should the SRIP divert 80 % of the river water into farmlands during winter season, the EIRR would become 19 % and the incremental production will further add 3,500 tons of potato and 9,200 tons of winter vegetables from the base case, contributing not only to the local people's food security but also enhancing the living standard as well as the national food security level.

The SRIP furthermore will create job opportunity particularly for the landless. The project will generate 116,830 man-days at the base case (166,170 man-days if 80 % of the river water were taken for irrigation during winter season) for agricultural work. For desilting and grass cutting work in maintaining irrigation canals, 14,290 man-days of labor will be generated, thereby contributing to poverty mitigation. The SRIP also pays attention to the disparity in location; namely, road-networking improvement in the western part of the Study area is incorporated to mitigate the disadvantage of accessibility to the area. This improvement will carry farm extension services or NGO assistances into the area as well as increase a sales opportunity of farm products, contributing to raising the people's living standard.

Taking into account all of the above benefits, this Study concludes that the SRIP should be implemented as soon as possible. The HMGN should take action immediately toward arranging the required funds available. Appropriation from the Government coffer should be made at least for land acquisition, administration, and other supportive components such as agriculture extension services, promotion of inland fishery, etcetera. Also, assistances from donor country(ies) as well as international funding agency(ies) should be sought.

Recommendations:
(Issues relative to Project Implementation)
1) Operation of SRIP during Winter Season

SRIP should not divert any water during winter season unless otherwise the two paper factories, located just downstream of the proposed headwork site, establish effluent treatment plant (ETP) since the river's present condition is already beyond the permissible level. In this case, irrigation during the winter season will have to be dependent on existing STWs (about 80 % farmers are using STWs even at present).

On condition that the factories install an ETP reducing the effluent by 80 %, the SRIP could proceed to diverting Sunsari water up to 50 % during winter season. The diversion of 50 % during winter season should accompany careful monitoring of both paper production and the river water quality. Such monitoring is required because the situation of Sunsari river would become a little worse than the present even with the ETP if Baba factory runs the production line with the full capacity (four times production than the present). Also, compensation for

180 fishermen dependent on the Sunsari river should be undertaken to about half of the fishermen to be affected.

If the SRIP intends 80 % water diversion during winter season, the Government should enforce upon the factories to obey the Nepal Standard. Unless otherwise the factories abide by the Nepal Standard, the SRIP should not proceed to the 80 % water diversion. Compensation for 180 fishermen dependent on the Sunsari river should also be considered to full extent in case that the SRIP diverts 80 % water.

As per downstream regulatory release, this Study recommends that at least 20 % of the flow in winter season should be released. This 20 % regulatory volume is more than the general practice in Nepal, which is 10 %. Based on the probability 80 % river discharge, the 20 % regulatory downstream flow is 0.8 cum/s. Even in case that the factories comply with the Nepal Standard, the SRIP should release at least 0.8 cum/s in order to keep downstream environment in a proper condition.

2) Process of Establishing Organization

One of the reasons, which causes water users' organization to become non-functional, must be rooted in the process of establishing the organization itself. Observing the manner of approach in existing organization, it seems that the organization was formed due to the convenience of the external agency side without fully consulting with all the farmers. If the external agency approaches in a hurry, without believing in the farmer's capacity, it is no wonder that farmers consider that they organize themselves for "external agency", but not for "themselves".

In this sense, the manner of approach should bear the active participation of farmer beneficiaries of the Project from its initial period and take enough time for establishing the organization. The external agency should also be in the stance of not pushing but stressing "ownership of farmers" for sustainability of the function of the organization.

3) Establishing Clear Information Dissemination and Transparency

For equal distribution of water, common information should be shared among all the users properly. Equal information dissemination will provide equal access and control to all users, regardless of poor and rich. Since the rotation use of irrigation water is required during winter, communication among WUG, WUG-WUC, WUC-WUC, and WUG/C with the Project Office must be very important. Especially communication between upper reach and lower reach must be very necessary in order to distribute the water equally.

