



INSTITUTE OF WATER
RESOURCES PLANNING



VIET NAM NATIONAL MEKONG
COMMITTEE

REPORT
ANALYSIS OF SUB-AREA 7V
BASIN DEVELOPMENT PLAN

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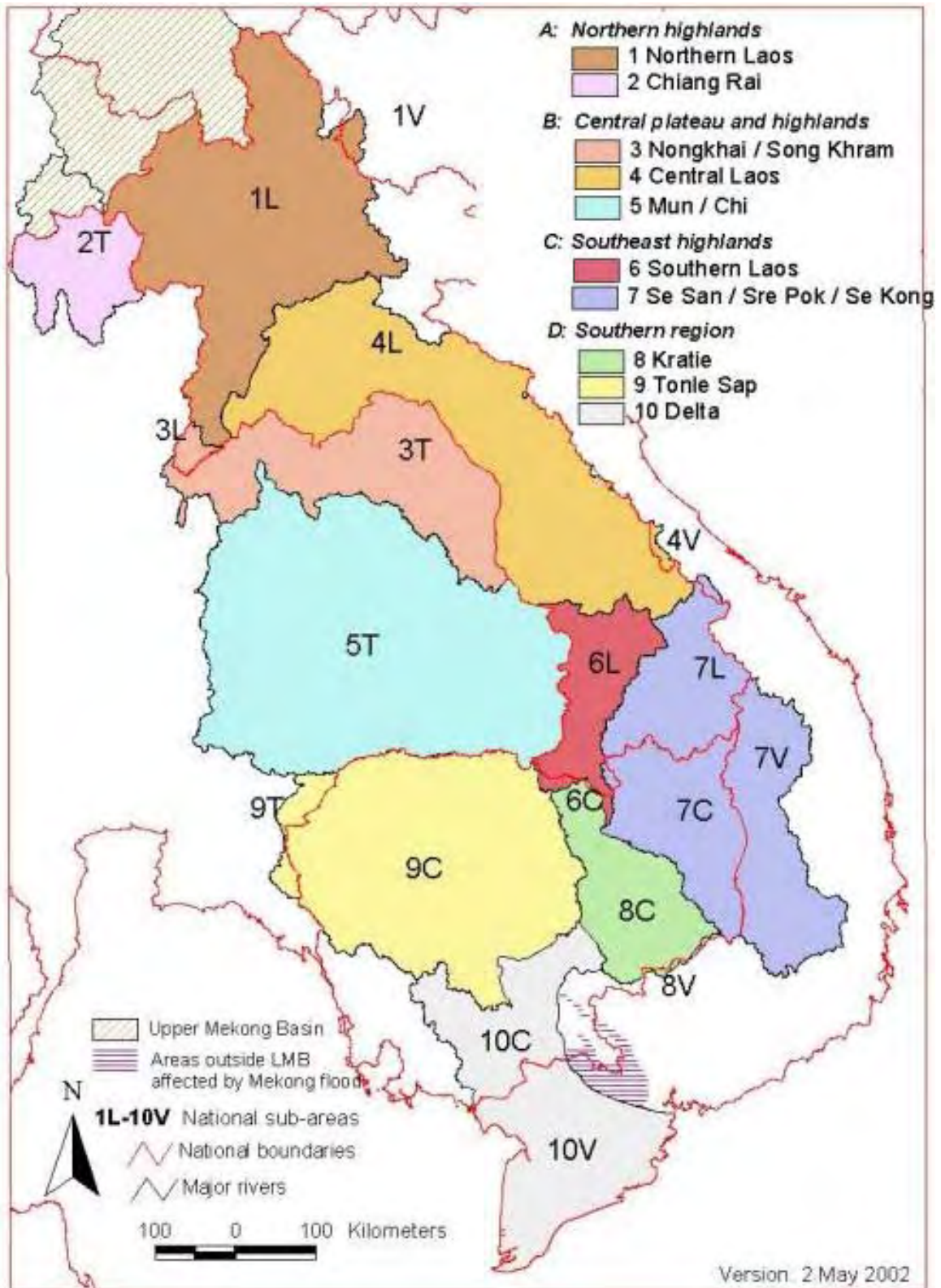
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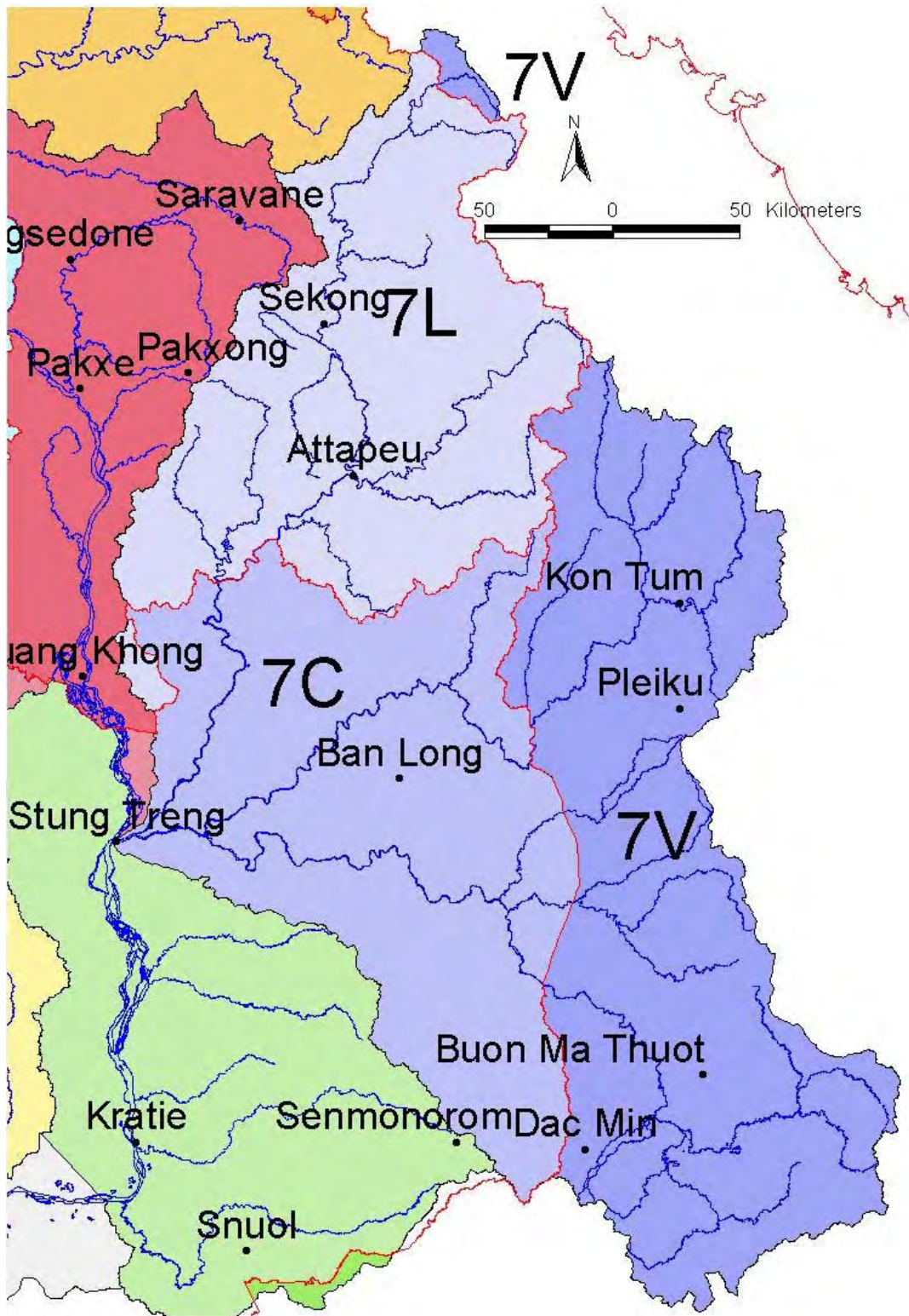
LIST OF ABBREVIATIONS

7V	Sub region 7 in Vietnam
BDP	Basin Development Planning
DANIDA	Danish International Development Agency.
DARD	Department of Agricultural and Rural Development
DSF	Decision-making Supporting Frame
EVN	Vietnam Electricity Corporation
FIPI	Forestry Investigation and Planning Institute
GDP	Gross Domestic Products
GSO	General Office of Statistics
ISD	Institute of Strategy Development
IWARP	Institute of Water Resource Planning
JICA	Japan International Cooperation Agency
MARD	Ministry of Agricultural and Rural Development
MOFI	Ministry of Fishery
MRC	Mekong River Commission
NIAPP	National Institute of Agricultural Planning and Projection
VND	Vietnamese Dong
VNMC	Vietnam National Mekong Committee
EP	Environment Programme
PECC1	Power Engineering Consulting Company 1

SUB-AREAS IN BASIN DEVELOPMENT PLAN



SUB-AREA 7V



SUMMARY

Background

The sub region 7V covers the areas of Dac Lac (71.3%), Kontum (90%), Gia Lai (41.5%), and Lam Dong (13.4%) and run through by rivers of Se San, Srepok and Sekong. The population of the region is 2.4 million people in which 42% is minor ethnic groups living on an area of 30840 km², including 344 communes, wards, towns in 34 districts and cities. During the past years, the economy of central highlands in general and of the sub-area in particular has rapid growth rate of 11.5% in spite of the fact that 80% of the local population lives on agriculture and small part of power industry. The poverty ratio at 25% represents one of the highest of the entire country. With the natural population growth rate of 2.5% and immigration 2.1%, by the year 2010, the population in the sub-area is expected to reach to 4 million. This high proportion means a big challenge to the investment in the region.

The vision of basin development plan (BDP) which is aimed at the promotion of cooperation and development of sub-basins through the establishment of a planning process and a framework for the investment and sustainable development. The Mekong River Agreement in 1995 has identified BDP as the tool and process for the comprehensive plan which are made by association of Mekong River Commission as the criteria for the identification, classification and ranking of prioritized projects and programs for support and planning implementation at the basin level.

According to the plan, the study and analysis of sub-area will be the first step of BDP.

Objectives of sub-area analysis

- To assess and review existing data, analyze current socio-economic development of the sub-area. The focus is the 8 key industries in BDP.
- To identify “urgent issues” of sub-area with focused issues relating the water use and transnational impacts; Identify opportunities, potentials, development trends and demands of the sub-area relating the water use.
- To identify development objectives and components of the scenario.

Scope of study

The analysis of sub-area will address the development of the 8 industries, namely irrigated agriculture, watershed management, hydropower, aquaculture, waterway transport, tourism, water supply, flood control and management. The fields that are integrated during the development are environment, resource development, socio-economic and community participation. The study will be carried out within the basins of se san, Srepok and Sekong rivers in the territories of Gia Lai, Kontum, Daclac and small portion of Lam Dong provinces in Vietnam.

Coordination

The plan and analysis of sub-area 7V belonged to the MRC BDP will be supported by its programs of Water Utilization Programme, Environment Program and other data and information available at the MRC Secretariat and Vietnam National Mekong Committee. At

Vietnamese side, the sub-area 7V plan will be supported by various sources, namely existing studies of Institute of Agriculture Planning and Projections, Institute of Forestry Planning and Investigation, Water Resource Planning Institute and other related central bodies as Institute of Strategy Development, Vietnam Electricity Incorporation, General Office of Statistics, Ministry of Agricultural and Rural Development, Ministry of Fishery. The local supports come mainly from Department of Agricultural and Rural Development, Department of Planning And Investment, Statistic Office. And other national programs, sector development strategy, master plans which have been being carried out in provinces as DANIDA funded Srepok river plan should be taken into account.

The participation of above mentioned bodies will be approved in meetings of various missions. The local bodies will constructively and actively participate in the meetings, forums and workshops in relevant provinces of the sub-area.

The study output will be step by step transferred to the MRC Secretariat through its Vietnam National Mekong Committee after the approval of the Steering Committee. The outputs of the following phases will apply the decision making framework for the validation and assessment in accordance with criteria set by MRC.

The national policies and sector development strategies, development priorities of individual localities will represent the focused issues to be considered in the BDP and the sub-area analysis. The bilateral development policies between Lao PDR, Vietnam and Cambodia relating the socio-economic development of the border area will be prioritized in the analysis and formulation of development scenario of the sub-area.

The transnational impacts among sub-area of 7V-7C and 7L will be studied and reviewed during the planning. The visible impacts will be analyzed and evaluated during the sub-area analysis with the focus as the impacts on environment ecosystem of the hydropower development in cascades of Se San and Srepok rivers. The development demands of the sub-area relating the basin development plan will also be considered or studied for support in BDP or in other programs of MRC.

Approach

The focuses of sub-area 7V analysis are issues of development opportunities; potentials, difficulties and restrictions raised during the water resource development and considered options to the issues in the sub-area. The development plans of sectors, programs and policies of national priority and especially the development demands are also the major issues addressed in BDP and the sub-area analysis.

The approach which covers the entire study is participatory approach. In the preparation of the sub-area analysis, Vietnam National Mekong Committee (VNMC) has held the “preparation workshop” which is aimed at introducing the 1955 agreement and BDP to relevant organizations concerning the planning and representatives from provinces. The “guidelines of sub-area analysis” compiled by the Secretariat also mention the support of above mentioned relevant bodies during the following phases of the study. After the study and analysis of the sub-area, the analyzed results will be presented at the “forum 1” in order to get comments from provinces and the “working group”. The content of “forum 1” will address the study results on (i) existing data and information, (ii) issues need solving of sub-area 7V, (iii) properties need protecting and studying in the next phases, (iv) opportunities,

challenges and development demands of the sub-area, (v) policies and priorities in development and (vi) identification of development objectives. The final study results will be reported and approved by working group and VNMC.

Implementation

As approved by VNMC and Mekong Secretariat, the analysis of sub-area 7V is assigned to IWARP with the implementation duration of 5 months. The Institute formed a study team of 9 people with the director of the IWARP as its team leader and other members as experts in various fields of agriculture, hydrology, modeling, environment, hydropower, economics and database. During the implementation, the work group receives the close directions of VNMC and feedbacks, comments from different localities and sub-sectors.

Outstanding issues

The agricultural development is rapid yet unsustainable, mainly depending on the nature and markets. The low productivity and product quality mean low competitiveness.

The water supply for agriculture is limited, especially in dry season. The underground water is over-exploited for the planting of coffee trees. The investment in the construction of hydraulic works is not corresponding and uniform to the development of young trees. Due to the specific features of the area, the construction of reservoirs for storage and regulation is of great importance.

The free migration from the other areas at high rate has strong impacts on the socio-economic development of the area. Especially, the deforestation for the planting of coffee and pepper has resulted in the soil erosion and climate change in the sub-area and upset the planning on land and water of the region.

The hydropower potential of the sub-area makes up for 18% of the total national capacity and 20% of the national electricity production. Hydropower is the key strength of the region. However, the construction and operation of hydropower works also have downstream impacts. During the water storing period of the reservoir and when the medium flood level is lengthened, there would be downstream effects. This should be considered in planning problems of sub-area 7V and of 7C, 7L and the entire river basin.

The poverty incidence is still high compared to the whole country. Especially 42% of minor ethnic groups are the main cause of wood cutting and shift farming.

Lack of electricity and domestic water supply, e.g. for the areas far away from the city is a problem.

The forest coverage is as high as 53%. The anti-deforestation should be linked with the conservation of wildlife and other national conservatories.

Regarding the management, the development of different sectors is not synchronic with that of socio-economy.

Impacts

Society: high free migration and population growth of the region have affected the land use, population allocation, job creation and forest resource protection. The large portion of minority ethnic group and low literacy are main challenges to the socio-economic development.

Economics: the transport network in remote areas is inadequate and inefficient. Poverty, unstable income, low investment rate in irrigation, unavailable market forecast for agricultural products, natural resource based production, unavailability of post-harvest technology for the processing of coffee, pepper, cashew nuts are various impacts and restrictions to the economic development and securing of food security in the region. Hydropower plays such an important role in the socio-economic development of the area and sub-area.

Environment: The deforestation has reduced the forest coverage and resulted in soil erosion and flash floods. The role of watershed of Sesan and Srepok rivers, once degraded, will lead to erosion and sedimentation. The followed effects will be on the aquatic life and downstream river channel terrain in Cambodia and Lao. The water quality started to show signs of pollution due to untreated waste water from domestic use and industry. As a result, the BOD and COD are higher than allowed limitations.

Water source development: the water resource in the sub-area is rather abundant, i.e. 28 billion m³. Due to the fact that only 10% of this volume has been exploited, the distribution is not even by seasons and its upstream location and low level of water during the dry season, the extraction of water for agriculture has to be carried out through structures, i.e. regulation reservoirs. Local people drilled wells for extraction of underground water randomly and without any control which resulted in lowered water table.

Development opportunities and potentials

The potential water sources are abundant with capacity of 9,100m³/ha on average and per capita 31m³/person/per day. Hydropower development with total installation capacity of 2437Mw is the major advantage of the sub-area. Together with soil and climate characteristics, the sub-area also has advantages regarding the planting of long term industrial trees as coffee, pepper, rubber, cashew nut, cotton. The area is also endowed with favorable climate and topography for cattle raising.

Nearly 40 ethnic minority groups in the sub-area, namely E De, Ban A, So Dang, Gie Chieng having typical and unparalleled cultural identities which can be seen through the various festivals and primitive landscape will be the favorable conditions for tourism development, say, ecotourism and cultural tourism.

Development objectives

- a dynamic development with high and sustainable growth rate and protected ecosystem and environment.
- gradually improving the living standards and developing the strong and sound politics, equal and civilized society.
- Improving the international cooperation with neighboring countries

Development policy

The socio-economic development of the sub-area received the favorable support from the government in terms of development policy, specifically policy on poverty alleviation, policy on power and small hydropower development policy for remote areas, policy on the investment in rural infrastructure as transport, irrigation, policy on subsidy for forestation and protection, policy on price subsidy of coffee and other related policies on technology development in agriculture and industry.

The international cooperation in the sub-area is emphasized. The focus is the economic triangle of 7 provinces, in which 3 in Vietnam, 2 Cambodia and 2 Lao. The governments of three countries have agreements on the master plan of the above mentioned 7 provinces. The plan addresses the investment preparation in many fields as hydropower, transport, irrigation, healthcare, education and tourism. The bilateral cooperation between governments will be ever enhanced. The VNMC involves in all the bilateral and multilateral cooperation in the sub-area.

Conclusion

The analysis report of sub-area 7V will represent the basic factor in the formulation of a development scenario of the area. The report will also lay the foundation for the phase II of the Basin Development Plan.

I. INTRODUCTION

1.1. Background

Sub-area 7V covers catchments areas on Vietnam's territory of Sesan, Srepok and Sekong rivers with a natural catchments area of 30,840 km² accounting for 90%, 41.5 %, 71,3% and 13,4% of Kon Tum Province's, Gia Lai Province's, Dak Lak and Lam Dong Province's territories, respectively. Population of the sub-area is 2.4 million persons in year 2001.

In last 10 years (1991-2001), the sub-area economic growth rate is 11.5% which is higher than the national growth rate of 7%. However, due to high population growth rate, low starting point and 88% of local population living on agriculture, average per capita income of the sub-area remains low at 2.78 million VND per year which is ranked as poor compared to other regions of the country. It is projected that local population will increase to 3.5 to 4 million persons by year 2020 making considerable investments in the sub-area increasingly pressing.

The vision of the Basin Development Plan (BDP) is to contribute to acceleration of inter-dependent sub-area growth by establishing a process and a framework conducive to investment and sustainable development. The 95 Mekong Agreement defines the BDP as 'the general planning tool and process that the Joint Committee of the Mekong River Commission would use as a blueprint to identify, categorize and prioritize projects and programmes to seek assistance for and to implement the plan at the basin level'.

- *Objectives of BDP*

- + A basin planning process, including a regional development strategy, indicators, selection criteria, decision making and public consultation guidelines, a basic knowledge base and a data system.

- + A short-list of high priority projects with regional significance or trans-boundary benefits and impacts agreed by the four riparian countries, i.e. Thailand, Laos, Cambodia and Vietnam.

- *Scope of BDP*

The BDP will cover the key areas such as irrigated agriculture; watershed management; fisheries; hydropower; navigation, transport and river works; water-related tourism and recreation; water supply for domestic and industrial use; and flood management and mitigation and cross sectors such as environment, human resources development, socio-economy and community participation.

- *Coordination with other programs*

The planning for sub-area 7V in particular and BDP for Mekong lower river basin in general is an important program of the Mekong River Commission (MRC). Therefore planning for sub-area 7V will closely coordinate with water utilization programs (WUP), environment programs (EP) of MRC, at the same time it is also targeted to link the program with "Srepok Action Plans" funded by DANIDA, with the Capacity Building for Srepok River Basin Planning Program (DANIDA) funded by Danish Government, and with the 5 million ha of forest, agricultural and forestry transform in the Central Highlands, national

hydropower development, poverty reduction in order to establish an information base on the sub-area, priority order of projects and development potentials of the Central Highlands. A study team of 9 members from Institute of Water Resources Planning was established to carry out study and analysis of the sub-area. The Team maintains a collaboration and exchange with Vietnam Mekong River Committee in realizing the above mentioned task.

The integrated water resources planning and management will be applied to BDP. BDP will comply with the national policies for social and economic development, support development efforts, balance economic growth with socio-economic and environmental considerations. Public participation is a key element of the process, in order to ensure a broad acceptability, appropriateness of sectoral development objectives and strategies.

Institute of Water Resources Planning (IWARP) has key responsibility in implementing the study in cooperation with relevant agencies such as NIAPP, Energy Institute, Forestry Inventory Institute and localities (Provincial Departments of Agriculture and Rural Development, Provincial Departments of Science and Technology, Departments of Planning and Investments of Kon Tum, Dak Lak, and Gia Lai provinces). Work is to be monitored and guided by the National Mekong River Committee.

- *Approach*

BDP focuses on issues relating to the development opportunities, potentials and constraints raised in the development process of sub-areas. Implementation will be considered taking into account related issues, sectoral development plans of the sub-area, national programs and planning and particular requirements at national and sub-area levels. This approach will ensure the linkages between mainstream and tributary, and between sub-area issues and national issues as well as inter-national issues.

The planning process comprise of five stages:

- Stage 1: Sub-area analysis
- Stage 2: Development scenario analysis
- Stage 3: Strategy development
- Stage 4: Establishment of list of programs and projects, and
- Stage 5: Selection of prioritized programs and projects.

In carrying out the planning, a system of evaluation criteria to compare projects and programs as well as to select priority projects and programmes for the sub-area will be developed.

- *Organization*

The Study Team for the sub-area 7V comprise of 9 senior experts from Institute of Water Resources Planning.

1. Le Van Hoc – Deputy Director, Team Leader – Water resources planning expert
2. Dang Ngoc Vinh –Division Chief, Deputy Team Leader- Civil Engineering expert
3. Nguyen Dinh Chung - Member- Irrigation expert
4. Nguyen Xuan Phung - Member – Hydrological expert
5. Le Hung Nam - Member – Modeling expert

6. Lam Hung Son - Member- Environmental expert
7. Dao Xuan Thang - Member – Hydropower expert
8. Nguyen Thi Thu Thuy - Member- Economist
9. Pham The Vinh - Member- Database expert.

BDP formulation started in May 2002. Preparatory work was done with participation of the Vietnam National Mekong Committee, sectors such as water resources, agriculture, forestry, electricity, fishery, navigation and tourism and also with participation of the Strategy Institute – Ministry of Planning and Investment; Provincial Departments of Agriculture and Rural Development, Planning and Investment of Kon Tum, Dak Lac, and Gia Lai.

Mekong Agreement was signed on April, 5, 1995 with the participation of member countries including Cambodia, Laos, Thailand, and Vietnam. BDP project of MRC serves as base for cooperation among riparian countries in environmental protection, water resources development and in favor of common benefits.

BDP will contribute to strengthen sub-area cooperation aims to establish a process and a framework conducive to the investment and sustainable development. BDP will formulate a planning framework for development programs, aiming at the balance between effective natural resources utilization and environmental protection and promoting social equity.

1.2. Context and scope of the sub-area analysis

The Sub-area 7V is located in Sesan, Srepok and Sekong river basins covering 344 communes, wards and townships of 34 districts and cities of three provinces (Kon Tum, Dak Lak and Gia Lai). It has a population of some 2.4 million people and a natural area of 30,384 km².

The sub-area 7V covers 90% of the area of Kon Tum province, 41.5% of the area of Gia Lai province; and 36% of the area of Dak Lak province.

Estimation on total domestic water resources is estimated at some 27.8 billion m³ with an average area unit amount of 9,100 m³/ha and average per capita quantity of 31 m³/person/day.

Accordingly, discharges on an area unit are evaluated as average compared to the national values but per capita discharge is considered as rather abundant. The present demand for consumptive uses is less than 10 percent of the average flow of which most of the present demands are for irrigation.

Agriculture is the cornerstone of the economy in the sub-area. Approximately 70,110 ha or 26.5% of the area is cultivated with rice (mainly single rice) and 359,819 ha with perennial crops. Total cultivated lands being irrigated represent 86,000 ha of which 40,000 ha of coffee are irrigated with shallow groundwater sources. There are important potentials for water resources infrastructure development and irrigation expansion in the sub-area.

In view of fishery, current fishery yields of the sub-area are 5.6 thousand tons a year (mainly from aquaculture). In general, fishery is underdeveloped in the sub-area.

Forests in the sub-area 7V possess rich potentiality and account for 14.5% of forest areas of the country and the coverage rate is rather high at 53.2%. Unfortunately, deforestation rate is rather high, too. Proportion of uncovered and bare lands remains large (about 500,000 ha) that opens large room for forestation expansion.

The sub-area 7V is also rich in hydropower development potentials with an estimated energy of 4,019 MW including 2,480 MW from Sesan river basin; 1,539 MW from Srepok river basin. So far, two important hydropower plants (i.e., Ialy and Dray Hlinh) have been completed with total capacity of 732 MW.

Severe floods occur very often in recent years, for example in 1996 and 2000. The consequences are very extensive, in terms of human lives, production loss, and damage to infrastructure and private property. Flood management and mitigation is an important issue worthy to be studied in the planning.

Currently, 88% of the sub-area's population lives in rural areas. Population knowledge is low in general. Population growth rate remains high at 4.6% while mechanic growth rate is 2.1%. Poverty rate is rather high at above 25% in the sub-area.

Given opportunities and challenges exert direct impacts on the necessity of a BDP for the sub-area.

- Economic structural transformation in the sub-area promoted by the government in the direction to industrialization and urbanization, and trade-oriented agriculture has made water demands increased in the dry season.
- Population growth, especially uncontrolled migration involves increasing poverty rate.
- Poverty rate is still high in most rural and remote areas with unbalance between rural and urban areas. Food supply can not be ensured, cultivable lands are unstable, agricultural techniques, infrastructure such as roads, health care, markets and social services systems are very poor which constitute one of the reasons of poverty.
- Deforestation and unsustainable agricultural production are causes of negative environmental impacts, for instance, changed flows resulting in floods, inundation, droughts, sedimentation, channel erosion, etc to the downstream.

II. OVERVIEW OF THE NATIONAL AND CENTRAL HIGHLANDS ECONOMY

2.1. Economic growth

Despite declined economies, low economic growth rates of regional countries, Vietnam's economy still attains high growth rate, ranking at second of the East Asia, just after China.

Table 2.1 GDP growth in 2001 (%)

Region	GDP	Agriculture-Forestry-Fishery	Industry-Construction	Service
Nation	6.8	2.7	10.4	6.1
Central Highlands	11	7	17.7	12.6

Source: Vietnam's Economy 2001 and Strategy Institute

The above table shows a higher GDP growth rate in the Central Highlands compared to the national average.

- **Agriculture-forestry and fishery:** the national production values increase at its lowest rate of last 5 years, representing 2.7% a year for the nation as a whole and 7% for the Central Highlands. The year 2001 is marked with notable phenomenon in agriculture-forestry and fishery development. Several agro-products such as rice, coffee face difficulties in finding markets due to production surplus while sharply decreasing prices on the one hand. Some other agro-products as materials for processing industry (sugar cane, Soya-bean, cotton and milk) are imported on the other hand due to deficit domestic production. As a result, the role of the government is of extreme importance in grasping and processing market information, minimizing risks due to price fluctuation, appropriately supporting agricultural production and processing, and enhancing application ability of technological advances.
- **Industry and construction:** Industrial and construction values increase at 14.2% with non-state sector's increase of 20.3%, which is the ever highest rate and higher than the other sectors (state and 100% foreign investment sectors) as the most remarkable achievement. The results are attributed to great efforts in enforcing the Law on Enterprises and policies on domestic investment mobilization.
- **Services:** In 2001, services sector has known prosperity with highly added values of trade, hotels, restaurants, transport, post, and tourism. Let's take the tourism as an example, number of foreign tourists reached 2.3 million in 2001 and number of those to Central Highlands (Dak Lak, Kon Tum and Gia Lai) is 8070 accounting for 0.35%. This revealed a very low rate of foreign tourists to Central Highlands comparing to other regions of the country.

2.2. Economic structure

Data presented in the diagram showed a trend of slow structural transformation in Central Highlands compared to the nations. In last 10 years, industrial GDP share increased 1.5% while that of agriculture and forestry decreased 1.5% and services remain constant.

Table 2.2 GDP Share By Economic Sectors (%)

Item	Highlands			Nations		
	1990	2001	Change	1990	2001	Change
Economic structure	100	100	0	100	100	0
Agriculture-forestry-	66,70	65,17	-1,53	38,70	24.30	-14,40
Fishery	11,70	13,17	+1,47	22,70	36.60	+13,90
Industry-Construction	21,60	21,66	≈ 0	38,60	30.10	-8,50
Service						

Source: *Planning for agro-forestry structural transform of the Centra Highlands in period of 2002÷2010*

2.3. Economic sector

2.3.1. Agriculture

In 2001, agriculture of Central Highlands faces difficulties and gain results not as good as projected. The added values of the sector decrease to its lowest of last 10 years due to a main reason of declined prices of agro-products and frequent droughts occurred in the region.

However, agricultural economy is still developing in the region with a growth rate of 7% a year in the 1900-2001 period, which is higher than the national rate of 4.5%. Agricultural lands of 3 provinces: Gia lai, Kon Tum and Dak Lak occupy 990.62 thousand hectares (in 2001) representing 22.60% of the national agricultural lands. Perennial croplands cover 477,1 thousand hectares of which 354.50 thousand hectares of coffee (accounting for 62.7% of the nation), 96.5 thousand hectares of rubber (23.1% of the nation), 8 thousand hectares of pepper, and 13.8 thousand hectares of cashew. That increase agro-product export values from 30 million USD in 1990 to 296 million USD and working productivity increase respectively from 6.95 million VND to 10.83 million VND per labor per year.

It is noted that in 2001 agricultural structural transformation actively happen but spontaneously without basing on adequate market information or thorough long-term economic analyses. In particular planting and development of material crops such as sugar cane and coffee do not closely link to production, processing and markets.

Table 2.3 Agricultural Production Values (comparative prices of 1994)
(Billion VND)

Region	1995	1998	1999	2001
Nation	82,307.1	99,096.2	106,376.9	114,989.5
3 provinces	3,581.0	5,280.1	6,780.2	10,004.3
Percentage %	4.35	5.33	6.37	8.7

Source: *Statistical Yearbook 2001*

Statistical data of 2001 showed that areas of crops in the sub-area occupy big proportions of the nation, for instance, coffee 62.7%, cotton 52.7%, rubber 23% and pepper 22%.

Table 2.4 Cropping Areas in 2001

Crop	Nation (10 ³ ha)	3 Provinces: Gia Lai, Dak Lak, Kon Tum (10 ³ ha)	Percentage %
Annual paddy	7,492.7	148.3	1.97
Maize	729.5	89.9	12.3
Cassava	292.3	36.5	12.5
Cotton	27.7	14.6	52.7
Sugar cane	290.7	23.9	8.2
Coffee	565.3	354.5	62.7
Rubber	415.8	96.5	23.2
Pepper	36.1	8.1	22.4

Source: Statistical Yearbook 2001

Table 2.5 Existing Irrigation Structures (in 2000)

Region	Number of structures	Irrigated areas (10 ³ ha)
Nation	17,240	3,300.0
Sub-area 7V	580	46.2
Percentage (%)	3.4	1.4

Source: Report on Water Resources Development and Management Strategy 2010-2020

2.3.2. Forestry

In a long duration, forestlands of Vietnam unceasingly decreased from 14.3 million hectares in 1943 to 9.3 million hectares in 1993. Nevertheless forest areas have known a clear tendency of expansion in recent years, i.e. from 10 million hectares in 1998 to 11.36 million hectares in 2001

Table 2.6 Forest Lands in 2001 (10³ ha)

Types of forest	Nation	Central Highlands	%
Total	11,359.30	2,452.5	21.6
Natural forests	9,587.9	2,330.6	24.3
Planted forest	1,771.4	44.7	2.52
Uncovered and bare lands	7,699.4	882.9	11.5

Source: Statistical Yearbook 2001.

Forests play an extremely important role in Central Highlands not only for its watershed resources but also for its significance of economic development, national defense and ecological conservation. Existing forestlands are 2.4 million ha accounting for ¼ of the national forestlands and coverage rate of 53.2% higher than that of the nation of 35%.

However, forest management, especially forestland allocation and protection is poor. Approximately 73.3% of forestlands are allocated to farmers but there are not economic incentives to encourage forest owners to actively participate in forest protection, development and production without attention on forest crafts. As consequence, forests are largely cleared in Central Highlands representing 50% of national cut forests in 2001.

Table 2.7 Fired and Cut Forest Areas in 2001 (ha)

Item	National	Central Highlands	%
Fired forests	1,523.4	249.5	16.38
Cut forests	2,819.8	1,152.3	40.86
Total	4,343.2	1,401.8	32.28

Source: Statistical Yearbook 2001

2.3.3. Electricity

Total installed capacities of electricity plants of Vietnam are 8,750 MW, of which hydropower represents 48.8%, thermal plants 20.4%, gas turbines-diesel 30.8%. In last 10 years energy of Vietnam gains an average growth rate of 12%, production scale increases at 3.5 times reaching 26.594 million KWh. Average per capita electricity consumption raises from 113 to 341 KWh per year.

Energy structure strongly changed with a sharp increase of gas and diesel energy (from 5.4% in 1990 to 23% in 2000) and a gradual decline of hydro and thermal energy.

Table 2.8 Electricity Production Structure in 1990÷2000

Electricity producer	Unit	1990	2000
Total generated energy	10 ⁶ KWh	8,678	26,594
Growth rate	%	11.4	12
Per capita average	KWh/year	113	341
Hydropower	10 ⁶ KWh	5,374	14,547
Percentage	%	61.9	54.7
Thermal plants	10 ⁶ KWh	2,841	5,941
Percentage	%	32.7	22.3
Gas turbines and diesel	10 ⁶ KWh	465	6,105
Percentage	%	5.4	23

Source: General plan 5 (EVN)

Table 2.9 Comparison of Generated Power in 2000

	Nation	Central Highlands	%
Total generated energy 10 ⁶ KWh	26,594	4003,5	15.1%
Hydropower 10 ⁶ KWh	14,547	3,774.5	25.94%

2.3.4. Water supply

- Urban water supply

So far, all of 61 cities and provincial central towns of the country have been served by piped water systems with total water supplying plants of 241 and total design capacities of 2.96 million m³ per day. Proportion of population served with clean water reaches 50÷60% only with daily consumption of 60÷80 liters per person per day. Among 547 townships and towns, there are above 140 having water supplying systems with capacity of 164,000 m³ per day. In remaining townships, water supplying systems have been built but they are of small scale or treatment facilities are not yet completed.

Table 2.10 Existing Urban Water Supply

Region	Number of water supplying plants	Capacity 10 ⁶ m ³ /day	Supplying quantity l/day	Covering percentage%	Source
Nation	241	2,96	60~80	50~60	Surface and groundwater
Central Highlands*	5	0,077	60~70	50~60	Surface and groundwater

Source: Institute of Water Resources Planning

*: Central Highlands include 3 provinces: Gia Lai, Kon Tum and Dak Lak

- Rural water supply

In rural areas, clean water supply and sanitation have been provided since 1982 to part of the rural population thanks to international assistance, governmental investments as well as efforts made by localities and people themselves. So far, about 35-40% of rural population has access to clean water with supplying standards of 30-40 liters per person per day in forms of drilled wells, dug wells, storage tanks and simple gravity systems.

However, there are about 60 ~ 70% of rural population who are not yet served with clean water, even pollution is more serious. It is worrying that more than 70% of households do not have standard latrines.

- Industrial water supply

In the sub-area 7V, industrial growth rate is 20-21% a year whose proportion is approximately 9.5-10% of GDP. Main industrial sub-sectors such as agro-food and forestry processing, building material industries are of small scale. Establishment of concentrated industrial zones is not yet done, therefore water supply demands by the sector is insignificant.

2.3.5. Fishery

Fishery sector include different production sub-sectors such as catching, aquaculture and processing. However, fishery in Central Highlands mainly involves fresh water fish raising which is mainly done in ponds and lakes.

Table 2.11 Fishery Production Status in 2001

Item	Unit	Nation	Gia Lai, Kon Tum, Dak Lak	%
Aquaculture area	ha	775,177.6	4,234	0.56
Production	ton	709,891	5,638	0.79
Of which				
Fish production	ton	421,020	5,089	1.2
Shrimp production	ton	154,911	52	0.03

Source: Statistical Yearbook 2001.

In Vietnam, water surface areas which are usable for aquaculture are estimated at 1.4 million ha. By year 2001, around 755 thousand ha or 44.4% have been used for aquaculture providing an annual aquaculture production of 710 thousand tons in 2001.

The above table revealed that fishery is underdeveloped in Central Highlands. Nevertheless, among three provinces of Central Highlands, Dak Lak is the one having the most developed fish and shrimp raising.

Table 2.12 Existing Fishery Production in 2001

Item	Total	Of which		
		Kon Tum	Gia Lai	Dak Lak
Aquaculture areas (ha)	4,234	284.3	97	3,852.7
Production (ton)	5,638	588	84	4966
Of which – Fish (ton)	5,089	588	84	4,417
- Shrimp (ton)	52	0	0	52

Source: Statistical Yearbook 2001.

2.3.6. Tourism

Tourism in Vietnam in general and in Central Highlands in particular has known clear development, bringing considerable benefits to local population and contributing to socio-economic development of the country. In 2000, number of tourists to Vietnam is 2.14 million representing 5.6% of the ASEAN tourist markets with an average growth rate of 18.6% for the 1998-2000 period.

Table 2.13 Present Tourism Development

Item	Unit	Nation	3 provinces: Gia Lai, Kon Tum and Dak Lak	%
Number of tourists	10 ³ tourists	8,510.8	126.9	1.5
Turnover	10 ⁹ VND	9,185.2	82.19	0.9

Source: Statistical Yearbook 2001.

Comparing with other regions of the country, tourism in Central Highlands is underdeveloped. Tourist infrastructure such as hotels, restaurants, tourism services are very poor.

2.3.7. Navigation

The river network in Central Highlands is rather dense, local navigation is, however, not developed because rivers and streams are very steep with many cascades and waterfalls, besides water level in the dry season is very low causing difficulties for boat and ship access.

2.3.8. Flood control

Big floods usually occur in Central Highlands from October to November. In the period of 1996-2000, big floods happened in Sesan and Srepok river basins.