Furthermore, in existing irrigation projects, there are various misunderstandings among users, and, in some cases, the farmers are not sure even who collects ISF and how the ISF is used. Above all, there are a lot of doubts by farmers, saying that the committee members of WUC are corrupted. If the corruption is a biggest issue, a way to solve this problem is to make the system transparent. For keeping transparency, information should be disseminated well to all the concerned people. The Government should pursue this transparency to all the concerned farmers.

4) Accountability of the Irrigation Agency

NISP study stresses the issue of budgetary system relative to the ISF collection, saying that

non-earmarking the funds collected as ISF for covering O&M expenditure in the irrigation systems would aggravate the poor performance of ISF collection. Namely, collected ISF goes to the government's central treasury and is not related to the O&M budget of the irrigation system, which leaves no material incentive to increase ISF collection efficiency. The ISF collection efficiency does not influence the budget allocation of the irrigation systems. Therefore, the rate of farmer's payment for ISF virtually lacks any effect on the quality of O&M.

The Government should be accountable to WUC about who pays ISF and how it is used. The current budgetary system cannot provide an exact balance sheet or income/expenditure statement of an irrigation system. It is, therefore, recommended that to make it possible to examine the financial autonomy of the irrigation system in order to show accountability to the farmer members, a budgetary arrangement to reflect ISF collection to the budget of the irrigation system should be considered.

5) Coordination among WUCs by the DOI

The organizational structure of the WUAs in SMIP is tall and highly centralized. As the leadership structure moves up, the leaders become unreachable by the farmers at the levels of the WUGs. There is too much concentration of power among the leaders and none is left among the farmers. The organizational structure that will be organized in SRIP will provide a mechanism where the beneficiaries' participation or democracy arrives at their decisions for the WUA and at the same time which has to be balanced with the beneficiaries' discipline in obeying to the decisions arrived by them in a democratic way.

Thus, the WUC operation is simply from-the-farmers-to-the-farmers mode. The farmers are also represented by the WUC (secondary canal level) Chairmen in the WUCC (main canal level) to coordinate water delivery and schedules along the main canal with concerned officials of the Project. For coordination purposes, the WUCC is not registered and no chairman is required for the WUCC except presiding officer for the purpose of facilitating a meeting. Only the WUCs are registered because they enter Joint Irrigation Management Agreement with DOI for the O&M of their respective command areas. The DOI should coordinate with all the chairmen representing their WUCs for equal water distribution along the main canal. This mechanism could avoid the tall and highly centralized structure unreachable by ordinary member farmers.

6) Coordination with Other Agencies

There have been several agencies in the Study area such as the Bank assisted SMIP, UNDP assisted LGP, and so forth, carrying out irrigation or rural development projects / programs. The SRIP will be able to contribute to the rural development of the Study area more effectively, if SRIP is properly positioned among the development activities of the area. Therefore, coordination among the agencies acting in the Study area should also be pursued even by the initiative of DOI if appropriate. For instance, since the landless could not be a member of WUA to be established for the irrigation development, SRIP could suggest other agencies to prioritize their target beneficiaries by land holding status.

This Study has proposed that SRIP should be operated and maintained by Sunsari Division Office in coordination with SMIP. Performance of both SRIP and SMIP will influence each

other for sustainable O & M of the irrigation system. Furthermore, there would be a case that SRIP could receive supplementary water from SMIP during winter season. In such case, issues of water and O & M cost allocations should arise between the systems. Therefore, coherent coordination between the two systems in O & M should be established.

7) Inconsistency of Policy Implementation

Irrigation policy of Nepal, which imposes upfront payment for the beneficiaries of irrigation projects and the cost sharing of 10 % for the capital cost in case of new construction, has not been consistent on the ground. For example, Chanda Mohana Irrigation System, whose part covers a southern part of the Study area (Sahebganj), was constructed without any due of the repayment from the beneficiaries. This inconsistency may discourage the potential beneficiaries of the irrigation development in the Study area to burden such expenses. The Government should purse the public equity based on the consistent policy implementation and if any exception takes place, the Government will have to be accountable in explaining to the people.