Table 2.14 Damage Caused by Floods

River basin	Year of occur	Number of people died	Inundated areas (ha)	Inundation duration (day)	Total loss (10 ⁹ VND)
Sesan	1996	16		3-:-6	72.6
Srepok	2000	25	12,000	60-:-90	122.4

In the river basins there are not any flood control structures.

III. ESSENTIAL STUDY OF THE SUB-AREA 7V

Analysis of economy of Central Highlands in comparison with the nation showed that forests, hydropower and perennial crops constitute strengths of the Central Highlands. Though following issues need to be solved in the socio-economic development process:

- Agriculture is the main economic sector. Initially a cash production has been established but it develops spontaneously facing difficulties in finding markets in addition to price fluctuation, and frequent droughts and floods.
- The sub-area possesses large forest areas and high forest coverage but deforestation is serious while bare and uncovered lands are large.
- The sub-area is rich in hydropower potentials but hydropower is slowly developing. Hydropower development should take into consideration of environmental impacts, especially transboundary impacts.
- Living conditions are poor, poverty rate is high in addition to low population knowledge and poor welfare infrastructure including roads, schools, electricity, health care, etc.

3.1. Development objectives, plans and policies

3.1.1. Goals

1. To create a dynamic development with high growth rate and sustainability and ecological conservation.
2. To gradually improve and enhance people' living standards, to establish a strong, healthy and stable political system, and a equal, democratic and civilization society.
3. To strengthen international cooperation with neighbor countries.

3.1.2 Development objectives of key sectors

Agriculture

To build up a fast growing and ecologically sustainable agriculture; apply diversification of crops and products aiming to meet domestic consumption and export demands.

It is targeted to gain a growth rate of 5.6% and 5% for the periods 2000 -2010 and 2010-2020, respectively.

Forestry

To concentrate on protection of existing natural forests, maintain and protect upstream protection forests, increase forest coverage to 65% and 70% by years 2010 and 2020, respectively.

Hydropower

To build 13 hydropower plants on Sesan and Srepok rivers taking into account transboundary impacts.

3.1.3. Development plan

Table 3.1 GDP Growth Rate

Phase	2001-2010	2010-2020
DP	10	7.5
Industry	16	11
Agriculture-forestry	7.8	4.5
Services	11.6	8.5

Source: Strategy Institute and Overview of 14 river basins (JICA)

3.1.4. Policies

1. Land policies:

- To complete land use planning, give use rights certificate for agricultural, forestry and residential lands.
- All kinds of illegal land purchase and transfer are prohibited.

2. Investments

- Water resources development
- Hydropower development
- Transport development
- Forest planting and taking care
- Employment and hunger elimination and poverty reduction
- Technology application and agricultural and forestry extension promotion

3. Price subsidy for coffee

4. House subsidy

5. Education and training

- Scholar fees, every contribution exempted, materials, books and notebooks supported.
- Every fees relating accommodation, meals, study for ethnic minority pupils at boarding schools fully covered by the Government.

6. Health care

Check-up fees at health care centers and clinics for ethnic minority people totally exempted.

3.2. Natural characteristics and water resources

3.2.1. Topography

River basins in sub-area 7V are in the West of Truong Son range. The topography of the area is lowered from north to south and from east to west. The north is a mountainous area with average height of 1200-1800m with Ngoc Linh peak as the highest point in the Central Highlands at its elevation of 2596m. High mountains surround the east and the south.

- Se san river basin: situated in a highland area with at elevations ranging from 400-2500 m, with sloping terrain in north-south direction. Mountains and hills are popular (making up to 93% of the natural area).
- Srepok river basin: The topography of the area is lowered from east-south to west-north. The terrain is complex whereas plains are mixed with valleys. In general, the basin can be divided into following types of topography:
 - + High mountains: are in the south and east-south of Daclak province, with average elevations ranging from 1000 to 1200m and high peaks namely as Chu-dang-Sin (2405m) and Chu-pan-Phan (2175m). Truong Son range runs through the district

- areas Krong Bong and Lak. In this region, the forest areas are numerous with steep slope and strongly divided terrain.
- + Highland: the highland is characteristic of waving plains and sloping terrain. This type of topography is found in two areas, namely Buon Ma Thuot highland and sub-areas (i.e. districts of Krong Buk, Krong Pach, Cu Mga) with average heights of 400-500m and Dak Nong highland in the west-south of Daklak province at the height of 700-800m.
 - + The Buon Ma Thuot highland is more even than that of Dak Nong. These highlands were formed from effusive basalt in pre-tertiary era. Weathered basalt rocks have formed a fertile red soil which is suitable for the planting of long term industrial trees.
 - + Low land area: including the even alluvial stretches along rivers. This type of topography is found mainly in districts of Lak, Krong Ana and Ea Soup. The area of Lak-Trap village runs along Krong Ana river from Lak lake, through villages of Trap and Triet to downstream, at the average elevations of 300-400m. The Ea Soup plain runs along two banks of Ea Soup stream and Ea Hleo, at the elevations ranging from 200 to 300m. This type of topography is ideal for the planting of rice, subsidiary crops and short term industrial trees.

The geographical location and topographical characteristics directly affect the climate and weather of the region which are characteristic of tropical features, i.e. hot and humid and the coolness of a highland area. This kind of weather proves to be suitable to the growth of different kinds of animals and facilitates the diversified economic development.

3.2.2. Climate

The regional climate is that of highland tropical monsoon regime. In general, the weather is divided in two distinct seasons. Firstly, rainy season from May to October sees the West south wind most of the time. Months with largest rainfall are July, August and September. The rain volume in this season makes up for 80-90% of yearly volume. The dry season lasts from November to April with reduced humidity and strong East-North wind, large evaporation and serious droughts.

Typical climatic characteristics of the region:

- 1- The outstanding features of temperature regime of sub-area 7V can be seen in the lack of cold weather and uneven temperature base with the insignificant difference in temperatures of various months and lowered temperatures according to the elevations. The annual average temperature is 22 – 23 oC. Months of lowest temperature are December and January with average temperature of 18-20oC. Months of highest temperature are April and May with average temperature of 24-26oC.
- 2- Annually relative humidity ranges from 82 to 85%. There are big changes in the temperatures in different time of the year. The changing processes coincide with that of rainfall and in reverse regarding that of temperature. The average relative humidity of the lowest month occurs in the months of February and April and in the highest months of September, October and November.
- 3- The evaporation measured by Piche tube is from 1000-1500mm/annually. During the dry period in March, the evaporation is highest whereas the smallest evaporation occurs in September, October and November which are also the months with largest rainfall.
- 4- Wind and storm:

The prevailing wind directions of the region change distinctly with seasons. The topography also has impacts on the changing wind speed and direction.

The main wind directions in the winter in Se san river basin are North or East North. They are West and West-South in the summer.

The main wind directions in the winter in Srepok river basin are west and south-west from May to September; east and south east direction from November to April.

The average wind speed at different locations is 1-2.5m/s. the average wind speed in winter months is greater than that in summer months. The average wind speed in winter months is 2- 5m/s and less than 3m/s in summer months.

Storms often occur in the east sea. Due to the role of Truong Son range as a wall, no storm has directly landed in the studied area. In the event of any storm, the blocking role of Truong Son range abates the storm and reduces the wind speed, forming a tropical low pressure and causing large rains in a large scale.

- 5- Rain regime: under the effect of rain regime of West Truong Son range and of regional topography, the average rainfalls in many years in the basin reach 1600-2000mm. In general, the rainfalls increase from the low area to higher one. In the wind catching side of the mountain, the rainfall is larger than in the wind sheltering valley.

The rainy season lasts from May to November which is the same time with the south-west wind. The rainfall in this period makes up for 80-85% of the yearly volume. The most of this occurs during months of August, September and October and makes up for 55-60% of the annual volume.

The variation of annual rainfall is great. The largest annual rainfall can be 1.5 to 2 times greater than the year with smallest rainfall.

* Flood characteristics

The different patterns of climate cause flood rain: big rains in Central Highlands are caused by the south-west monsoon wind and climatic turbulence in the East Sea. Due to the wind restricting ability of Truong Son Range, the area is not under the direct impacts of storms, low pressure and other climatic turbulences in the East Sea. However, these patterns of climate still cause big rains in the studied area even when they are abated. Highest volume of daily rainfalls are measured respectively stations in the region at Sa Thay (286mm), Kon Tum (41mm), Trung Nghia (135mm –in 1996).

3.2.3. Surface water resource

a. River system

The part of Me Kong river basin in sub-area 7V includes rivers of Se san, Srepok and Se Kong.

Se san river system: the major branch of Me Kong river with total catchments in Vietnam of 11620 km² and a main river length of 210 km (the part of river in Vietnamese territory). The main flow starts in Truong Son range at the height of 2010m. From the northern upstream of Kon Tum, the river runs in north-south direction. From Ialy waterfall to the border line, the river takes northeast – southwest way to merge Mekong at Stungtreng. The average height of the basin is at 737m with a mean gradient of 14.4%. The river density of the entire area is 0.38km/km² with winding coefficient of 1.45. Some of the large branches of the Se San river are namely Dakbla, Dakpsy, Sa thay and Lagrai.

- Dakbla river is I graded tributary with catchment area of 3050km² and the river length of 152km. The branch starts from Ngoc Co Rin range at the height of 2025m and runs in northeast – southwest direction and merge the main river flow of Sesan (river branch of Krong PoKo) at Sa Binh which is 16km away from YaLy waterfall downstream. The river network density of Dakbla river is 2.03km/km² and the river slope is 4%.
- Krong Po Ko tributary has a catchment of 3530 km² and a length of 121 km.

Srepok river system: the tributary of MeKong river with a catchment of 30600km² in which an upstream area 18.480km² is in Vietnamese territory. The average elevation is 570m and the river network density is 0.55km/km². The two affluents of the river are KrongAna and KrongKno.

- Krong Kno river starts at a mountain range with peaks of 2000m high. The river runs along the southern borders of Dak Lak province, then turn northbound and merge with Krong Ana river beyond Dray village. The total catchment area is 3920km² and the main river flow is 156km with a mean river slope of 6.8‰ and a river network density of 0.86 km/km². The length of river basin is 125km, a mean elevation of 917m and an average gradient of the basin of 17.6%.
- Krong Ana river is the confluence of big streams of Krong Buk, Krong Pach and Krong Bong. The total catchment area is 3960km² and the main river flow is 215km. The main flow runs in west-east direction. Along the river midstream and downstream is the lowland area which is frequently inundated during the flood season. The slopeness of river bed is not even, i.e. large branches upstream have gradients of 4-5‰ whereas downstream sections in Lak-Buon Trap only 0.25 ‰.
- In addition, rivers of Ea Hleo and Ia Drang in Dak Lak and Gia Lai provinces also merge into Sre pok river in Cambodia. Ia Hleo river starts at Ea Ban peak at the height of 720m in Dle Yang commune of Ea Hleo district in Dak Lak province. The river of 143km long runs through two districts of Ea Hleo and Ea Soup before merges in to Ea Lop river 1km from border between Vietnam and Cambodia and then merges again into Srepok river in Cambodia territory. The catchment area of Ea Hleo is 4760 km², belonging to territory of two provinces of Dak Lak and Gia Lai. Ia Drang river begins in mountain ranges of 700m high. The river length is 78km with a catchment area of 977 km².

Se Kongriver system: Se Kong river in sub-area 7V has a catchment of 284 km² in the administrative area of Kon Tum province.

b. Surface water hydrology

* Annual flow : depends on the rainy regime, vegetation cover of the basin and under the effect of topography. The annual flow changes temporally and spatially. The water volume of this area is normal with specific runoff of 25 -35 l/s/km².

- + Spatial change of water source : by space, the annual flow is rather abundant in mountainous area and in wind catching sides as in the upstream of Sesan river. Here, the specific runoff of annual flow can reach 35-40 ls/km², in river basin of IA Drang 30-35 l/s/km², and in other areas 20-25 l/s/km².
- + Se san river basin with a catchment area of 11,450 km², annual flow of 408 m³/s with relevant specific runoff of 35.6 l/s/km² and total annual flow of 12.9 billion m³. The main stream of Sesan at Sa binh, the catchment area is limited to 6732 km², which is 14km away from the confluence of Prong Po Ko and Dak bla. The average flow in many years is 240 m³/s with relevant specific runoff of Mo=35,6 l/s/km².

- + In the catchment area of 12,300km² of Srepok river basin, the annual flow is 286 m³/s with total annual discharge of 9.0 billion m³ of water.
- + In the catchment area of 10,700 km² of Srepok in Don village, the average annual flow is 258 m³/s with with relevant specific runoff of 24,1 l/s/km².
- * Catchments of Ea Hleo and IA Drang have a total area of 5737 km², annual flow 163,5 m³/s, total annual discharge 5,2 billion m³ of water and a relevant specific runoff of 25 l/s/km².

Table 3.2 Characteristics of Water Resource in the Studied Area

River basin	Location	Catchment area (km ²)	Qo (m ³ /s)	Mo (l/s/km ²)	Wo (10 ⁹ m ³)
- Se san	Entire basin	11450	408	35,6	12,9
+ Dak Bla	TV. Dak Bla	2968	96,9	32,6	3,06
+ Krong Po ko	Entire basin	3530	126	35,7	3,97
+ Main flow of Se san	Sa Binh	6732	240	35,6	7,56
- Ia Hleo + Ia Drang	Entire basin	5737	163,5	25	5,2
- Sre pok	Entire basin	12743	307,1	24,1	9,69
+ Krong Ana	Giang Son	3180	72,8	22,9	2,30
+ Krong Kno	Duc Xuyen	3080	106,3	34,5	3,35
+ Sre pok	Cau 14	8610	232,3	27,0	7,33
+ Ban Don	Ban don	10700	258	24,1	8,14
Total					27,8

Source: Institute of Water Resource Planning

- The annual flows in many years change greatly. The high water year saw a discharge volume of 1.5 – 2 times greater than the average values in many years. The high water year also saw a discharge volume of 1.5 – 5 times greater than the year with lowest discharge volume.
- Distribution of annual flow: the annual flow is the product of climate and plant cover. As a result, the distribution of annual flow is similar to that of rainfall. There are high flow season and low flow season in equivalent to rainy and dry seasons. However, due to the regulation activities of the basin, the high flow season often comes 1 to 2 months later than the rainy season. In the 7V region, the flood season starts in July or August until November or December and the low flow season the remaining months. The total annual discharge concentrated in the flood season with the discharge makes up for 70-80% of the total annual volume, whereas only 20-30% occurs in the low flow season.

* High flow

- Flood regime: the floods on rivers in 7V sub-area vary unexpectedly.
- + Se san river: the river is under the impacts of flood regime of two tributaries of Krong Po Ko and Dak Bla. However, the flood regimes of these two rivers are different from each other.
- + Krong Po Ko river is under the climate effect of west Truong Son Range with the flood season starts in June and ends in November.
- + Dak Bla river is under the climate effect of East Truong Son range which means the flood seasons start and end one month later than those in Krong Po Ko river.

Annual big floods in Se san river often occur in October and make up for 43-45% of the total. Floods in Dakbla river come at the same time as ones in Sesan at Sa Binh. Floods in Krong Poko river come earlier than those in Dakbla river which means that the area of Kontum is usually inundated as floods in Dakbla river meet the one in Krong Poko river coming earlier than expected.

According to statistics of floods in years from 1977 to 1997, big floods in Krong po Ko and Dak Bla river occur virtually at the same time and concentrate in months of October and November.

- Srepok river: floods in the basin change greatly. At the same hydrological station, a flood may occur 2-3 months earlier or later in certain year. This results in different durations of annual floods. In some year, the flood season may last for 2-3 months or 5-6 months in the other which reflects the instability of the seasons in the basin. In years when south-west wind becomes strong right the beginning of rainy season (every May), flood season in the basin occurs earlier. Towards the end of rainy season if coincided with typhoons and low pressure from South China Sea, flood season durations will be longer.

Regarding the monthly discharges in a year, the flood seasons are observed as follows at hydrological stations:

- + In Krong Ana river at Giang Son, there is 4 month-flood season which lasts from September to December. The flood discharge in this period makes up for 67.0% of the annual discharge. Month with largest discharge is November in which the discharge makes up for 21.2% of the annual discharge.
- + In Krong Kno river at Duc Xuyen hydrological station, the flood season lasts for 4 months from August to November in which the discharge make up for 61,6% of the total annual discharge. October is the month with largest discharge in which the discharge makes up for 19.2% of the annual discharge.
- + In Srepok river at hydrological station of Bridge 14 the flood season lasts for 5 months from August to December in which the discharge makes up for 69.6% of the total annual discharge. October is the month with largest discharge in which the discharge makes up for 18.3% of the annual discharge.

The largest flood events in Krong Ana river often occur around 1 month later than in Krong Kno river (for the Krong Ana river basin is affected by the climate of East Truong Son range). The earlier start of floods in Krong Kno river results in the flood inundation in the downstream of Lak-Buon Trap as they meet floods in Krong Ana river and the flood drainage is inefficient, causing long term flooding and water logging.

Discharge of flood peak

In recent years, the increased incidence of floods in river basins in sub-area 7V with extremely large floods have resulted in enormous damages as ones in 1992, 1993, 1994, 1996, 1998, and 2000.

- + Sesan river: In the branch of Dakbla, the biggest flood has $Q_{\max} = 3,620\text{m}^3/\text{s}$ on 3rd November 1996. However, the historical flood is the one in October 1972 with $Q_{\max} = 4,320\text{m}^3/\text{s}$. The main flow of Sesan is the confluence of two rivers with the largest 7-day-discharge in Dakbla river making up for 47.1% of total flood discharge in Se san river at Sa Binh, the remaining is in Krong Po ko river.

- + Sre pok: the biggest flood in river of Krong Ana has $Q_{max} = 1,620\text{m}^3/\text{s}$ (on 22nd November 1998), in Krong Kno river $Q_{max} = 4,020\text{m}^3/\text{s}$ (10th October 2000). The largest flood in the downstream of Srepok river at Bridge 14 has $Q_{max} = 3600\text{m}^3/\text{s}$ (on 12th October 2000).

The total flood discharge

- + In Se san river basin, the durations of floods are 7 to 10 days. The total maximum 7-day- flood discharge corresponding to 5% frequency is 536 million m^3 at Kon Tum station. The typical statistical results of total flood discharges at Kon Tum station are listed in below table.
- + In Srepok river basin, due to the topographical features, the floods often lasts for 10-15 days, resulting in the inefficient flood drainage and long term flooding and water logging.

See the typical statistical results of total flood discharges at different stations in the Annex 1C.

Flash flood

Flash flood is a kind of big flood which happens suddenly and in a very short time causing enormous destruction. Flash flood is caused by local rain with high intensity and concentrated in a small area and in steeping terrain. It also occurs in areas where the forest cover has been largely damaged or where there are structures restricting flows or in the event of broken dams.

Due to the fact that the watersheds have been seriously destroyed and left barren, and during the dry season, draughts have caused the soil layers to become bare. As a result, these soils fail to keep moisture and are strongly eroded in the event of large rains. Moreover, the underground water penetrates into cracked and weathered soil and rock layers, causing land collapse. The streams themselves are flows of sand and mud which wash many villages away. Flash floods often occur in high mountains and in remote areas in central Highlands where most of the population are minor ethnic groups.

In recent years, there are more flash floods which are followed by great damages in terms of property and people. They are:

- + Se san river: Flood on 3rd November 1996 with maximum one-day rainfall measured at Dak Gley of 197,4 mm, at Dak To Ve 159,0 mm, the flood peak discharge observed at station of Dak Bla is $3620\text{ m}^3/\text{s}$ with $M_{max} = 1,22\text{ m}^3/\text{s}/\text{km}^2$.
- + Sre pok river: in Krong Kno river in 2000, there occurred an extremely big flood with flood peak discharge of $4020\text{ m}^3/\text{s}$ which was measured at Duc Xuyen and a specific flood discharge $1,31\text{ m}^3/\text{s}/\text{km}^2$.