The issue of the consistency will also be crucial for the case of ISF collection, as the low ISF rate in SMIP (200 Rs/ha/yr), which can hardly cover the necessary O&M cost of the irrigation system (it is estimated that SMIP would require 1,100 to 1,300 Rs/ha/yr to cover the O& M cost), would discourage farmers to pay higher ISF in other irrigation systems. The ISF rate should be identified based on the necessary O&M cost of the irrigation system and equal rate should be applied for the similar type of irrigation systems.

(Refining the Existing Policy and Regulations)

Institutionalized policies and regulations guide the concerned officers, consultants, and planners in preparing such development plan as SRIP. Policies and regulations are, on the other hand, refined in such a way of getting feedback from the ground where actual planning and implementation take place. Following are the feedback from this Study, which may serve for refining the present policies and regulations:

1) Project Development

The Irrigation Policy (IP) of 1992 (2049) section 3.24 provides that “His Majesty's Government shall invest in the project only after having formal agreement with the Water Users' Association by clearly defining the functions, duties and rights of the concerned Irrigation Office and Water Users' Association by adopting a transparent method in relation to the construction, implementation, operation and management of the project.” Further, section 3.25 stipulates that the agreement concluded with the Water Users' Association should be regarded as the basis of resource mobilization.

This pre-project investment agreement includes areas that have something to do with the project such as land for the watercourses, cost sharing according to the levels of canals and upfront deposit of the WUA. As such, all pertinent conditions and stipulations can be included in the Agreement. However, making farmers’ contribution mandatory not only to provide land free of cost for the small canal that is to irrigate up to 30 ha block (IP Article 2.2.3) but also a cost sharing of 25 % on the cost of construction thereat and without contributions on the higher level canals such as sub-secondary or secondary contradicts the essence of the pre-project investment agreement.

The policy should not limit, and specifically mandate at what level and at what rate the farmers' contribution should be. There are tertiary canals which may cover 20-ha watercourses. With the policy, the farmers' contribution has been set at 25 % but the farmers and their organizations can also contribute 100 %. If the contribution is already mandated at a given level with a given rate, what is there to agree between the Water Users' Association and the concerned Irrigation Office? Thus, there are contradictions within the IP itself.

The defined cost contributions of both parties contradict the provision on the farmers' donation of land for small canals to irrigate up to 30 ha block and of the construction cost of the field channels. The contradiction confuses the meaning as to the size of the watercourse particularly in the field. In order to rectify the essential contradictions, the provisions of the IP in terms of fixed contributions relative to the area and level of canals should be relaxed in favor of a mutually understood pre-project investment agreement. The Water Users Committees and the concerned Irrigation Office will have to go through an agreement process without being restricted because of the fixed contributions provisions. In other words, the Policy and the practice in the field should be guided by an open pre-project investment agreement within the context of the parameters to be agreed upon by both parties. In this way, the contradictions within the Policy can be resolved.

2) Operation and Maintenance

Rules 7 and 8 of the Irrigation Rule of 2000 provide for the organization of the Users Coordination Association and the establishment of deposit for maintenance fund. Furthermore, it provides that the Coordination Association will be registered. In the proposed SRIP, however, the Water Users Committees (WUCs) at the secondary level are planned to be the Associations that will be registered. All levels from the watercourses to the headworks require coordination where higher level coordinates the works of the lower levels. Without specifying which level this coordination will be confuses which level should be registered. This confusion will be cleared out if the IR specifies the Water Users Coordination Committee is not to be registered but mainly serves coordinative purposes.

On the maintenance fund, the Rule stipulates that the Users' Association shall establish a separate fund for the maintenance of the irrigation system and the structures and deposit at least 90 % of the Service Charge and other income. The WUCs will determine how much will go to maintenance and other works of the Association and fixing maintenance to be 90 % does not have meaning. So, in SRIP it is up to the WUCs to decide this purely internal and very specific matter like maintenance fund allocation.