Low flow

The low flow season lasts from December to June with the low flow of making up for 20-30% of the annual discharge. The lowest flow time falls in March and April, the specific discharge of monthly low flow is 10-15 $\text{l}/\text{s}/\text{km}^2$, and that of daily low flow is only 3-5 $\text{l}/\text{s}/\text{km}^2$, and even 1 $\text{l}/\text{s}/\text{km}^2$ at some locations such as Don village, Giang Son, Dak Nong... The small low flow results in lower water levels in rivers and streams. Most of the rivers and rivulets are shallowed, causing serious draughts. The years with typically hard draughts are 1994, 1996, 1998 and 2003.

3.4.4. Underground water

Underground water in sub-area 7V in particular and in the Central Highlands in general exists in two forms, namely porous aquifer and fissure aquifer.

Porous aquifer s

- Holocene sediment aquifer (Q_{IV})
- Pleistocene sediment aquifer (Q_{I-III})
- Neoga sediment aquifer (N)

Fissure aquifer

- Mid bazan Pleistocene aquifer (Q_{II})
- Lower bazan Pliocene - Pleistocene sediment aquifer (N₂-Q_I)
- Upper creta sediment aquifer (K₂)
- Lower-Mid Jura sediment aquifer (J₁₋₂)
- Aquifer in Upper Proterzoi Metamorphic rock P₁₂₃

In addition, there are small areas of water poor formations and waterless formations scattered in the north-west edge of Buon Ma Thuat highland and in the east of Dak Nong highland.

According to investigation, the total underground water storage in 7V sub-area is 25,5 million m³/day, with the active storage of 15,6 million m³/day. The underground water has been exploited to the limitation level. The water table has been much lowered compared to the time prior to 1990.

Underground water is a very precious resource, especially to provinces in 7V sub-area and the Central Highlands. This water source plays such an important part to the economy and livelihood of the local people. Therefore, it should be managed and conserved so as to ensure proper exploitation and to prevent the negative impacts of human and natural activities and processes. In recent years, due to the changing weather, the careless activities of well digging for watering the coffee trees have seriously affected the water table for inappropriate drilling. Another important reason for the exhausted underground water is the deforestation. According to observation data of geological and hydrological team No 704 in Dak Lak made in 1998, the water tables in many locations have been lowered by 1.27 m compared to the year 1994, even by 1.05m in some others (e.g. Krong Ana town) and by 2.4m (in Dak Mil). On the other hand, underground water and surface water are intertwined. As the surface water is exhausted, the water table is also lowered to a deep level. Especially in 1998, in some investigated areas as streams of Krong Buk, Krong Pach, as the stream flow become as less as 1 m³/s , even wells having depths of 20 to 30m failed to have water in.

In order to meet the demands on water resource development, there should be study on exploitation and management approach so that we can ensure both adequate supply and proper conservation of this precious resource.

In conclusion: the 7V sub-area has such a great potential regarding the natural conditions. This area has fertile bazan soil and favorable natural conditions which are suitable for the development of industrial trees. However, for the water source of the area is unevenly distributed annually and most of the resource is concentrated in the flood seasons whereas the low flow only makes up for 20-30% of the annual discharge, the water exhaustion

become prevailing throughout the dry months. Therefore, it is necessary to enhance the afforestation and forest coverage. It is also recommended that the study on construction of reservoirs to ensure the water storage and supply for different demands of socio-economic development should be considered.

3.3. Socio-economic situation and water use information

3.3.1. Social situation

- *Population*

- Population of the study area is approximately 2,400,000 persons in 2001. Average population density is 79 persons per km², but unevenly distributed. Large population live in cities and towns, for instance population density is 977 persons per km² in Buon Ma Thuot, 769 persons per km² in Pleiku, and 284 persons per km² in Kon Tum town. In contrary, population in mountainous districts live scattered like in Sa Thay district with 11 persons per km², in KBang 29 persons per km².

Table 3.3 Area and Population of the Study Area in 2001

Province	Area (km ²)	Population (10 ³ person)	Density Pers./km ²	Urban population (person)	Rural population (person)	Population growth rate 95-2001 (%)
Dak Lak	19,599	1,901.4	97	389.3	1,512.1	5.3
Gia Lai	15,496	1,019	67.8	283.6	735.4	3.8
Kon Tum	9,614	338.7	34.3	107.5	231.2	3.26
3 Provinces	44,709	3,259.1	73.4	780.4	2,478.7	
Sub-area 7V	30,384	2,400	79.6	647.7	1,752.3	4.6
% of 3 provinces	68	74		83	71	

Source: Compiled from Statistical Yearbook of Gia Lai, Dak Lak and Kon Tum provinces

- Population growth rate for the 1995-2001 period is 4.6% which is much higher than the national average of 1.49%. Natural growth rate on population in the sub-area is 2.5 % meanwhile the mechanic population growth rate of 2.1%. Mechanic migration, mainly spontaneous migration increasingly happens in recent years being one of the reasons causing deforestation for cultivation that destroy land use and water resources planning
- *Ethnic peoples*: Communities of local ethnic peoples living in the sub-area include 40 ethnics, i.e. Kinh, Ba Na, Gia Rai, Xo Dang people, etc... of which Kinh peoples represent 58%, and other groups 42%. In general ethnic minority groups have known advancements with more experiences in cultivation of irrigated paddy, coffee, industrial crops but their knowledge remain low, self-finance capabilities are poor. Ethnic minorities live in separate communities in hamlets and villages which have been last for long.

- *Labor and employment*

- Population at working age range accounts for 1,257,000 persons or 52% of total sub-area population. The working population mainly lives on agriculture and forestry with 88% while the remaining 12% live on non-agricultural occupations. Broadly, labor forces of the sub-area largely represent but their skills and qualifications are limited. Number of graduate or post-graduate labors accounts for 3.5% only, number of intermediate and

technical workers for 20%, and manual labors for 76.5% and most of them are agricultural labors.

- *Living conditions*

Average per capita incomes are low at 2.78 million VND / a year. Poverty rate is 25%. Poor households are mainly found in rural areas and in ethnic minority community.

Poverty situation is much improved but living conditions still are poor. Majority of population is poor and lack social welfare facilities such as roads, schools, electricity, clean water and health care. According to statistic data, 97% of communes are accessible by cars, 97% of communes have primary schools, 97% of communes have health care centers; 97% of commune has access to electricity, 50-60% of urban population and 30-35% of rural population is served with clean water.

3.3.2. Economic situation

- *GDP*

Total domestic products of the sub-area are estimated at current prices at 6,594 billion VND (or 430 million USD approximately) in 2001.

Table 3.4 GDP in 2001

Province	GDP 10 ⁹ VND	Per capita GDP 10 ⁶ VND	Agri.-For.- Fis			Ser.		Growth rate 1995-2001 (%)
			(%)			Cons- Ind.		
Dak Lak	5,135	2.7	63	12	25		12.7	
Gia Lai	2,871	2.81	58	18	24		11.0	
Kon Tum	960	2.83	45	16	39		10.8	
Total	8,966							
Sub-area 7V	6,594	2.78	60	14	26		12.0	

Source: Synthesis from Statistical Yearbooks of Gia Lai, Dak Lak and Kon Tum Provinces

GDP growth rate is 12% in the 1995-2001 period which is much higher than the national rate of 7%. However due to high population growth rate and low starting point of localities in the sub-area, people living conditions are very poor, per capita GDP is 2.78 million VND a year.

Table 3.5 Economic Structure during 1995 –2001 (current prices)

Item	In 1995		In 2001	
	Values (10 ⁹ VND)	Share (%)	Values (10 ⁹ VND)	Share (%)
Total GDP	5,457	100	8,966	100
Agriculture-Forestry- Fishery	3,569	65	5,380	60
Industry-Construction	639	12	1,255	14
Services	1,249	23	2,331	26

Source: Synthesis from Statistical Yearbooks of Gia Lai, Dak Lak and Kon Tum Provinces

In last 5 years, economic structure of the sub-area has been slowly changed, agricultural share relatively decreases compared to other sectors but it still constitutes large parts. Industry and construction nearly don't change and represent low share.

- *Agriculture-forestry and fishery sectors*

Agriculture and forestry are main economic sectors of the sub-area with a gross product of about 3,956 billion VND, accounting for 60% of total GDP of which agriculture represents 91%.

In agriculture alone, cultivation contributes the biggest share of 86%, followed by livestock (11%) and agricultural services with 3%. Agricultural structure transformation is slow, cultivation remains the key. Thanks to advantages of natural conditions and natural resources (lands, climate, etc), a large-scale industrial concentrated agriculture has been established in the sub-area with key products such as coffee, tea, rubber, pepper, cashew and cotton. Despite conditions are not favorable for irrigated rice, provinces in the sub-area still develop irrigated paddy and partly ensure their food self-sufficiency.

- *Industry – construction sectors*

Industrial and construction growth rate was 15% in past 5 years. However, industry and construction is still underdeveloped. Industrial and construction products account for 14% of total sub-area incomes only. Main industrial sub-sectors include agro-forestry processing of coffee, rubber, tea, cashew, cassava, timber, handy craft, plywood, joined wood, building materials, etc...

- *Services*

Incomes from services represent 26% of total GDP. Average growth rate is 13% for the 1995-2001 period. Main service activities are exportation of agro-products such as coffee, rubber, cashew, pepper, bee's honey, processed timber, importation of fertilizers, steel, agricultural machines, and services relating to tourism, hotels, restaurants, etc.

- *Key socio-economic issues*

- Unevenly distributed population, divers ethnic groups
- Low people knowledge, poor living conditions, high poverty rate, sharp difference between urban and rural living conditions, between Kinh peoples and other ethnic minorities.
- High migration rate, continuous shift cultivation and settlement, uncontrolled deforestation resulting in negative impacts on ecological environment of the sub-area.
- Poor infrastructure and deficient services can not meet production requirements
- Unbalanced economic structure, high shares of agriculture and forestry while industry and services underdeveloped.

3.3.3. Water-related economic sectors

(1) Agriculture

- *Land use*

Total natural areas of the sub-area cover 3,038,400 ha. In 2001, used agricultural lands are 676,385 ha accounting for 22% of total natural areas.

- Annual croplands are 264,465 ha, of which 70,110 ha of paddy. In recent years, paddy areas remain unchanged meanwhile annual croplands increase mainly due to expansion of subsidiary and annual industrial crops.

- Perennial croplands are 359,819 ha representing 75% of perennial croplands of 3 provinces and have known a tendency of rapid increase in recent years, however land use is not very appropriate or not pursuant to the planning, for instance, coffee trees are grown on forestlands or on other unsuitable or less suitable lands.
- Non-used lands are large with 609,050 ha which mainly are hills or mountains. There is large room for agricultural and forest land expansion but important investments are required in order to well exploit the potentials.

- **Cultivation results**

Cultivation sub-sector has known significant development since 1995. Sown areas increased from 350,928 ha in 1995 to 609,050 ha in 2001. Cultivation sub-sector is the one having highest commodity values representing 86% of total gross products of the sector and 35% of total sub-area products.

Food crops

- Food production focuses on 2 main crops, i.e. rice and maize. In recent years from 1995-2001, sown areas of food crops added more 26,315 ha. Sown paddy areas increase insignificantly thanks to water resources investments, mostly for the winter-spring crop (with 6,806 ha) because the crop brings up higher yields (5.0-5.5 tons per ha), but sown areas are limited compared with paddy areas of the sub-area (24,783 ha with 69,270 ha). Meanwhile areas of autumn paddy reduced 5,101 ha in consequence of decrease of low yields upland paddy areas.
- Second to paddy, maize is fast developing in the sub-area. Maize area increased 24,610 ha more from 18,917 ha in 1995 to 43,527 ha in 2001. At present, hybrid maize varieties of high yields are largely grown supplying animal feeds.
- Total food production is 506,520 tons averaging 213 kg per capita per year. Foods are locally consumed, only maize is exported to other regions for animal feed factories in South-East and South Central.

Annual industrial crops

- In 2001, short-term industrial croplands occupy 55,379 ha. Main industrial crops are cotton, sugar cane, Soya-bean, cigarette, sesame, etc.
- Industrial crops have robustly developed in recent years in both cultivation areas and growing areas. Growing areas increased from 34,609 ha in 1995 to 55,379 ha in 2001 (20,770 ha more). Among industrial crops, sugar cane increased 4,624 ha more, and especially for cotton from 1,725 ha in 1995 to 13,746 ha in 2001 mainly in Srepok river basin and cotton has become the main industrial crop of the sub-area.

Perennial industrial crops

- Agricultural predominance of the sub-area is perennial crops including coffee, rubber, and pepper as key crops for commodity production and export.
- In 2001, total perennial croplands of the sub-area are 354,079 ha which is double that of 1995, in particular coffee areas added 145,735 more to that in 1995 making the present 259,974 ha and averaging an annual increase of 24,289 ha. Due to sudden increase and monoculture of coffee, declining prices of coffee cause serious effects on people' life. Beside coffee, rubber has also known increase of growing areas with 43,540 ha more meanwhile tea has tendency to decrease its growing areas.
- Yields of perennial industrial crops: on average coffee gained 1.9 tons and above 2.0 tons per ha in 1995 and 2001 respectively, Dak Lak province has the highest coffee yield of more than 2.2 tons per ha.

- Production in 2001, coffee: 339,452 tons, rubber: 50,463 tons, tea: 2,974 tons, pepper: 6,438 tons, and cashew: 4,387 tons.

Summary

- Cultivation sub-sector has known strong development in last 5 years, growing areas increased 1.7 times of that in 1995. High value industrial crops being developed fast include coffee, rubber, sugar cane, cotton that constitute key factors to promote economic development of the sub-area.
- However, cropping intensity is low (0.98 a year for annual crops), only single crop is practiced in the rainy season. Over development of several crops such as coffee raises issues relating product quality, markets, land use, spontaneous migration, water supply, etc.

• Drought situation

Droughts frequently occur in last years, especially in years 1994, 1996, 1998 and most recently in 2003.

Table 3.6 Areas Affected by Droughts in 1998 (ha)

Province	Autumn rice		Winter-spring rice		Perennial industrial crops	
	Droughty	Fully lost	Droughty	Fully lost	Droughty	Fully lost
Kon Tum	14,036	1,217	13,837	1,199	678	233
Gia Lai	8,884	3,226	13,444	7,986	3,418	1,770
Dak Lak	0	0	6,727	2,363	51,965	31,965
Total	22,920	4,443	34,008	11,548	56,061	33,968

Droughty areas in 2003: According to inadequate statistics, there are about 40,400 ha of coffee being droughty in Dak Lak province in the dry season resulting in an estimated loss of 277 billion VND.

• Water requirements

Water requirements of crops in 2001 are estimated at 2.8 billion m³, mainly fallen on the dry season from December to May.

Total run-off of local rivers and streams reach 27.8 billion m³, of which water discharges in dry months (from December to May) represent 5 billion or 20% of annual discharges. Groundwater reserves in the sub-area are evaluated at 25.5 million m³ per day in equivalence to 9.3 billion m³ a year.

Accordingly, water requirements for agriculture account for 10% of total run-off only. However, agricultural water requirements represent 56% of discharges in the dry season, it will, therefore be unsecured exploiting basic flows with pumping stations and weirs and it may cause significant impacts on dry flows in downstream. Water supplying solutions for Central Highlands in general and for the sub-area 7V in particular is to build reservoirs to regulate water discharges.

• Existing irrigation structures

According to inventory, there are 580 structures of different types and scale in the sub-area 7V, including:

Se san river basin: 238 structures, comprising:

- 61 small and medium reservoirs with design irrigation capacity of 9,139 ha
- 177 small weirs with design irrigation capacity of 12,961 ha

Total design irrigation capacities of existing structures are 22,100 ha, and 16,010 ha are irrigated. Existing structures are of small and medium scales, with following notable structures:

- Dak Uy reservoir built in 1975 has a catchment area of 82.8 km² and storage capacity of 23 million m³, design irrigation capacity of 4,320 ha, irrigated areas of 300 ha of paddy and 1,400 ha of coffee. The reservoir performs a limited irrigation capacity because of unfavorable topography of the beneficiary areas resulting in difficulties in expanding irrigation area.
- Bien Ho reservoir built in 1979 has a catchment area of 38 km², storage capacity of 42 million m³, design irrigation capacity of 2,300 ha, irrigated areas of 1,625 ha, and domestic water supply for Plei Ku town. Existing headwork and canals are in good conditions.
- An Phu weir has designed irrigation capacity of 400 ha, and really serves 380 ha of paddy.

Srepok river basin: 342 structure, including:

- 205 reservoirs with design irrigation capacity of 31,563 ha.
- 137 small weirs and pumping stations with design irrigation capacity of 13,357 ha.

Total design irrigation capacities of existing structures are 44,920 ha, of which 30,170 ha are actually irrigated. Following are considerable structures:

- Lower Krong Buk reservoir has catchment area of 38 km², storage capacity of 3.2 million m³, design irrigation capacity of 2,001 ha, of which 1,500 ha are irrigated.
- Ea Nhai reservoir has catchment area of 21 km², storage capacity of 8.1 million m³, design irrigation capacity of 2,600 ha, of which 2,500 ha irrigated.
- EaKao reservoir has catchment area of 76 km², storage capacity of 14 million m³, design irrigation capacity of 1,200 ha including 870 ha actually irrigated.
- Chu Kap reservoir has catchment area of 11.2 million m³, design irrigation capacity of 3,500 ha of which 2,800 ha are irrigated.
- Buon Triet reservoir has catchment area of 32 km², storage capacity of 25 million m³, design irrigation capacity of 1,800 ha, including 450 ha actually irrigated.

Existing structures in the sub-area 7V have design irrigation capacities of 67,020 ha of which 46,180 ha or 68% of design capacities are served.

Besides, about 40,000 ha of coffee are presently irrigated with shallow groundwater sources.

Total irrigated areas reach 86,180 ha accounting for 17% of annual croplands and coffee areas. Remaining coffee areas are irrigated by farmers themselves with basic flows from local rivers, streams and shallow groundwater sources that result in prolonged drying up of rivers, streams and droughts in last years.

Summary

Existing structures can not satisfy production requirements. Most of existing structures are weirs mainly exploiting basic flows. Water resources exploitation is not adequate, irrigation efficiency is low, areas served with stable irrigation are limited, and droughts occur more frequently.

Reasons of low irrigation efficiency:

- Water resource: most of the existing structures are weirs or small reservoirs with low regulation capacity. The ruthless wood cutting and unplanned coffee planting have resulted in exhausted water resource.
- The management and maintenance of hydraulic works are not efficient, especially small structures under the management of districts and communes. Many of them are not repaired in spite of their damages and degradation.
- The irrigation technology is out of date. The inundated irrigation will lead to the waste of water.

• **Livestock husbandry**

One of the strong points of the studied area is the raising of cattle. Beside the large area of grass, nearly 2 million ha of forest is such an advantage for the livestock husbandry. However, the livestock of the region is scattered, i.e. in households. By the year 2001, the quantity of cattle and poultry is as follows:

Table 3.7 Number of Cattle Heads in 2001 (Heads)

Livestock	3 provinces of CH	Sub-area 7V
Buffalo	50898	35214
Cow	466138	268938
Pig	923763	626598

Source. Provincial Statistical Yearbook 2001

Livestock growth rate is very limited, its scale and quality are poor too, otherwise consumption markets are not yet found.