If the Irrigation Policy, Water Resources Act and the Irrigation Rule have to be reformed, these will be stated as general guidelines and not as specifics. The general guidelines will serve as the framework of the specifics on the ground. These guidelines should not be stated as specifics because these will limit flexibility and innovations as implementers pursue these in the field. The specifics are the expressions of the guidelines best formulated according to the requirements of the actual local situations.

CONTENTS

APPENDIXES

ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
ADBN	Agriculture Development Bank of Nepal
ADO	Agriculture Development Officer
AIC	Agricultural Inputs Corporation
AO	Association Organizer (employed by SMIP)
APP	Agricultural Perspective Plan
AREP	Agricultural Research and Extension Project (WB funded)
ASC	Agriculture Service Center
CBS	Central Bureau of Statistics
CDO	Chief District Officer
CE	Collection Efficiency (of Irrigation Service Fee)
CMC	Chatra Main Canal
EDR	Eastern Development Region
ERID	Eastern Regional Irrigation Directorate
CGWISP	Community Groundwater Irrigation Sector Project (ADB funded)
DAC	District Agriculture Committee
DADO	District Agricultural Development Office
DDC	District Development Committee
DIO	District Irrigation Office
DO	Division Office (to be set up by merging two to three DIOs)
DOA	Department of Agriculture
DOI	Department of Irrigation
DSSTW	Deep Set Shallow Tubewell
DTW	Deep Tubewell
DWRC	District Water Resources Committee
EIRR	Economic Internal Rate of Return
FAO	Food and Agricultural Organization
FIRR	Financial Internal Rate of Return
FMIS	Farmer Managed Irrigation System
FO	Farmer Organizer
GFO	GWRDP Field Office
GTZ	German Society of Technical Co-operation
GUG	Groundwater User Group
GWRDP	Groundwater Resources Development Project
HMG(N)	His Majesty's Government (Nepal)
IBRD	International Bank for Reconstruction and Development
IDA	International Development Agency
IFAD	International Fund for Agriculture Development
IIMI	International Irrigation Management Institute (presently IWMI)
ILC	Irrigation Line of Credit (WB funded)
IMD	Irrigation Management Division (under central DOI)
IMT	Irrigation Management Transfer
INGO	International Non-Government Organization
IP	Irrigation Policy

IPM	Integrated Pest Management
ISF	Irrigation Service Fee
IWMI	International Water Management Institutes (former IIMI)
JICA	Japan International Cooperation Agency
JT	Junior Technician
JTA	Junior Technical Assistant
LDO	Local Development Officer
LGP	Local Governance Program
LRMP	Land Resources Mapping Project
MLD	Ministry of Local Development
MOA	Ministry of Agriculture
MOWR	Ministry of Water Resources
NARC	National Agricultural Research Center
NEA	Nepal Electricity Authority
NGO	Non-Governmental Organization
NISP	Nepal Irrigation Sector Project (WB funded)
O & M	Operation and Maintenance
PRA	Participatory Rural Appraisal
PVC	Polyvinyl Chloride
PWL	Pumping Water Level
RADO	Regional Agriculture Development Office
RRA	Rapid Rural Appraisal
Rs	Nepalese Rupees
SCO	Savings and Credit Organizations
SDE	Senior Divisional Engineer
SISP	Second Irrigation Sector Project (ADB funded)
SMIP	Sunsari-Morang Irrigation Project
STW	Shallow Tubewell
SWL	Static Water Level
UNDP	United Nations Development Project
USAID	United States Agency for International Development
VDC	Village Development Committee
WB	World Bank
WC	Water Course
WRC	Water Resources Act
WRR	Water Resources Regulation
WUA	Water User's Association
WUCCC	Water Users Central Coordination Committee (in SMIP)
WUCC	Water Users Coordination Committee
WUC	Water Users Committee
WUSC	Water Users Sub-committee
WUG	Water Users Group

CURRENCY EQUIVALENTS (as of August, 2002)

1 Nepalese Rupee (Rs)	=	0.0128 US$
1 Nepalese Rupee (Rs)	=	1.53 Japanese Yen
Rs 78	=	1 US$
Rs 0.655	=	1 Japanese Yen

NEPALESE FISCAL YEAR, AND NEPALESE YEAR VS. GREGORIAN YEAR

Fiscal year starts at mid of July according to the Nepalese calendar.