• **Constraints in agriculture and water use**

In past years, agriculture of Central Highlands in general and of sub-area 7V in particular has known fast and continuous development which play an important role in sub-area economic structure. Nevertheless there exists following constraints:

- Fast but unsustainable agricultural development, agricultural production dependent too much on nature and markets, only single crop practiced in the rainy season, unsecured cropping schedule, low crop yields due to frequently menaced by droughts.
- Product yields and quality as well as competitiveness are poor, processing industries and post-harvest technologies are limited. Products are of rude forms facing difficulties in consumption.
- Planning and management are inadequate. Agricultural planning does not coordinate with other sectors such as water resources, forestry, industry and services. Mass development of specific crops results in inappropriate land and water use. Too large

areas of coffee and monoculture of coffee cause declining prices and strongly impacting producers.

- Infrastructure serving agricultural production is poor, especially hydraulic systems can not yet meet production requirements.
- Water resources are abundant but unevenly distributed, mainly fallen in rainy season. Flows in dry season are exploited at 56% resulting in flow drying up and frequent droughts.
- Mass development of coffee involves overexploitation of groundwater resulting in regression and drying of groundwater resources.
- Changes in land use (due to uncontrolled migration, development not pursuant to planning), changes of consumption prices and markets resulted in changes of water requirements and causing difficulties for water resources planning and management.

(2) Forests

Forest areas in the sub-area 7V are mainly found in watersheds of Sesan, Srepok river basins and at estuaries of IaDRang- IaHLeo, Srepok and SeSan rivers flowing into Cambodia and Laos.

Forest areas in year 2001: 1,649,892 ha

- Natural forests: 1,589,547 ha
- Planted forests: 34,855 ha
- Growing and nursery forests: 25,490 ha

Despite the sub-area has an average coverage of 53.2% which is rather high compared to other region of the country, forest coverage of watersheds are too low comparing to requirements.

The sub-area is one of the regions having highest forest coverage of Vietnam. However, shift and burnt cultivation and uncontrolled deforestation continue happening. In 1995-2001 period, lost forests due to fires and cutting are estimated as follows:

Table 3.8 Damaged Forest Areas (ha)

Province\Year	1995	1996	1997	1998	1999	2001
Dak Lak	555	4644	2671	1889	2243	979.2
Gia Lai	1235	2104	159	482	194	140.8
Kon Tum	3332	295	815	234	165	281.8
Total	5122	7043	3645	2605	2602	1401.8

Source: Provincial Statistical Yearbook 2001

Annually 2,000 -7,000 ha of natural forests are lost. Newly grown forests increase slowly accounting for 10 -15% of annually cut forests. Forest coverage reduced from 60% in 1990 to 53.2% in 2000.

Table 3.9 Forest Cover Rate

Year	1990	1996	2000
Forest cover rate (%)	60	56,1	53,2

The sub-area possesses large bare and uncovered lands that open a large room for forest development. Development orientation in coming years is to rehabilitate forest resources to create driving forces for development, especially in ethnic minority living areas. Furthermore forest planting and protection of existing forests will better perform functions of protection forests in protecting biodiversity.

(3) Fishery

Fishery in Central Highlands in general and in the sub-area 7V in particular mainly involves freshwater fish raising in ponds and lakes. Fish raising in rivers and streams are very limited because local rivers and streams are very steep, in addition they are dry in the dry season but have swift flows in the flood season.

Aquacultural areas and production of the sub-area 7V in 2001 are showed in following table:

Table 3.10 Fishery Area and Production in 2001

Province	Aquacultural area (ha)	Shrimp production (ton)	Fishery production* (ton)
Dak Lak	3,852,7	4,966	6,333
Gia Lai	97	84	214
Kon Tum	284.3	588	901
Total	4,234	5,638	7,448
Sub-area 7V	2,680	3,670	4,880

Source: *Statistical Yearbook of 3 Provinces*

Fishery production *: Production of catching and aquaculture

Total aquacultural areas of the sub-area are 2,680 ha generating an aquacultural production of 3,670 tons, catching and raising production of 4,880 tons averaging a per capita production of 2 kg per person per year which is much lower than the national average per capita production of 9-10 kg per person a year.

(4) Transport

- Navigation: Despite the local river network is quite dense, navigation is underdeveloped due to highly steep rivers with water falls and cascades, important difference of velocity and water levels in dry and rainy season that cause difficult traffic for ships and boats.
- Airways: there exist flights from Pleiku and Buon Me Thuot to Da Nang and Ho Chi Minh cities.
- Roads: road network in the sub-area is rather appropriate distributed. Road network includes vertical axes in North-South directions and horizontal axes in West-East direction. Then local roads link with inter-district roads creating a conjugate in the sub-area and with other regions of Vietnam, Laos and Cambodia. The road systems run through the sub-area comprise followings:
 - + National Road No. 14 is a vertical axe running throughout the sub-area 7V in North-South direction from upstream of Sesan river via Kon Tum town and Pleiku and Buon Me Thuot cities.

- + National Roads No 19, 26, 27, 25, and 24 run in Wes-East direction connecting the sub-area with central coastal provinces such as Quang Ngai, Binh Dinh, Tuy Hoa, and Khanh Hoa.

In general, the provincial and national road network is rather dense. National Road No. 14 plays an extremely important role because it runs throughout the sub-area. Inter-district and inter-commune roads are not in good conditions, 5% of district roads only are graded, besides many of remote roads are not accessible in the rainy season. Communal roads are all earth filled and 80% of them only are accessible throughout the year.

(5) Tourism

The sub-area 7V possesses rich potentials in tourism development thanks to its natural and traditional cultural characteristics that create original aspects. Many Natural Reserves such as Ea Soup, Ea So, Jok Don National Park; attractive landscapes with waterfalls like Dray Sap, Trinh Nu, Dray H Linh (Dak Lak), natural lakes and reservoirs including Lak (Dak Lak), Bien Ho (Gia Lai), Ia Ly (Kon Tum), etc are found in the sub-area.

There exists two main types of tours:

- Cultural tours involve visits and learn about traditional festivals of Central Highlands peoples such as festivals of gongs, buffalo' battle, etc...
- Ecological tours involve activities such as visits to Jok Don National Park, to Lak Lake, to stilt houses, water falls like Dray Sap, Trinh Nu and Gia Long, elephant riding, etc...

Broadly, tourism infrastructure, especially hotels, restaurants and services are limited. Tourism services are not attractive, monotonous and very simple without community participation.

(6) Hydropower

According to professionals, potential energy of Sesan and Srepok systems are estimated at 35 billion KWh (accounting for 13% of the nation). Cascade development planning for Sesan river identified 6 projects with total installed capacities of 1,743 MW, annual energy production of 8.23 billion KWh. Cascade development for Srepok river also proposed 7 projects with total installed capacities of 694 MW and an annual energy production of 3.33 billion KWh.

At present, there are on Sesan and Srepok mainstreams two hydropower plants which come into operation, details are as follows:

- On Sesan river: Ia Ly hydropower plant with installed capacity of 720 MW, and Eo of 3.6 billion KWh
- On Srepok river: Dray Hlinh hydropower plant with installed capacity of 12.48 MW, and Eo of 99 million KWh.
- Also on Sesan river, construction of Sesan 3 and Sesan 3A hydropower plants has been initiated.
- In addition, there are also other small hydropower plants on small rivers and streams of the sub-area.
- On Sesan river basin there are 8 small hydropower plants with total installed capacities of 1,410 KW, of which 2 hydropower plants, i.e. Kon Dao (Dak To) and Dak PoKo (Dak Glei) hydropower plants are connected to the national 22 KV gridlines.

- On Srepok river basin, there are 22 small hydropower plants which are separately operated with total installed capacities 5,600 KW.

Existing hydropower plants in the sub-area have importantly contributed to socio-economic development, meeting national energy requirements. Once completed, the cascade development on Sesan river will contribute to regulate river flows, reduce flood discharges and increase low flows in downstream. However, operation and development of those projects, especially Ialy hydropower plant will influence flow regime in downstream in Cambodia. Vietnam agencies is now carrying out environmental impact assessments to propose mitigation measures in applying hydraulic models to simulate flow regime to confluence of Sesan and Srepok river. Thorough consideration of possible impacts requires coordination and cooperation with parties including Cambodia.

(7) Water supply

Existing population of the sub-area is 2,374,000 persons including 623,900 of urban population (26%) and 1,750,100 of rural population. In the sub-area there are 2 cities and 1 town. Local industries are mainly agro-forestry and food processing based in cities and town because large scale industrial zones are not available. Existing industrial water supply systems use the same of domestic water supply systems. Total domestic and industrial water demands are currently estimated at 50 million m³ a year.

• Urban and industrial water supply

Domestic and industrial water for 3 cities and towns of the sub-area, i.e. Kon Tum town, Pleiku and Buon Me Thuat cities are supplied by following water plants:

- Kon Tum water supplying plant has design capacity of 7,000 m³ per day and water sources are from Dak Bla river. In fact, the plant supplies 3,000 m³ per day only.
- Pleiku water supply plant has capacity of 20,000 m³ per day taking water from Bien Ho reservoir.
- Buon Me Thuat water supplying plant has capacity of 49,000 m³ per day using groundwater sources.

Total design capacities of the 3 plants reach 76,000 m³ per day. Actually, about 50-60% of urban population is served with piped water.

• Rural water supply

In several townships there exist centered water supplying systems with design capacity of 500-1,000 m³ per day. Real time operation of existing systems are good in general, but most of them cannot fully perform their design capacity and now operate at 60% of their design capacity only because some systems are not very appropriate for local population resulting in deficient operation, maintenance and poor monthly fee collection to cover pumping costs.

Rural population actually use water from all types of water sources, for instance, irrigation schemes, drilled wells, dug wells, storage tanks, gravity systems, etc.

- Domestic water supplying combined with irrigation schemes is a predominant way where water resources systems are available.
- Gravity systems are mainly found in high mountains near rivers and streams using bamboo pipe to divert water to hamlets.

- Other ways including drilled and dug wells, storage tanks, etc are also large used in rural areas.

There are presently about 30-35% rural population served with clean water. In mountainous districts, this figure is 13-15% only. A large proportion of rural population still use river and stream water which is not hygienic.

(8) Flood control

• *Flood situation*

The rainy season starts in May and last until November. Big floods usually occur in October and November. In recent years, floods happen more frequently and abnormally in river basins of the sub-area. In years 1992, 1993, 1994, 1996, 1998, and 2000, big floods occurred continuously resulting in serious damages.

- + In Se san river: the flood biggest happened recently on November, 3, 1996 with maximum flood discharges of 3,620 m³/s at Dak Bla. However, the historical flood occurred in October 1972 with maximum flood discharges of 4,320 m³/s at Dak Bla. Big floods in Dak Bla river caused inundation of Diem Binh and Kon Tum town with inundation depth of 3-4 m, and inundation duration of 4-6 days. Damages caused by floods are estimated at 72.6 billion VND, total dead and missing are 16 persons.
- + In Srepok river: Rain regime and topographical conditions are main causes of floods in Lak Buon Trap area which is situated downstream of Krong Kno and Krong Ana rivers. During the main flood season from September to November, there area about 9,000 to 10,000 ha in the whole area inundated under 2-4m of water depth in 2-3 months. In the small flood periods (May) and early flood period (August) and late flood period (December), the area is also inundated in 15-30 days with inundation depth of above 1m on 5,000-6,000 ha. In case of the 2000 flood, the historical flood occurred in Dak Lak province and also in Lak Buon Trap area, there are 25 people died, 12,000 ha of cultivated lands inundated making total losses of 122.4 billion VND. For Lak Buon Trap alone, there are 15 people died, estimated losses of 26.7 billion VND.

• *Existing flood structures:*

In the study area, there is not any considerable flood structure which can reduce floods for the downstream. Existing reservoirs have small storage capacity. In fact, there are 34 reservoirs having storage capacity of more than 1 million m³. There is not any structure with storage capacity of above 15 million m³. These structures has main task of supplying irrigation water.

Existing revetments are built to protect river banks as follows:

- + Dak Bla river revetment has length of 1,075 m to protect cultivated areas and Kon Tum prison vestige.
- + Dak Sir river revetment has length of 6,527 m from downstream of Dak Sir weir to Sa Thay township with task to protect riparian agricultural lands and population.

Issues relating status of economic sector in the sub-area 7V

- (1) Important economic sectors in the sub-area are agriculture, forestry and hydropower;
- (2) Fast but unsustainably growing economy;
 - + Unbalanced agricultural-forestry economic structure, underdeveloped industry and services;

- + Not available integrated sectoral planning;
 - + Agriculture is the key economy but its development much depends on natural conditions;
 - + Processing industries and post-harvest technologies face difficulties, market competitiveness is limited, product consumption face difficulties;
- (3) Forest resources are exhausted resulting in land and water degradation, floods, droughts happen more frequently and seriously.
 - (4) Infrastructure including transport system, processing, industry is underdeveloped. Special attention has been paid on water resources development but existing systems can not meet water requirements or flood control requirements.
 - (5) There are rich potentials for hydropower development not only to meet energy demands of Vietnam but also to serve cooperation and exchange at borders, however trans-boundary impacts such as possible downstream impacts of hydropower plants should be taken into account.

3.4. Economic sector development

3.4.1. Agriculture

The orientation for agricultural development will be a fast growing agriculture and a sustainable biological environment. Intensive farming, diversified products, mixed agriculture, forestry and processing industry, phased industrialization, modernized rural area will be priorities. Agriculture is still the vital sector of the sub-area. The growth rate of the sub-area is expected to reach 5.6% in the period of 2000 -2010.

- **Cultivation**

Food production

- + The food production goal of the area is adequate supply of food demand of local people and animals. The rice area will be stabilized and the two crop area will be extended. The development of the key area for intensive farming and shift of land pattern for subsidiary crops in rotary direction are encouraged. The target crop would be maize.
- + The rice area of three provinces of Dak Lak, Gia Lai and Kon Tum by the year 2010 would be 117,080 ha with an output of 540,100 tons. The maize area would be 63,850 ha and an output of 280,000 tons. The total food production by the year 2010 would be 820,100 tons.

Annual industrial trees

- + Sugarcane: ensure the supply for the existing sugar factories in the area. By the year 2010, the sugarcane area is expected to reach 15,980 ha, mainly in Dak Lak: 10,200 ha, and in Kon Tum: 4,870 ha with future sugarcane production of 2,307,700 tons.
- + Cotton: Central Highlands is estimated as one of the two key cotton areas of the country. The intensive area of cotton in Dak Lak is expected to be expanded to an area of 25,000 ha.

Perennial industrial trees

- + Coffee: the stable area for coffee in the sub-area is 208,600 ha. This area has been reduced compared to year 2001 by 51000 ha which is mainly the unsuitable or less suitable area or non-irrigated area.

Changes in coffee variety pattern: depending on different areas, the portion of coffee and tea can be allocated to 8-10% for enhancement of product quality.

- + Rubber: increase the rubber areas by farmers. The planed rubber area by the year 2010 would be 137,600 ha, 57,430 ha increased compared to the year 2001. The rubber trees can be planted on land for coffee, subsidiary crops and unused land.
- + Tea: the tea land is mainly in Gia Lai. In the forthcoming years, intensive planting will be encouraged. The planned tea area will be 1500 ha.
- + Pepper: the intensive and irrigated pepper areas continue to be planned. The area will not be expanded randomly for the limited world demand for pepper. The pepper production is expected to increase to 5,300 ha by the year 2010.
- + Cashew: the area for cashew is expected to be expanded and intensified to raise the cashew land to 14,600 ha by the year 2010.

Water demand

Basing on the allocation of different crops, the water demand for crops in provinces of Gia Lai, Dak Lak and Kon Tum by the year 2010 is estimated at 5.16 billion m³/ year. The water demand of crops in 7V sub-area by the year 2010 is 3.8 billion m³/ year, in which:

- Water demand in dry season (from December to April): 3.15 billion m³.
- Water demand in rainy season (from May to November): 0.65 billion m³.

The water demand in dry season represents 63% of the total runoff. The solution for irrigation supply for Central Highlands in general and for the studied are in particular will be the construction of small and medium reservoirs. These reservoirs will store and provide irrigation water for rice, coffee, subsidiary crops and short-term industrial crops as maize, sugarcane and cotton.

Development of irrigation works

According to irrigation plans for provinces of Gia Lai, Dak Lak and Kon Tum which have been carried out previously for the upgradation of existing works, about 658 irrigation works are expected to be constructed. They are:

- 472 reservoirs
- 142 small weirs
- 44 pumping stations

Two rice crop areas of the three provinces are basically irrigated. The irrigated coffee area is 181,951 ha which is only 87 % of the required area (181,951ha/208,600 ha). The remaining area of 27,000 ha is recommended to be irrigated from the shallowed underground water.

The areas of irrigated crops are listed in table 3.29.

Table 3.11 Irrigated Areas (ha)

Province	Total	Rice	Sub-crops & annual industrial crops	Coffee
Gia Lai	159.425	50.542	61.832	47.051
Dak Lak	312.807	45.500	97.000	170.307
Kon Tum	29.520	11.500	7.020	11.000
Total	501.752	107.542	165.852	228.358
Sub-area 7V	353.567	76.061	95.555	181.951

Source: Institute of Water Resource Planning

- **Livestock**

Livestock is the key sector of the area after forest and long-term industrial trees. The livestock development would place the priority on cows for meat and milk cows and pigs for export and consumption in big cities. By the year 2010, livestock would be as follows:

- Buffalo: 45,780 heads
- Cow : 362,640 heads
- Pig : 768,000 heads
- Goat/sheep: 23,300 heads

3.4.2. Forest

In the next coming years, the main development trends would be protection and restoration of forest resource. This is aimed at creating dynamics for the development of minor groups. The forest conservation will bring into play the protection functions of the watershed and ensure diversified ecosystem.

The development goals would be focused on the protection of existing natural forest, zoning and protecting of watershed. This will help conserve the land, regulate the water resource, increase the plant coverage by 65% and provide adequate materials for the demand of wood processing industry in the area.

By the year 2010, the allocation of forest area in the region would be 1,945,420 ha, of Which:

- Natural forest : 1,634,280 ha
- Artificial forest : 296,860 ha
- Zoning forest and plant nursery : 14,280 ha

3.4.3. Aquaculture

The area has such a large water surface which is a potential resource. Beside natural lakes as Lak, Bien Ho, other existing and future reservoirs which will be available by the year 2010 are Ialy, PleiKRong, ChuBong KRong, Lower KRong Buk....

At present, the aquacultural area of the three provinces is 3745 ha. The unused surface water is 4500 ha. With the construction of new reservoirs expected by the year 2010, the aquacultural area would be increased to 35.000 ha, in which the cage fish are raised in 2,000 ha in Ia Ly, Bien Ho, Lower KRong Buk , ChuBongKrol, Lak....

3.4.4. Transportation

Expansion and upgradation of transport network:

- Upgradation of highways running through the sub-area as highways No. 14,19, 26, 27, 25, 24...
- Expansion and upgradation of inter-district and inter-commune roads to ensure the road access to 100% of the communes in both rainy and dry seasons.

3.4.5. Tourism

Enhancement of cultural tourism and eco-tourism. Tourist activities should be adhered to the environmental protection and protection of natural conservatories and wetlands. Effective coordination of tourist network of the region with those of Central Coast, Eastern South and Lao, Cambodia and improvement of existing tourist establishment as well as the human resource for tourism are quite necessary

3.4.6. Hydro-power

The plan of hydro-power cascades on Se san river includes 6 structures with the total installation capacity of 1743 MW, annual electricity production 8.23 billion KWh. Cascades on SRePok river includes 6 structures with the total installation capacity of 694 MW, annual electricity production 3.33 billion KWh. According to the plan by the year 2010, apart from existing hydro-power works of Ialy on Se san river and DRayHLing on SRePok river, others will be constructed and put into operation.

- Se san river: proposed construction of Se san 3 hydro-power plant (273MW), Se san 3A (100 MW), Se san 4 (330 MW), PLeiKRong (100 MW) and Kon Tum upstream (220 MW).
- SRePok river: proposed construction of hydro-power plants of ChuBong Kron - Buon Kuop, Buon TuaSar (85 MW) and SRePok 3 (180 MW).