Nepalese Year	Gregorian Year
2060	2003/04
2059	2002/03
2058	2001/02
2057	2000/01
2056	1999/00
2055	1998/99
2054	1997/98
2053	1996/97
2052	1995/96
2051	1994/95

UNIT CONVERSIONS

1 meter (m)	=	3.28 feet
1 kilometer (km)	=	0.62 miles
1 hectare (ha)	=	2.47 acres
	=	1.50 bighas
	=	30 khatas
1 bigha	=	0.67 ha
1 khata	=	0.03 ha
1 bigha	=	20 khatas
1 man	=	40 kilograms (local unit)
1 maund	=	37.324 kilograms
1 quintal	=	100 kilograms

1 cubic meter per second (m^3/s)	=	35.31 cubic feet per second
1 cubic foot per second (cusec)	=	28.3 liters per second (l/s)
1 cubic meter per hour (m^3/h)	=	0.28 liters per second (l/s)
1 kilowatt (kw)	=	1.34 horsepower (hp)
	=	1 kilovoltamp (kVA)

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CHAPTER 1

INTRODUCTION AND PURPOSE

CHAPTER 1 INTRODUCTION AND PURPOSE

This Final Report is presented in accordance with the Scope of Work and the Minutes of Meeting concerning the Feasibility Study on the Sunsari River Irrigation Project (the Study) agreed upon between the Department of Irrigation (DOI), the Ministry of Water Resources (MOW), His Majesty's Government of Nepal (HMGN) and Japan International Cooperation Agency (JICA) on November 29, 2000. This Report describes the findings made during a series of field surveys, development framework, development strategy, the irrigation and drainage development plan, project justification, implementation arrangement, and conclusion and recommendations.

1.1 Introduction

The Terai plain used to be a tropic jungle up until late 19th century, demarcating the Kingdom of Nepal from the Ganges plain in an Indian territory. Resettlement into this Terai area started at early 20th century. With the effort of malaria eradication that started in 1954, the Terai area became very accessible and many people have been coming in. Heavy reclamation machineries, available since around mid 20th century, have also greatly helped to open the area, thus the Terai area has turned to be a granary nowadays. Once it was a dense forest, but now it supplies huge amount of cereals and other agricultural products not only for the people in the Terai but also for the nation.

The Study area falls in an eastern part of the Terai. The administrative district wherein the Study area is located is the Sunsari, the 3rd district from the eastern border of the Country along the Terai plain. The area is well known for a large national irrigation system called Sunsari-Morang Irrigation Project (SMIP), source of which is the Sapta Koshi river. The SMIP was commissioned in 1975, and is the biggest irrigation system as of today in Nepal. The irrigation system, however, has a difficulty of supplying enough water over all the irrigable area of 68,000 ha.

The Study area occupies a south-western part of the SMIP, starting at E-W highway at its northern most part and running down to the international border with India. Running through the Study area is a perennial river called Sunsari originating in Siwalik mountain range. The Sunsari river is quite small if compared with the Koshi river. However, if the Sunsari river could well be developed for irrigation, the Study area would enjoy irrigated agriculture that the local people have long been waiting for. Development of the Sunsari river would also increase the irrigation reliability of SMIP simply because it works as a supplement for the SMIP's farmland.

With the Sunsari river developed, how much area can enjoy irrigated agriculture? How should the outlook of the Study area be? How much benefit would be brought upon the local people? Is the project feasible in terms of technical, financial, economic, institutional, etc., and what are the environmental implications if any? If negative environmental impacts were foreseen, what could the mitigation measures be? This Study attempts, as a feasibility study, to answer these questions.