Table 3.12 List of Hydro-Power Cascades on Se San & Srepok Rivers

Works	Catchment area (Km2)	Nlm (MW)	Eo (GMH)	Note
Se san river		1743	8226	
Upper Kon Tum	350	220	945	Expected 2010
PLei KRong	3224	100	675	Expected 2010
YaLy	7455	720	3650	Existing
Se san 3	7795	273	1127	Under construction
Se san 3 A	8084	100	481	Under construction
Se san 4	9326	330	1348	Expected 2010
Se RePok river		694	3.329	
Duc Xuyen	1100	58	196	
Buon Tua Srah	2930	85	335	Expected 2010
Chu Bong KRong	3860	23	88	Expected 2010
Buon Kuop	7980	280	1372	Expected 2010
DRay HLinH	8880	28	194	Existing
SRePok 3	9410	180	931	Expected 2010
SRePok 4	10700	40	213	

Source: EVN

The hydro-power of 7V sub-area in Me Kong river system have such a great significance that it not only meet the energy demand of Vietnam but are also traded to Lao PRD and help regulate the water supply for domestic used and production in the localities. However, the construction of large scaled reservoirs as PLeiKRong ($1020 \cdot 10^6 \text{ m}^3$), Ya Ly ($779 \cdot 10^6 \text{ m}^3$), Se san 4 ($471 \cdot 10^6 \text{ m}^3$) will have enormous impacts on the natural and social environments through the process of relocation and resettlement, reduced forest area, changes in plant coverage, aquaculture, soil quality, hydrological regime, especially environmental issues in the downstream of Cambodia. These problems should be studied carefully with the participation and coordination of related parties.

International environmental issues relating to the impacts of the exploitation of water resources in 7V sub-area should be prioritized in the framework of MEKONG cooperation. Vietnam is focusing its efforts in the formulation of operation procedures of hydro-power reservoirs and hydraulic models for flow regimes to confluence of Se san and Srepok. This is aimed at evaluating the environmental impacts and recommending mitigation solutions.

3.4.7. Water supply

- Objectives

- + By the year 2010: 100% of the urban population is supplied with clean water of 120-150 l/person/day and 85% of rural population has access to clean water with an amount of 60 l/person/day.
- + Supply water for industrial zones
- + Urban drainage and sewage: in addition to the long term drainage to avoid inundation, the local government ensures the adequate drainage and sewage systems in all the urban areas.

- Water demand

- + Domestic use

The population growth rate in the sub-area by the year 2010 is expected to be 2.1 % (25% of which will live in the city and the 75% in the countryside). From 2010 to 2020, the population growth rate would be 2.7% (30% of which will live in the city and the 70% in the countryside). The estimated population in the sub-area is as follows:

Table 3.13 Population Forecast In Sub-Area 7v (1000 people)

Area	Total			City			Countryside		
	2001	2010	2020	2001	2010	2020	2001	2010	2020
Central highlands	3,259	3,929	5,140	750	985	1,542	2,449	2,953	3,598
sub-area 7V	2,400	2,922	3,814	624	730	1,144	1,750	2,192	2,670

Existing water demand for domestic use: $50.10^6 \text{ m}^3 / \text{year}$.

By 2010: $90.10^6 \text{ m}^3 / \text{year}$

By 2020: $179.10^6 \text{ m}^3 / \text{year}$

+ Industrial use

At present, the GDP of industry sector of the region is insignificant, i.e. 14%). The concentrated industrial zones have not yet established and there is a lack of modern industrial infrastructure. The major industries are agri-forestry product processing, food processing, construction materials...

In the future, the following planned industrial zones would be constructed:

- Kon Tum province: three industrial zones in this province are: (i) the industrial zone of Kon Tum town and its surroundings; (ii) Dak Ha industrial zone; (iii) Dak To industrial zone. The sectors in these zones are agri-forestry product processing, production of paper pulp, garments, and construction materials. The water demand of these 3 industrial zones is $70,000 \text{ m}^3 / \text{day}$.
- Gia Lai province: the industrial zone of PLei Ku town and its surroundings, industrial zones of Bien Ho , An Khe , and Ayun Pa. The industrial zone of PLei Ku town and its surroundings and the industrial zone of Bien Ho are located within the sub-area. The major industries are agri-forestry product processing, mechanics, construction materials... The water demand of these industrial zones is $170,000 \text{ m}^3 / \text{day}$.
- Dak Lak: three industrial zones in this province are: the industrial zone of Buon Me Thuat city and its surroundings, the industrial zones of Gia Nghia- Dak Nong and Tam Thang. The major industries are agri-forestry product processing, mechanics, fertilizer, construction materials... The water demand of these industrial zones is $100,000 \text{ m}^3 / \text{day}$.

Apart from the small scaled industries in the rural areas, the future water demand of the major industrial zones would be $340,000 \text{ m}^3 / \text{day}$.

3.4.8.Flood control

- **Objective:** limiting the flood-related damages and especially main floods. Controlling early floods and small floods, late floods so as to ensure the production of two rice crops.

- **Orientation in flood control**

• *Non-structural measures*

+ Afforestation and protection of watershed.

+ Land Management and use in accordance with approved plan. Appropriate allocation

- of people and crops in a way that main floods can be avoided.
- + Improvement of flood warning system. Enhancement of communication and information services.
 - + Mapping of flood prone areas and flood warning system in the downstream of Dak Bla and Lak Buon Trap.
 - + Cooperation with Lao PRD and Cambodia in flood forecasting and warning for the entire basin of Se San and Srepok.
- *Structural measures.*
 - + Building embankments of the area of Lak Buon Trap in order to prevent small floods, early floods and late floods.
 - + Reinforcing the revetment and enhancing the flood drainage for Kon Tum town.
 - + Construction of multi-purpose reservoirs such as Dak BLA reservoir on Dak Bla river, PleiKrong on KRong Po Co river for the storage of water and flood control of Kon Tum town. Reservoirs of upper KRong Buk, lower KRong Buk, and Krong Pach on KRong Ana river, hydropower reservoirs of Ban Tour Sarh and ChuBong Krong on Krong Kno river for flood control of Lak Buon Trap area.

3.5. Environment

* Soil environment

Sub-area 7V has such an abundant soil resource. The soil here is fertile and suitable for the development of agriculture and forestry, especially the planting of long term trees as coffee and rubber. However, the land in the region is being deteriorated due to the natural and human impacts.

- Tree cutting caused soil erosion, flash floods, sedimentation and drought. In 1990, the vegetation coverage was 60% which has been reduced to 53,2% in 2000. Every year, about 2000ha - 7000 ha of forest area disappear. The forest management and protection are not efficient which have been made worse by the destruction of the wars and climatic conditions. As a result, the wood quality has been decreased, affecting the ecological environment. The biology diversification has declined as many endangered species are in the danger of being extinct due to the loss in ecological balance. Therefore, more effective protection measures of special forests should be worked out.
- The rapid increase of agricultural land is explained by the fact that parts of unused and barren hills and lands have been exploited. However, most of the coffee and sub-crop lands are burnt forest lands. Lands with big steepness are also exploited for agricultural production but with inappropriate cultivation pattern. As a result, increased erosion and washed away top soils are inevitable. Feralit process occurs so strongly that clotting and laterization are found in many places.
- The overusing of fertilizer and pesticide chemicals has caused many lands to become hard and polluted and reduced the useful micro-organisms in soil.
- The above mentioned reasons are blamed for the deteriorated and exhausted land resources. The danger of desertification is visible if we cannot work out the effective measures for the management and long term and sustainable utilization of land resources.
- The unplanned land use combined with the excessive planting of industrial trees and wood for pulp and the over exploitation of underground water beyond the limitation have resulted in reduced and exhausted underground water resource.

* Water environment

- Surface water
 - + The turbidity of river water depends on the topographical features, climate and vegetation in each river basin. The average river turbidity is 60-100 g/m³ and varies greatly with seasons. In flood season, the river turbidity can reach 100-200 g/m³. The highest turbidity measured at Duc Xuyen (Krong Kno river) is 1360 g/m³, at Don village (Sre pok river) is 965 g/m³. During the low flow months, the river turbidity is less than 50 g/m³, even 10g/m³ in the driest month.
 - + The mineralization of rivers is low, i.e. less than 100 mg/l on average. This figure varies between 35 and 60 mg/l. Ions in N and P groups are small and within the natural limits of river water. However, the value of Fe ions exceeds the allowed concentration in drinking water.
 - + River water is short of organic substances with average oxidization of 1,5 mg/l. River water with average pH of 6 to 8 and hardness under 1,5 mg/l, is soft water which is suitable for industrial use.
- Underground water quality: this water is unsalted with the mineralization less than 0,5g/l and major element is Bicarbonat (Na, Ca, Mg...) with low content.

In general, the water quality is acceptable with most of criteria within the standard limitation. As a result, this water can be used for domestic uses and other civil sectors.

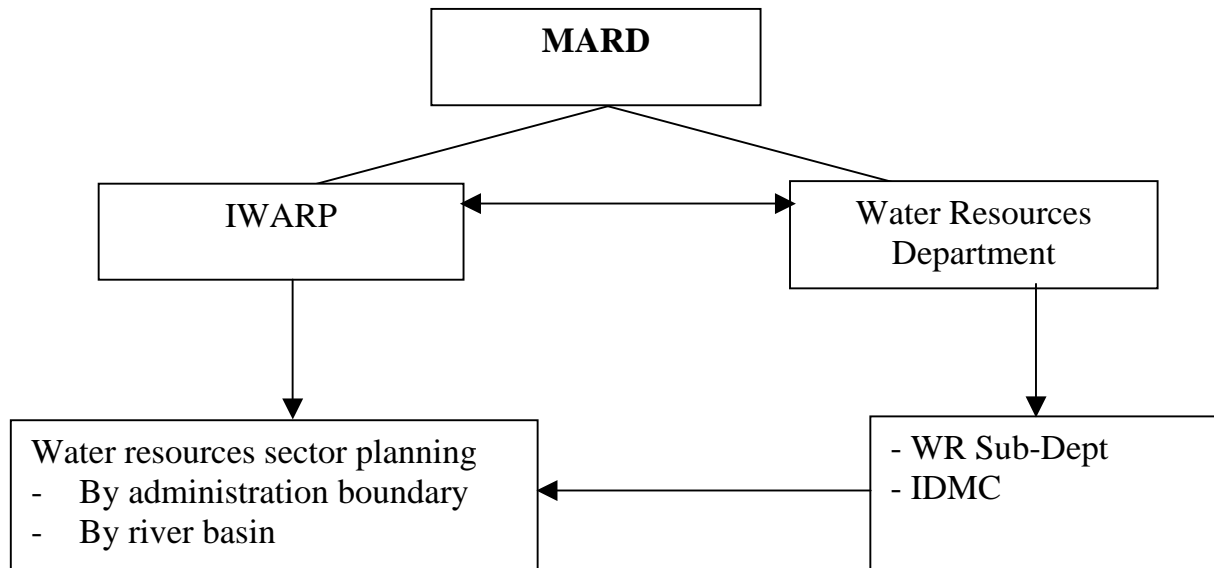
Pollution and environmental problems:

- For the time being, the sewages of industrial zones, hospitals and urban areas are not treated. They represent a source of pollution with COD, BOD at higher level than allowed.
- The deforestation and wood burning have led to the degraded water and land resources. Many precious animal species in the basin are being endangered to extinct, resulting in declined biological diversification.
- Natural disaster: the water related dangers have been increasing such as floods, drought, basin and river bank erosion.
 - + Drought: 6-months into dry season every year see a rainfall making up 15-20% of the annual volume. In some areas, there is no rain in some continuous months. In the region, years of 1994, 1996, 1998 and 2003 are the driest ones. In these years, the agricultural production was seriously affected. In 1998, about 22,920 ha of summer rice area suffered drought, in which 4,443 ha was completely lost, and another 34,008 ha of winter rice, in which 11,548 ha was completely lost, long-term industrial trees 56,061 ha and 33,968 ha completely lost .
 - + Lack of drinking water: in 2003 there was a serious drought in the entire area. It was estimated that up to 190,000 people were in the shortage of water for day to day use.
 - + Flood, inundation and water logging: due to the topographical and climatic characteristics, every year Lak Buon Trap in Sre pok river basin has been threatened by floods and suffered both inundation and water logging. The frequent waterlogged area is 9,000 to 10,000 ha with the water depth of 2-4 m and duration of 2-3 months in main flood and 5,000 to 6,000 ha with water depth of 1-2m and duration of 15-20 days in small, early and late floods. Annual damages are estimated at 15-30 billion VND. In Se san river basin, annual flood related damages are estimated at 2-72 billion VND. The Kon Tum town suffered most damages with 1000 ha inundated for several days under the water.

To sum up, the most outstanding environmental problems of sub-area 7V are forest planting and protection, and sustainable use of surface and underground water resources. Of no less importance is the monitoring and conservation of environment and control of sources of polluted sewage.

3.6. Institutional capacity

WATER RESOURCES ORGANIZATION AND DEVELOPMENT CHART



Constraints in institutional capacity:

1. River Basin Organization not available
2. Integrated river basin planning not existing (only sectoral and domain planning available)
3. Hydropower planning, land use planning, mineral, forest exploitation planning not yet linked with river basin planning

IV. ANALYSIS OF THE SUB-AREA

4.1. Development opportunities, demands and limitations

4.1.1. Development opportunities

The 7V sub-area is located in the territory of 4 provinces of Kon Tum, Gia Lai, Dac Lac and Lam Dong with a population of 2,374,247 people in 2001 (there are 37 minor ethnic groups making up for 50% of the total population in the area). The area is characteristic of mountains. The local infrastructure is in poor conditions and the lives of local people are difficult. The annual population growth is 1.5-2.8%, even 2.5-2.8% in the rural area. The mechanic population growth is as high as 2.0-2.8%. The poverty is still prevailing in many areas with high proportion. According to statistics in 2000, the poverty incidence is 27%, event to 34.85% in Kontum. However, the development opportunities of the region are visible. Followings are some major advantages of the region:

• Priority policy for development of Vietnamese government

The local community of 7V sub-area is not homogenous. There are big differences between production technique, living standards and literacy. The local government is posed with such urgent problems as economic rights, exploitation of agricultural land, forest and forest land, inferiority complex regarding the low living standards, life style and literacy level.

Basing on the existing conditions of sub-area 7V in particular and Central Highlands in general, in the fast few years, ***Vietnamese state and government have had priority policies and investment assistance for the regional development.*** (Decision No. 656/TTg issued on 13th September 1996 relating socio-economic development of Central Highlands area during period of 1996-2000 and 2010). The government also issued policies of economic pattern shifting, development of economic sectors aiming at improving living standards of local people, especially those of minor ethnic groups. Among these aims is filling the gaps in the living standards between mountainous areas and the delta and other regions in the country.

The government has promulgated following policies in terms of investment assistance.

- Encouraging non-state enterprises and individuals to invest in agriculture, forestry, processing of agricultural and forestry products and the production of other key products of each area.
- Establishing and expanding the production and trading of industrial trees and agricultural goods.
- Entitlement of land use and provision of land right certificate for households who area planting coffee, rubber, sugarcane. These certificates can help households get access to bank credit service.

The remote areas or areas used to be revolutionary bases during the war are favored in terms of investment in settled agriculture, transport, electricity, health care, cultural life and information.

- An appropriate portion of state budget in combination with ODA fund will be used to invest in the development of transport and irrigation works.

Some preferential policies relating tax in accordance with Decision No. 656/TTg:

- Leave larger proportion of taxes imposed on land use and ones imposed on the use of water resource and hydro-power to provinces.
- Consideration of the application of standard increase of budget expenditure and investment disbursement for disadvantageous provinces.
- Exemption and reduction of income tax, VAT for investment projects in sectors of processing industry, agricultural related industries. Exemption and reduction of tax on the use of agricultural land for business households in the mountainous areas.
- Implementation of preferential investment policies both domestically and externally. Reduction of land hiring cost and tax on initial income.

Some of the major objectives by the year 2010 of the region:

- GDP growth rate of industry is expected to reach 16%, services 11.6%, agricultural and forestry 7.8%. GDP per capita is expected to increase by 2.2 times by the year 2010 compared to that of 2000.
- Reduced rate of population growth of 1.2-2.0%, and controlling of free immigration.
- Reduced rate of poverty to 13% in 2005 and to 5% in 2010. By the 2005, no starving and extremely poor household left. 100% of communes have seven necessary infrastructures.
- Construction of transportation infrastructures and access to motorway by communes.
- Most of the local people have access to clean water in wells, water taps and tanks.
- 90% of the communes would have adequate electricity.
- All the clinics are capable of providing health care services to the local people.
- Fulfillment of compulsory education of primary levels. All the cities, towns and 30% of the communes would complete the compulsory education of secondary levels.
- 18-20% of the labors in domestic economic sectors are trained with necessary skills and each district will have at least one boarding school.
- Effective solutions to social problems, enhancement of educational and literate levels of local people and improvement of cultural and living standards of residents.
- Efficient completion of national programme on job creation. By the year 2005, about 400,000-420,000 labors are expected to have jobs which mean that the unemployment rate will be reduced by 4% with the increased labor proportion in agricultural production of 82%. All these will create the dynamics in the labor quality and productivity.

• **Sub-area cooperation with Lao PDR and Cambodia**

The 7V sub-area is adjacent to 2 countries. Specifically, 3 provinces of Vietnam of Dac Lac, Gia Lai, Kon Tum have boundaries with two Cambodian provinces of Stungtreng, Ratanakiri and three of Lao, namely Attapu, SeKong, Champksak. As a result, the region has great potential of cooperation, development and cultural exchange between front gates.

Three governments of Vietnam, Lao and Cambodia have agreed on the common study of a development plan for all three nations. Basing on this agreement, Decree on Trade and Commerce among the three countries will be signed. The Decree will help remove tariff and reach a common agreement in terms of commerce and tourism.

Through the activities of cooperation and joint ventures, the key emphasis on tourist and commercial development, cultural exchanges among provinces will be encouraged and promoted to form the “socio-economic” ring along the boundaries of the three neighboring countries. The strong shift in production pattern of agriculture and forestry should be

stimulated. The activities of forestation, exploitation and processing of forest products and management of timber exploitation and processing should be promoted. The increased investment in the construction of infrastructures for long term industrial trees production is also recommended.

The development of infrastructures and upgradation of highway system connecting the front will help form a uniform and effective transportation system. This will facilitate the relation and coordination of the activities of international transport network. One of the priorities of Vietnamese government will be the improvement of important highways connecting the front gate and the inland; accessing the sea and routes that link tourist locations and significant economic zones. It is also necessary that the border rings including highways No. 14 and No 14C will be cleared to develop the fishbone road system and farmer roads leading to border gates of Duc Co and Bo Y.

Within the framework of ASEAN cooperation, apart from transportation, the construction of information infrastructure should be relevant to the requirements of the informatics revolution which is booming in the global scale. This can be done through the formulation of legal institutions for the development and connection between international information networks and regional ones. The activity may encourage the development of communication relations between member countries. Regarding the sub-area itself, the communication and information systems between border communes and centers of neighboring countries and relevant exchanges should be developed and maintained.

Finally, the cooperation in infrastructure development of energy sector through the conservation and effective use of energy sources of member countries should be enhanced. This will help form a link in the efficient exploitation and utilization of regional energy resources. The sub-area has an abundant hydro-power source and is capable of using this source in the development of the region as well as in cooperation with neighboring countries.

• **International cooperation of the sub-area**

In the past few years, the Central Highlands has been studied and invested by many international organizations. Followings are typical cooperative projects.

- Infrastructure Development for Central Highlands Area project (funded by ADB).
- Programme on clean water and rural environmental sanitation which is funded and assisted by UNICEF.
- Action plan of Sre pok river basin whose study on development plan of water resource in Sre pok river basin is funded by DANIDA of Danish government (coordinated by IWRP) from 1991 to 1995. The study has proposed some hydraulic works as that of Giang Mao, management of Ea Tul river basin and construction of water supply system of Buon Ma Thuot city.
- Mekong River Commission (MRC) also funded some study programmes such as Basin Development Plan (BDP), Program on Fish Development in reservoirs in Dak Lak, Environmental Programs (EP). The overall cooperation objective of all Mekong riverine nations is sustainable development and planning of the entire river basin.
- Comprehensive study on the development and management of water resources in the entire territory of Vietnam by (JICA) funded by Japanese Government from 2000-2003 also consider the sub-area 7V and river basins of Se san and Sre pok in Vietnam one of

the 14 river basins for analysis and evaluation in the Comprehensive Study on Nationwide Development and Management of Water Resources.

- Hydro-power development of the border area by three governments of Vietnam, Lao and Cambodia.

• **Investment in the study and planning of water resource development of the sub-area**

The study on the exploitation of water resource of the Central Highlands area has been carried out by the IWRP under MARD. The major studies are as follows:

- Water Resource Development Strategies by the year 2010 by Institute of Water Resource Planning (IWRP), completed in 1991.
- Water Resource Planning of Gia Lai province, by Institute of Water Resource Planning (IWRP), completed in 1999.
- Water Resource Planning of Dac Lac province, by Institute of Water Resource Planning (IWRP), completed in 2001.

In addition, IWRP has implemented two overview studies for river basins of Se san and Sre pok:

- Overview of Sre pok river done from 1989 to 1993.
- Overview of Se san river done from 1994 to 1999.

Together with studies of DANIDA and JICA, the above mentioned studies have outlined the exploitation diagram which facilitates the water demands in different economic sectors and restricts the negative water-related impacts on the sustainable development of the region.

• **Potentials of the sub-area**

Apart from the above mentioned advantages, the local resources of sub-area for the development are abundantly potential.

- Human resource: the population in the labor age makes up for a large portion (i.e. 71.6%). There are 586,650 pupils at all levels and 22,730 teaching staff.
- The population density of the region is lower than the average density in the other areas of the country. As a result, the region welcomes more people coming in to contribute to the regional economy.
- According to statistics of the year 2001, the sub-area's area is 3,038,400 ha with existing agricultural land of 676,385 ha, making up for 22% of the total natural area. In which:
 - + Land for long term industrial trees of coffee and rubber is 359,819 ha
 - + Land for annual crops is 264,465 ha, in which rice field is 70,110 ha, terraced field 72,130 ha and 122,225 ha for other annual trees.

The most important soils include:

- + Bazan red soil: soil with high fertility which is ideal for the development of high value industrial trees as coffee, rubber, tea and trees for paper pulp.
- + Alluvial soil scattered along the streams and rivers are allocated for the cultivation of two rice crops with high productivity. These rice fields will ensure the food stuff production of the region.

A significant proportion of land in the sub-area has not been exploited. The land includes 608,013 ha with 38,028 ha of plain and 518,390 ha of hills which make up for 20% of natural area. These areas can be used for the forestry development.

The forest land in the sub-area by 2001 is 1,649,892 ha which mainly concentrates in upstream of Se san river, Srepok river and three rivers of IaDrang-IaHleo, part of Se san and Sre pok river running through territory of Cambodia. The vegetation coverage compared to natural area is 53.2% which includes the natural forest (1,589,547 ha) for the most part and a small portion of artificial forest (34,855 ha). This area is also one of the areas having largest vegetation coverage in Vietnam.

- + Major minerals are Bockit and gold in mineral sand, tin, iron, limestone, stone for construction and coal.
- + Hydro-power potential of the area is one of the largest in Vietnam. Such of the hydro-power works have been put into operation as Ialy hydro-power plant (installation capacity of 720 MW) and Dray Hlinh (installation capacity of 12.48MW).
The two hydro-power works under construction are Se san 3 and Se san 3A. In addition, other hydro-power plants which are expected to be constructed in the sub-area are Upper Kon Tum hydro-power plant (220MW), Se san 4 (330MW) on Se san river; Buon Kuop (280MW), Buon Tua Srah (85MW), Sre pok 3 (180MW) and Plei Krong (100 MW).
There area more than 500 hydraulic works of all kinds in the area. The total designed irrigation area is 67,000 ha in which 46,180 ha has been actually irrigated, making up for 72% of the designed irrigation capacity and 13% of the irrigated area of annual and perennial trees.
- + Road network of the sub-area is belonging to the highway and inter-provincial road system of Vietnam, forming a dense and proper scheme (in terms of direction and distribution). The network consists of longitudinal arterial roads in south-north direction and horizontal ones in west-east direction. This network is linked to local routes in different provinces, creating an uninterrupted connection within the region and with other regions of Vietnam, Lao and Cambodia.

Along the longitudinal arterial roads is Highway No. 14 which plays such an important part in the transport system. This highway runs through territories of provinces along the west corridor of Vietnam, crossing throughout the sub-area 7V in south-north direction to connect the urban centers of Kon Tum, Plei ku city, Buon Ma Thuot city and other concentrated residential area. Horizontal arterial roads include highway No. 19, 24, 25, 26 and 27 linking the coastal area of East Sea, sea port to Central Highlands and border areas.

Beside the horizontal arterial roads, the inter-provincial road system also connects the highway system to the remote areas and the borders. River basin of Se san is run though by inter-provincial roads of 656, 664, 666, 670 and 671. Inter-provincial road of 666 runs in west-east direction from Kon Tum to the borders with Cambodia.

The inter-provincial road of system of 686 in Srepok river basin runs along the borders with Cambodia. The other inter-provincial roads are 687, 689 and 722.

In sum, the highway and inter-provincial road networks in sub-area are rather dense. The road quality is in relatively good condition. Highway No. 14 is trans-Asian route of high quality (running through the Central Area). Some planning alternatives suggest that

Highway No. 19 be selected as the trans-Asian route to link Vietnam, Cambodia, Lao and north-eastern Thailand. In the future, Highway No. 24 will connect Kon Tum and sub-area 7V to Dung Quat seaport (in Quang Ngai province).

According to the 2010 plan, the highway system running through the sub-area will be upgraded to Grade III. However, data on the existing conditions of the regional road system are not adequate.

Regarding the airlines, there are two flights from Plei Ku and Buon Me Thuot to Ho Chi Minh and Da Nang, the two major cities of the Central Area and the South of Vietnam.

The river and stream network is relatively dense. However, the navigation has not been developed due to the steepness, swift-flowing water of the rivers and the presence of many rapids and waterfalls.

The sub-area has a potential tourism thanks to the spectacular landscapes and traditional cultures of different ethnic groups in the area.

Some places of interest that attract tourists are waterfall of Dray Sap , Trinh Nu, Dray Hlinh, such natural lakes and reservoirs as Lak lake, Bien Ho lake and Ialy reservoir. Apart from that, there is an abundant system of national parks, ecological conservatories, cultural and historical conservatories with a total area of 400,000 ha.

Upon the implementation of priority policies of Vietnamese government and thanks to regional potential, in the past few years, the infrastructure of the sub-area has been significantly developed. By 2000, all the arterial roads have been improved and upgraded. The inter-provincial, inter-district and rural road systems have been significantly upgraded.

During the period of 1996-2000, the entire Central Highlands has been invested with a total investment capital of 25 trillion VND, increasing by 49.5% than initially expected and 4 times greater than the amount invested in the area during period of 1991-1995. This is an important contribution to create the drive of the regional economy with the average growth rate of 11.5% in the 5 year period of 1996-2000, exceeding the objective set in Decision 656/TTg and previously planed. This rate also exceeds the average growth rate of 7% of the whole country.

The capital and investment credit during period of 1996-2000 are mainly allocated for energy sector, national electricity network, transport, irrigation and construction. The investment allocations help complete and develop the social and technical infrastructure, upgrade and newly construct large-scale works as hydro-power plant of Ialy (capacity of 720MW), strategically important routes connecting Central Highlands with eastern south area, coastal area of southern central region and with Lao and Cambodia. The upgradation of Buon Ma Thuot airport, construction of headworks of EaLau dam (Gia Lai), Dac Cam reservoir (Kon Tum), Lower Ea Sup reservoir (Dac Lac), many water supply projects and the upgradation of electricity systems in provinces worth at hundreds of billion dong have been implemented.

4.1.2. Development demands

In the past few years, the natural population growths of the Central Highlands and sub-area are relatively high. The flux of free immigration into the area recently has caused the poverty incidence to increase which has placed such a pressure on economy.

At the same time, the government is considering the acceleration of industrialization, modernization and rural development as well as commercial promotion that contributes to the increased water demand. As a result, the water resources have been reduced and exhausted and polluted. This change has big impacts on the regional environment.

The outcome of boosted population and pressure of economic development followed by reduced water resources and increasingly serious deforestation posed such a threat to the region. According to recent statistics, the annual area of destroyed forest land of the sub-area makes up for 40% of the destroyed area of Vietnam.

The above mentioned urgent problems require such a basin plan for the utilization of natural resources of the sub-area. This plan will contribute to the sustainable development for a civilized and equal society.

The sub-area 7V belongs to Central Highlands of Vietnam. The region is identified by the Government as the prioritized area for development investment in the coming years. The common development view for the whole region is formed based on the directions of socio-economic development strategies of the nation during the period of 2001-2010 set in the Party Congress IX as follows: “Enhancement of industrialization, modernization and development of an independent and autonomic economy to turn the country to an industrialized one; active integration into the international economy for a fast, efficient and sustainable development”.

The strategic development of Central Highlands is put in the relationship with Lao, Cambodia and Thailand. The development process has to take into account the improvement of living standards of local people and enhancement of friendships between ethnic groups and other neighboring countries.

The development trends of the sub-area focus on the followings:

- Hydro-power
- Construction of hydraulic works for the development of other economic sectors
- Forest planting and protection
- Promotion of services and processing industry and post-harvest technology.
- Improvement of awareness of local people
- Monitoring of resettlement and immigration process.
- Boundary cooperation with Lao and Cambodia.

The annual electricity demand during period of 2000 to 2020 of Vietnam is estimated to increase by 10% to 20%, i.e. from 4800 MW in 2000 to 27,000-32,400 MW by the year 2020.

The total installation capacity of hydro-power plants in Vietnam was 4100 MW by in 2000. The figure is forecasted to increase to 12,000- 14,000 MW by the year 2020. The Northern Vietnam will make a major contribution to this increment (including hydro-power plants of Son La with installation capacity of 600 MW and Tuyen Quang 342 MW). However, sub-area 7V has one of the greatest hydro-power potentials in Vietnam for the hydro-power

cascades of the area have been studied and invested in order to meet the energy demand of the country in the next coming time.

Sustainable water resource development is becoming an urgent matter of the region as the underground water are showing signs of deterioration recently due to the uncontrolled exploitation beyond the natural restoration ability, causing more destructive natural disasters and floods.

Protection and development of water resources for the shift in crop patterns, industrial use and other sectors together with environmental protection should be promoted. The water resource development, construction of reservoirs, irrigation system and drinking water scheme and other demands as flood control are necessary. Some large-scale hydraulic works are Upper Ia Soup, Ia Lau and Ia Mo.

In order to overcome the typical limitations of low skilled labors that affect the socio-economic development of the sub-area and the Central Highlands, we should prioritize the labor quality in terms of both intellectual and manual. At the same time, it is recommended to apply suitable policies relating the effective use of local labors. On top of this are the training of staff to balance the educational level, promote vocational training and capacity building.

For better health of local people, it is necessary to promote the investment in the improvement of living standards through the food security and community health care. Restructuring of rice production and other sub-crops and fruits in the area will help ensure the nutrient balance. More doctors should be allocated to local clinics as well as health care centers. There should be policies relating initial medicine cost and exemption of health care fee for extremely disadvantaged communes. Other activities as cultural exchange and telecommunication and post, television broadcasting and entertainments should be encouraged and assisted.

Capacity building can be done through the support of fund and human resources for the training of capacity, skills and leading staff.

The National goal of Jobs program has facilitated the labor utilization. The government also set the regulations relating wages, salary, allowances, working time, and retirement for local staff. There should be favorable policies for teaching and medical staff who work in remote areas.

There are many barren hills in the sub-area 7V so the potential for forest development is quite great. The development trends in the coming years are restoration of forest resource to cover the forest at the proportion of 64% by the year 2010. The forestation will represent a drive to the regional development. Moreover, the process would bring into play the protection role of watersheds and ensure the ecological diversification.

Comprehensive and effective forestry development will be a breakthrough in the strategic development of Central Highlands area, specifically the planting of woods for materials and building of processing plants. The development plan includes:

- + Taking care and protection of existing forest area. Planting and zoning of the new forest areas to raise the vegetation coverage to 64%.

- + Prioritized investment in the planting of woods for paper pulp of paper mills. Ensuring the stable material source of MDF plywood and meeting the demands of timber processing plants.
- + Effective prevention of illegal exploitation of forest products and encroachment of forest land as well as deforestation. Encouraging the zoning of forests and allocating forest lands to households in ethnic communities. There should be policies which attract minor ethnic groups to live on forests.

Maintenance and enrichment of forest resources should be based on relevant policies as forest zoning for protection, reasonable exploitation and settled cultivation.

Industrial development should be focused on hydro-power generation, agricultural and forestry product processing, biological technology and post-harvest technology. Completion of hydraulics works of Plei Krong, Se san 3, Se San 3A, Se San 4, Upper Kon Tum, Chu Bong Kron-Buon Koup, Sre pok 3, Ban Tua Srah should be accelerated.

Promotion of the application of science and technology in practical production to include the followings:

- + Application of technology of agricultural product reservation and processing. Application of biological technology in planting.
- + Application biological technology in breeding, reservation of genes, transplanting and multiplication of animals and trees.
- + Carrying out primary investigations of natural resources, socio-economic conditions and markets.

4.1.3. Disadvantages and limitations

• **Natural conditions**

The development of transport, irrigation works, electricity and water supply systems have difficulties for this area is typical of a mountainous highland. .

The highway system in the sub-area is in good condition compared to other areas in Vietnam. However, the inter-provincial and inter-district roads are of low quality. Only 5% of inter-district roads are applied with asphalt. During the rainy season, the local roads to remote areas are often interrupted. The inter-commune roads are earth filled. The improvement is focused on the highways rather than on the local roads in remote areas.

Despite a dense network of rivers and stream, the waterway transport has not yet developed. The main reason is the steepness and the presence of many rapids and waterfalls. At present, there are only two flights to two big cities of Da nang and Ho Chi Minh.

Unevenly distribution of annual moisture is such a big restriction to the regional development. The lengthened dry season caused serious shortage of water. The over-exploitation of underground water beyond allowed limit has resulted in continuously declined water tables in recent years. The curved terrain of the region requires greater investment in the construction of hydraulic works.

The unsuitable lands for cultivation make up for a large proportion for they contain high contents of sulphate and acid, aluminium toxic and less phosphate. Most of the cultivation

areas are located at the beginning of rivers and streams. As a result, a large area is inundated for 3-4 months annually, posing difficulties to production and livelihood of local people. Therefore, increased investment should be made in development of hydraulic works.

• **Socio-economic conditions**

The literacy levels of the region are low and the production skills are not homogenous.

- High natural population growth rate (on average 2-2.8%).
- High immigration ratio i.e. 2-2.4%.
- Shifting cultivation and burning forest for fields still exist. As a result, the replanting forests only account for 10-15% of the destroyed areas.

Rapidly increased population is made worse by different demands on lands for accommodations, gardens, cultivation, planting of industrial trees and others. Solutions to meet these demands are impacts on forest environment by local residents.

Free immigration is a matter of great concern in the Central Highlands. Most of the immigrants choose to live near the watersheds and prohibited forests for they can live on their abundant resources of woods and lands.

Another difficulty is that the settlement of shifting cultivation is such a daunting task as the protection of local forests. Increased population explained for the reduced forest resources. The migration of every two households in plan is followed by that of 3 free migrant households. It is estimated that a relocated household will destroy one hectare of forest. In fact, every household has two hectares of forest land, even 5 hectares. Therefore, the local authorities have to prevent this situation by returning 270 people to the North. However, the free immigration in some areas is still as high as 2,8%.

Shifting cultivation and burning forest for fields still exist in some villages. This cultivation pattern has great impacts on the forest resources. Many forests of good quality and high production have been cut down for cultivation land. After being cutting down, the biological cycle of the forest is broken. The concentration of large volume of rainfall during the rainy season and improper cultivation technique lead to reduced productivity. As the households move, they affect the forest resources by cutting woods down for rice fields. In spite of efforts of local government regarding policies on settlement for minor ethnic groups, the burnt forest areas still increase.

• **Planning and management**

The planning of forest resources is not uniform, flexible and fails to take into account the element of market.

There is a boom in areas of industrial trees and woods for paper pulp. In the past few years, the fever of coffee price has stimulated the burning of forest for coffee land. As planned, the coffee area of Dac Lak in 2000 was 120,000 ha. In fact, the figure is as much as 250,000 ha which is equal to 200% of the planned area. However, despite the increased coffee land, the quality is ignored. As a result, the *eugenia* coffee makes up for 95% of coffee production of three provinces of the Central Highlands. In the world market, this kind of coffee can only be sold at half price of *tea* coffee.

In practice, many forests, especially evergreen forests with large volume of high value trees and fertile soils have been destroyed for the planting of less valuable trees as industrial trees. The development of material zones for paper pulp of Kon Tum pulp factory with capacity of 130 tons of pulp/year also means some impacts on the forest resources. A large area of immature and replanting forests have been cut down and replaced by woods for paper pulp. The dislocation of forest also reduced the biological diversification and natural forest areas.

Regarding the exploitation of wood for timber and other specialties, after the reunification of Vietnam, Central Highlands has been providing a large volume of timber, say, the largest quantity in Vietnam. In the past few years, the criteria for timber exploitation have been reduced, yet at the high level. The burning fuels are mainly timber and coal coming from forests. The lost forest areas mean significant impacts on the eco-balance and decrease the protection function of forest.

The investments in forest management are not adequate and forest owners are not fully responsible for their forests. The inappropriate exploitation procedures and poor sanitation have resulted in reduced resources.

Violations of forestry laws as illegal wood exploitation, cutting wood for fuel and coal happen every year. The trading of forestry products still exists. The discovery of some illegal trading of woods had big impacts on the forest quality, e.g. the case of Sa Thay Plantation. Apart from that, some agencies who are allowed to exploit even abuse their rights and break the forest structure. As a result of all the above mentioned violations, the biological diversification and natural forest areas would decline in the near future.

The increased illegal hunting and trading of endangered species are challenging the local government. At present, no effective solution or preventive measure to this situation has been worked out. So far, the problem has been alleviated, yet at the alarming rate. The movements in which the local people hunt animals for exporting to China also make the problem worse and cause the endangered species to become extinct.

The existing shift cultivation practice and free immigration from other areas have led to a large area of forest land destroyed, amounting to 2000-4000 ha/year, which is much greater than the newly replanted forest areas.

Although the traditional practice in agricultural production has been improved, the technical portion is still small which results in unstable production and low quality products and low competitiveness.

In the sub-area, the main industries are electricity supply, exploitation and processing of forestry products. The processing of forestry products has been paid significant attention but due to the lack of proper plan, the material zones have not developed to meet the demands of this sector. The local industries focus on the exploitation of natural resources.

The inefficient management and planning are followed by the unreasonable investment mechanism. For the area is always in lack of water during the dry season, the investments in hydraulic works to supply water for industrial trees is not adequate and effective as taking into account the large area of industrial trees. Moreover, investments in infrastructures for processing industry and technology are limited.

The economic structures shift slowly in sectors of agriculture and forestry. The regional economic structures during period of 1995-2001 showed insignificant changes. In 1995 agriculture and forestry made up for 65%, industry 12%, service 23% and in 2001, the figures are 60%, 14% and 26% respectively. The changes in GDP allocation of the region are smaller than the common trends of Vietnam.