1.2 Background and Rationale

The Sapta Koshi river, flowing at an eastern part of Nepal, is the biggest river in Nepal with a drainage area covering about one-third of the Country. In 1964, India constructed a main canal called Chatra, which withdraws water from the Koshi River, on compensation for a water right downstream. India had poured in one wave of reinforcements after another for the construction of the canal, requiring 12 years. The canal was supposed to supply irrigation water to the farmlands of 68,000 ha in Sunsari and Morang districts. However, the design unit water requirement was very small, resulting in a shortfall that the entire area cannot enjoy reliable irrigation.

A plan was then made to cover the vast farmlands of 68,000 ha by introducing modern irrigation techniques. The farmlands, the prospective irrigable area, was divided into three stages and a project titled Sunsari-Morang Irrigation Project (SMIP) was commenced, which included among others the construction of a new intake at the Koshi river with a design capacity of 60 m^3/s. Stage I was started in 1978, Stage II in 1988, and Stage III was further divided into 3 phases and the first phase of the Stage III was commenced in December 1997. The Phase 1 of the Stage III is to be completed in June 2003.

Though the SMIP has been rehabilitated/renewed through those three stages of construction, it still requires many years until the irrigation system becomes fully operational with the full design capacity of 60 m^3/s because more than 30,000 ha of SMIP are not yet rehabilitated. The area not yet rehabilitated falls in the Phase 2 and Phase 3 of the Stage III; Phase 2 covering 15,400 ha at the eastern most area and Phase 3 covering 15,500 ha at the western most area wherein a part of this Study area is located.

Yet, even with the full design capacity of 60 m^3/s being realized, whole SMIP may not be able to enjoy irrigation as originally planned. An area of SMIP, especially south-western part, is very much dominated by sandy soils. Field tests carried out in the Study area give us as high as over 20 mm/day percolation which is much more than the original SMIP design percolations of 2.5 and 3.0 mm/day. A measure to cope with the high percolation is now being sought; that is to supplementary develop the rivers running through the SMIP area.

Several rivers are flowing from north to south of the extensive farmlands. Sunsari river, one of them, is flowing at around mid way between two SMIP's secondary canals; Shankarpur and Suksena. Though the two canals have been trying to deliver irrigation water that can meet the farmers' demand, it is very difficult specially after entering into the Study area. The farmers who are along the upper reaches of the canals in the Study area still can, though not enough, receive an amount of water but ones who are in the mid and southern parts of the Study area have hardly received irrigation water through the canals.

The Sunsari river is perennial. If a headwork were so constructed at a place of Sunsari river that could deliver by gravity the water to the both secondary canals, an irrigation development could well be realized for the farmlands spreading along the two canals. Development of the Sunsari river would realize the local people's long lasting dream and furthermore could greatly raise the agriculture production there, which is destined as an area in the Terai plain.

HMGN thus feels a pressing need to establish an efficient irrigation system by providing sustainable and stable irrigation water over the farmlands, which are commanded by the two canals. HMGN requested in September 1998 to the GOJ for a study, titled as the Feasibility Study on the Sunsari River Irrigation Project in the Kingdom of Nepal (the Study), aiming at realizing the sustainable irrigation development for the farmlands as well as sustainable agricultural development that could be brought to fruition even by small scale farmers.

In response to the request by HMGN, the GOJ sent the Scope of Work mission of JICA in November 2000. The Minutes of Meeting on the Scope of Work were agreed and signed on November 29, 2000 between the two governments, and Sanyu Consultants Inc. of Japan was contracted by JICA in March 2001 to carry out the Study. The Study Team first showed up in Kathmandu on April 17, 2001 and proceeded to the subsequent field survey, and has now completed all the surveys presenting this Final Report.

1.3 Objectives and Scope

The overall objective of this Study is to improve the living standard of the local people in the Study area based primarily upon irrigated agriculture development. The development plan is prepared in partnership with the DOI, the counterpart agency, and incorporates the views of the beneficiaries and other stakeholders such as Department of Agriculture (DOA), local authorities, international funding agencies, NGOs, etc. The process of this Study centers on the following which themselves are the objectives of the Study:

- To conduct a feasibility study on the Sunsari River Irrigation System, basic concept of which is to formulate an efficient water use plan aiming at agriculture development, and
- To carry out technology transfer/exchange to and with the Nepalese counterpart through on-the-job training during the course of the Study.

To attain the above objectives, this Study was divided into two phases; namely, Phase 1 for a preliminary development plan formulation and Phase 2 undertaking so called feasibility study, and covers the following scope:

Phase I;

- Review of the SMIP,
- Review of other development projects/plans related to the Study,
- Collection of relevant data through field surveys and those analysis,
- Formulation of preliminary irrigation and drainage development plan, and
- Initial Environmental Examination (IEE)

Phase II;

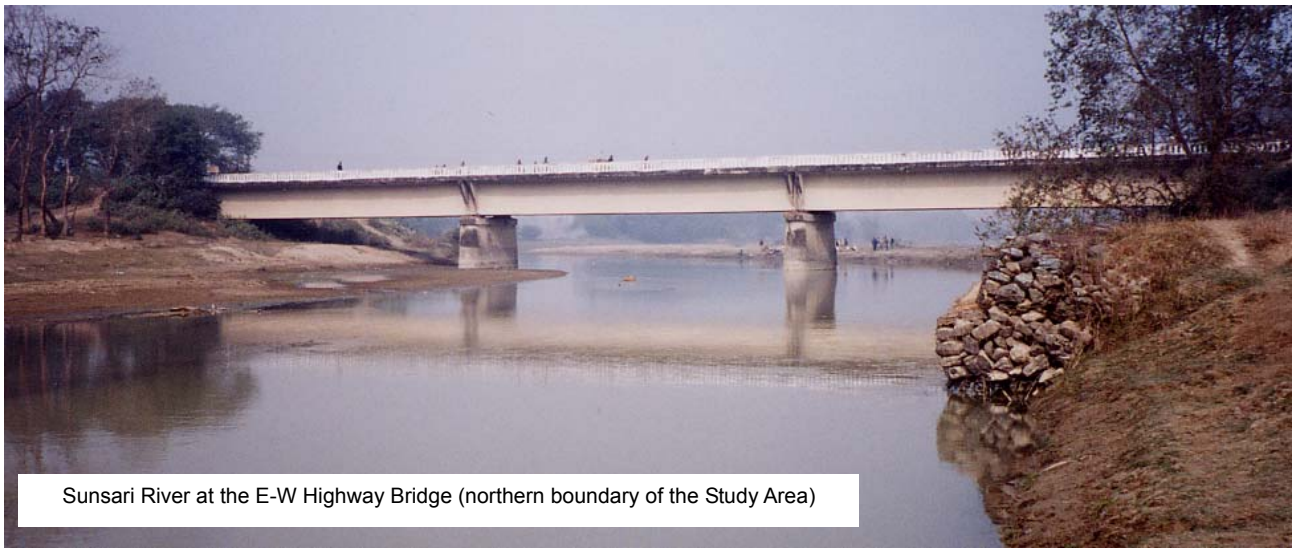
- Field survey to collect supplementary data and information,
- Formulation of effective irrigation and drainage development plan,
- Formulation of agriculture development plan,
- Design of irrigation and drainage facilities,
- Formulation of operation and maintenance (O&M) plans,

- Environmental study,
- Preparation of implementation schedule,
- Estimation of project costs and benefits, and
- Project evaluation and justification, and presentation of recommendations.

1.4 The Study Area

The Study area, about 16,800 ha, is located in lower reaches of the Shankarpur Branch Canal and the Suksena Branch Canal from the Chatra main canal of SMIP. The area is in Sunsari District, Koshi Zone, Eastern Region (see Location Map). The total area of Sunsari district is 125,700 ha, out of which the Study area occupies about 13 %. The Study area is at its western and southern sides demarcated by the international border with India and at its eastern part by Budhi river. The northern tip of the Study area is East-West highway. There are 13 village development committees (VDC) in the Study area, an administrative village block, over which about 98,000 population reside, consisting of about 16% the whole Sunsari district population of 625,653[1].

Typical Paddy Fields beside a Village



Sunsari River at the E-W Highway Bridge (northern boundary of the Study Area)

[1] 2001 Population census