The employment structures need improving. Although the labor source is abundant, there is a high unemployment rate in many sectors. Such industries as garment production, electronic assembly and shoes manufacture have failed to attract labors to create jobs and generate incomes for the employees. In spite of the fact that the living standards of local people have been improved, the gaps between different social classes and regions are still unbridged. 20% of the local population in the Central Highlands area has highest income whereas the other 20% has lowest income with the difference between these two variables is estimated at 13 times compared to 8.9 times nationwide and 7.1times in the North West region.

The scale of international investment in the Central Highlands is so small that it could not bring into full play the technology potential and production management capacity of local businesses and labor sources.

Average income per capita in the sub-area 7V in 2000 is nearly 200 USD/annual which is 2.5 times as much compared to the year 1991, yet lower than the national average income per capita, i.e. 394 USD/annual.

4.2. Possible impacts of water resources development activities

4.2.1. Possible impacts on socio-economic environment

Water resources development activities of the sub-area aim to serve ideologies and directive views for socio-economic development of Central Highlands in general and of the sub-area 7V in particular. In fact, water and energy supply aims to:

- Support industrialization process of the sub-area, gradually increase economic growth rate, create local speculation.
- Serve fast economic structure and labor structure transformation in the direction of industrialization.
- Serve the process of cropping and livestock pattern transformation, develop natural potentials and advantages of the sub-area and closely link with markets. The sub-area has largest industrial croplands of Vietnam. Therefore hydraulic measures serving cultivation sub-sector play a particularly important role to enhance production efficiency and facilitate agro-forestry processing industries.

In particular, water resources development alternatives for the sub-area will basically solve severe water shortage in the dry season in recent years. In addition, they will also contribute to improve and regulate climatic conditions in the sub-area and its surrounding areas.

Economic development of the sub-area will create job opportunities for local people and gradually stabilizing their common life, it will especially help ethnic minorities to stop shift

and burnt cultivation, and reduce deforestation and protect ecological environment of the sub-area.

The Central Highlands sets a target of average GDP growth rate of 10% for the 2000-2010 period (including agriculture and forestry 7.8%, industry and construction 16%, and services 11.6%) that increase average per capita income in 2010 to 2.2 times higher than that in 2000.

Together with great economic benefits, several disadvantages during implementation of water resources development projects can be noted as follows:

- **Resettlement**

Land acquisition and resettlement are unavoidable in implementing structural measures, for instance:

- Construction of weirs and reservoirs
- Channel improvement and building of flood control dike systems
- Irrigation system rehabilitation and development
- Development of domestic and industrial water supply and sewage

Impacts on land acquisition and resettlement caused by development of water supply and sewage usually are insignificant.

Whereas three remaining activities will bring important impacts on people removal as well as on agricultural and residential land acquisition.

- **Ethnic issues**

As discussed above, sub-area 7V is living area of people of 40 different ethnic groups. Construction of reservoirs and water systems force them to remove to other places. This change will considerably influence their living conditions and social situation at new resettlement areas.

- **Community analysis**

Removal of people living in reservoir areas will result in changes in communities, (i) in areas to be removed as well as (ii) in receiving areas.

- **Infrastructure**

Implementation of water structures usually accompanies with changes of existing transport systems. At the same time, economic development will increase consumption and traffic needs requiring necessary investments in existing infrastructure.

- **Culture and history**

It is possible that construction of hydraulic works may have impacts on cultural and historical vestiges because those vestiges are situated in areas to be removed.

- **Landscape**

Impacts on landscape may mainly happen during the construction stage due to modified basin surface. Development of irrigation schemes as well as of water supply and drainage systems usually have limited and locally impacted spheres.

Whereas reservoir building will cause considerable impacts on landscape on large scale. Bank collapse, sedimentation and erosion at downstream are unavoidable.

- **Hygiene and community health**

Possible impacts are as follows:

- Degraded hygiene and community health due to a large number of workers immigrates to the project area.
- Increased epidemic spread and wastes from construction sites.

4.2.2. Possible impacts on ecological environment

Water resources development should be in parallel done with following activities:

- Forest protection and planting
- Construction of regulation reservoirs and multi-purpose reservoirs.
- Agricultural production

Other possible impacts including increased forest coverage, regulated ecological environment, increased groundwater reserves, increased low flows constitute good conditions to conserve rare and precious animal genes, natural reserves, national parks and wetlands. This is the upstream watersheds of the river basin, forest protection and development of the sub-area will therefore exert very considerable impacts on sustaining ecological environment in downstream.

Together with watersheds, reservoirs and multipurpose reservoirs have effect to regulate flows in river basin, improve climate conditions of the sub-area, provide habitat and develop ecological systems in reservoirs.

However, construction of reservoirs and irrigation systems also mean:

- Loss of migration fish-way and breeding areas.
- Land acquisition and loss of animals and vegetation in reservoirs.
- Increased eutrophication in reservoirs
- Disturbed fauna and flora in reservoirs and riparian areas.
- Changed habitat of aquatic systems
- Impacts to special used forests, national parks, conservation zones (see Table 18 in Annex)

Source pollution (large-scale pollution) due to agricultural production activities, application of fertilizers, pesticides and herbicides is inevitable. Therefore possible impacts of sources pollution are significant without any available controlling measures while existing overcoming measures are very costly.

4.2.3. Possible impacts on physical environment

- **Topography and morphology**

Main possible impacts due to construction of reservoirs, dike systems and canal systems include following:

- Increased bank erosion and collapse
- Changed channel topography due to modified flow regime
- Sedimentation in reservoirs and downstream
- Seism in reservoir and surrounding areas

Those impacts are difficult to be measured and evaluated in reality.

• **Surface water**

In parallel to possible positive impact such as increase of low flows in dry season, improvement of climatic ambient, of ecological environment, and minimization of flood caused damages, water resources development may also cause possible negative impacts as follows:

- Eutrophication in reservoirs
- River water pollution due to irrigation, chemical application in agriculture.

• **Groundwater**

- To complement groundwater reserves through watershed development and protection.
- Increased water table thanks to water storage in reservoirs.
- Lowered water table due to water utilization for irrigation, domestic and industrial water supply.

4.3. Possible inter-region and transboundary impacts

Sesan and Srepok are two of the biggest tributaries of Mekong river. These tributaries originate in Central Highlands of Vietnam and run through mountainous areas of Kon Tum, Gia Lai and Dak Lak provinces of Vietnam before flows into North-East region of Cambodia where topography is rather low and flat. Running in East-West direction through Ratanakiri province then Treng province of Cambodia, these tributaries join each other and continue their East-West direction to Sekong river and Sekong river running to Mekong mainstream near Stung Treng township.

Water resources development projects besides their significant benefits usually cause also negative social and environmental impacts. In the extent that a water resources development project has its impacted spheres in a single country, impact assessment is broadly very complex through and impacts are clear. Impact assessment becomes extremely difficult in case a project location is in a single country but its important impacts perform in territories of other countries. Impact prediction is indispensable for the sub-area 7V when implementing water resources development projects in the sub-area in order to propose mitigation and exclusion measures at the most appropriate extent as possible before realization of development planning alternatives.

Following are possible impacts caused by water resources development activities:

4.3.1. Possible impacts of watershed development

Increase of forest coverage in sub-area 7V is one of the objectives set up by the Vietnam Government for the Central Highlands up to 2010. Because this is watershed areas of two tributaries namely Sesan and Srepok, forest development and protection will bring up considerable benefits for the sub-area itself and for the whole lower basin in Cambodia territory and in Mekong Delta. Main inter-regional and trans-boundary impacts include:

- Establishment of habitat for precious endangered species, sustain and development of the genetic sources for the sub-area and surrounding areas.
- Contribution to sustain biodiversity and existing fauna and flora in the region.
- Regulation of river flows in Cambodia territory and in lower Mekong basin, increase of low flows, regulation to minimize damages caused by annual floods, and especially to eliminate flash flood.
- Reduction of soil erosion and sedimentation in downstream.
- Climate regulation for sub-area 7V and its surrounding areas, increase of humidity in the dry season.
- Improvement of river water quality in the dry season thanks to regulation to increased low flows in the dry season.
- Enlargement of coverage to protect from surface erosion, improvement of water quality in downstream and prevention of land loss.

4.3.2. Possible impacts of hydropower development

Proposed reservoir systems in the sub-area 7V are of small scale so their negative impacts are insignificant comparing to their economic, social and environmental benefits. Following are significant impacts.

Positive impacts

- Energy production serving socio-economic development in and outside of the sub-area 7V, and cooperation with Cambodia, Laos and Thailand, especially bordering areas.
- Reservoirs as well as forest development have effects on flow regulation, low flow increase in the dry season for downstream.
- Regulation operation reduces flood caused damages for downstream.
- Increased aquacultural and catching production contributing to change of cropping and livestock patterns in agricultural and fishery production, income increase and living standard enhancement of people in the sub-area along Vietnam and Cambodia borders.
- Creating an ecological environment and aquatic species in reservoir areas.
- Maintaining biodiversity.

Negative impacts

- In line with the peak discharge reduction for downstream, stored water in reservoir will gradually discharged causing prolonged inundation duration in downstream. Also improper operation procedures may cause artificial floods inundating lower parts even in the dry season.
- Migrating fish species may be lost due to construction of weir on rivers. Previous studies showed that at beginning of the dry season, several freshwater fish species of small size and soft fin migrate from Ton Le Sap lake and lower Mekong basin in Cambodia to upstream, even to Sesan river. Changeable water level may disturb their migration

because some species dependent on flow regime will decide themselves not to migrate to upstream.

- Most of fish species are influenced by flow regime changes as well as by water quality variation. Sediments in river flows will deposit and fill up riparian lowlands downstream of weirs causing loss of their habitat and breeding areas.
- Bank collapse and erosion in downstream also increase turbidity, silt load in river water resulting in difficulties to movement and catching quarries by fishes as well as to development of aquatic vegetation.

Several impacts of riparian fauna and flora changes, genetic modification, biodiversity changes are not yet thoroughly considered despite they merit further study.

4.3.3. Possible impacts of agricultural production

- Agricultural production may cause water quality degradation and downstream wetland ecologies resulted from misuse of fertilizers, pesticides and herbicides. These pollutants move in run-offs to rivers or infiltrate in soils causing water pollution and threatening human health in downstream. On the other hand, they also risk life of aquatic species.
- Cultivation development increase erosion and silt load in river and resulting therefore in sedimentation in downstream.

4.3.4. Border cooperation

The water resources development project for sub-area 7V will have positive impacts as follows:

- Economic growth, encouragement of good exchange with other sub-areas in Laos and Cambodia.
- Enhance living standards for ethnic groups in the sub-area in contributing to conservation of national cultural traditions, to security and national defense of border countries.
- Cooperation among countries in ecological protection, flood control and poverty reduction.

V CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

The sub-area covers an area of 30,384km², including the most part of 3 central provinces of Dac Lak, Gia Lai and Kontum. The potentials are agriculture, forestry and hydropower. In order to form a basis for basin development plan, the analysis report of sub-area 7V is carried out using existing data up to 2001, estimated data of socio-economic development by the year 2020 and outputs of forum 1 (11-12 July 2003) in Pleiku. Adhering to principles of applying and fully exploit the data and community consensus, the report studies in depth the strong points and existing problems of the area.

Main issues of the sub-area

- Economic sectors of the sub-area is agriculture, forestry and hydropower
 - There has been rapidly progressive in agriculture. The current trend in agriculture is a central production in which a large scope of products includes such goods as coffee, tea, rubber, pepper, cashew and cotton.
 - Large volume of wood and a forest area making up for one quarter of the whole country and largest plantation coverage.
 - Hydropower is the potential industry which ranks the third national wide. However, the development rate of the sector is still slow and not up to the local potential.
 - Other sub-sectors of fishery, tourism and navigation are not adequately attended.
- The rapidly yet unsustainably developed economy is reflected in following aspects
 - Agricultural production depends greatly on natural conditions, i.e. mainly rainy season
 - The management and utilization of land resource are not appropriate as most of the long term industrial trees are planted on forest land or on unsuitable land.
 - Low quality products with inefficient competitiveness in the market and limited consumption.
 - The infrastructure does not meet the production demands
- The forestry resources are becoming ever exhausted which result in the deterioration of water and soil resources. Frequent floods and droughts with ever increasing magnitudes are constant risks.
- Abundant water resource yet unevenly distributed. The water resources concentrate mainly in rainy season. About 56% water in low flow season is exploited. The forestry resources are becoming exhausted. The exhaustion of flow and water in dry season is attributed to above mentioned reasons.
- The participatory planning is not paid adequate attention. The unavailability of master plans for individual basins explains for the inappropriate land use and water resource exploitation.
- Low literacy and education, high poverty incidence, lack of welfare systems as school, hospital, public transport, high rate of migration result in the fact that large quantity of forests are burnt and damaged every year.
- Such environmental issues as soil erosion, sedimentation, water resource pollution, protection of wetlands are the most concerned which need urgent solutions in terms of water resource management.
- Promoting the irrigated agriculture, hydropower, forestry and other industries which relate to transnational impacts, say, both negative and positive. These impacts should be taken into account during the promotion.

Sub-area assets in need of protection

- Forest: most of the regional forests are in the upstream of river system. The existing forest land covers an area of 1.6 million ha. Most of these lands are of great importance for they not only preserve soils, regulate the water resource, conserve biodiversity but also create an impetus for the development, especially that of minority groups. However, during the past few years, due to ruthless deforestation and over exploitation, the resources become ever exhausted.
- Water resource: with the total surface water volume of 27.8 billion m³ and underground water 9.3 billion m³, the water resources of the sub-area are estimated to be abundant. However, the water intake occurs mostly in the rainy season. The inappropriate exploitation of water resources has resulted in shallow flow and lowered water table to exploitable limitations.
- Soil: diverse types of soils suit various crops and trees. Especially, the area of bazan soil, the good and high fertility soil, represents the largest proportion of the country. This kind of soil is suitable for high valued industrial trees as coffee, rubber, tea ... However, the land resources are being degraded due to the natural and human impacts.
- Human resource: the population in labor range accounts for 71.6%. The labor skills are low with most of them live on agriculture.
- Culture: the ethnic minority community in the sub-area has a wide variety of traditions. There is cultural diversity with typical features of each ethnic minority, namely E De, Ban A, Gia Rai.
- Scarce and endangered species: the natural forests here account for the largest part of the country. Therefore, the quantity and species of animals are numerous. Such scarce and endangered species as tiger, buffalo, rhino ... need urgent protection.
- Landscape and environment: there are many natural landscape and conservatories also need strict protection as Lak reservoir, Easoup park, national park of Jok Don.

Development objectives

- General objectives
 - Promoting the economic development through the shift in economic pattern in terms of modernization, industrialization and formation of a dynamic commodity economy.
 - Developing a sustainable economy basing on the proper use of natural resources
 - Gradually improving and enhancing the living standards of local people; developing a strong and sound politics, equal and civilized society.
 - Enhancing and strengthening the border link with Lao and Cambodia.
- Development objectives of key sectors
 - Agriculture: developing a rapidly and sustainable growing agriculture. Implementation of diversified cultivation and production; agriculture, forestry and processing industry will be combined. The growth rate during period of 2000-2010 is expected to be 5.6%.
 - Forestry: protection of existing natural forests. Fencing and protecting of protection watershed will help preserve soil, regulate the water source and increase the forest coverage to 65% by the year 2010.
 - Hydropower: development of hydropower structures in the main flows in order to meet the national power demand and provide electricity for the mountainous areas.

These structures will help regulate the water supply for agriculture and domestic use, having taking into account the transnational impacts.

5.2 Recommendations

1. Sub-area 7V is located in watershed areas of Sesan, Srepok and Sekong rivers, ecological environment of the sub-area accordingly have impacts not only on production and common lives of millions of people in the sub-area itself but also on other millions of people in downstream of Laos and Cambodia. Therefore, an integrated basin development plan is required.
2. Development of small and medium water resources structures in remote areas aims to supply domestic water, serve agricultural production for the ultimate purpose of settling down local life, especially of ethnic minority groups, limiting deforestation and reducing poverty rate.
3. Hydropower development will have positive impacts on flow regulation in dry and flood seasons, increase of ecological environment security. However a study on operation procedures and establishment of a sufficient information network is necessary for downstream sub-areas.
4. Strict management of sewage and disposal system construction is indispensable in order to ensure water hygiene, water storage for the dry season, overexploitation prevention, ecological balance, and deep investments in management aiming to reduce water losses.

There should be a suitable and appropriate regime and policies for a long term and sustained border cooperation between three countries of Vietnam, Lao and Cambodia.

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16. Flood control planning for Kon Tum province
17. Irrigation planning for Dac Lak province
18. Irrigation planning for Gia Lai province
19. Plan of the shift in agriculture-forestry production patterns in the Central Highlands

ANNEX

Annex 1 AVERAGE TEMPERATURE IN MANY YEARS IN DIFFERENT LOCATIONS IN THE REGION (°C)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Kon Tum	20	22	24	25	25	25	24	24	24	23	22	20	23.2
Plei Ku	19	20	22	24	24	23	22	22	22	22	20	19	21.7
Dac to	18	21	23	24	24	24	22	23	23	22	21	19	22.1
Buon Me Thuat	21	22.6	24.8	26.3	25.8	24.7	24.3	24	23.9	23.4	22.2	20.9	23.7
Buon Ho	18.4	20.2	22.4	24.1	24.2	23.1	22.2	22.4	22.3	21.5	20	18.6	21.6
Dak Mil	20.1	21.7	23.7	24.5	24.3	23.6	23.3	23.1	22.9	22.2	20.8	19.4	22.5
Lak	21.4	22.6	24.7	26	25.9	24.9	24.6	20	24.2	23.6	22.6	21	23.5
M'Drak	20	21.3	23.6	25.4	26.1	25.9	25.7	25.5	24.6	23.3	21.9	20.1	23.6
Dak Nong	19.9	21.2	22.8	23.8	23.9	23.1	22.7	22.6	22.6	22.3	21.6	20.2	22.2

Source: Institute of Water Resource Planning

Annex 2 AVERAGE MONTHLY RELATIVE AIR HUMIDITY IN MANY YEARS AT STATIONS (%)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Kon Tum	71	68	68	72	81	85	87	88	87	83	78	74	78
Plei Ku	77	74	72	75	84	90	92	93	91	87	82	79	83
Dac to	74	72	72	77	83	88	89	89	88	84	80	77	81
Buon Me Thuat	76.6	73.1	70.4	71.3	79.4	85.4	86.9	88.3	88.9	86.8	83.3	81.0	81.0
Buon Ho	84.7	79.2	75.7	75.4	80.8	87.1	88.9	90.3	90.1	89.2	88.9	87.7	84.8
M'Drak	87.7	84.9	80.8	79.5	79.7	79.3	78.8	78.3	84.9	88.9	90.5	90.2	83.6

Source: Water resource planning in provinces of Gia Lai, Dak Lak, Kon tum

Annex 3 MONTHLY PICHE EVAPORATION IN MANY YEARS AT DIFFERENT STATIONS (mm)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Kon Tum	170	176	203	160	109	71	63	63	56	86	116	150	1414
Plei Ku	122	134	159	136	86	50	41	35	39	59	84	107	1050
Dac to	131	139	176	137	92	57	55	46	51	55	95	118	1151
Buon Me Thuat	177	189	224	192	123	77	69	63	52	76	99	132	1473
Buon Ho	94	120	166	157	131	94	80	70	62	60	60	69	1162
M'Drak	77	90	134	137	125	140	151	157	90	61	52	56	1272
Dak Nong	109	113	126	122	71	54	52	46	44	55	77	100	969

Source: Institute of Water Resource Planning

Annex 4 MONTHLY AVERAGE WIND SPEED IN MANY YEARS AT SPECIFIED STATIONS (m/s)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Kon Tum	1.7	1.6	1.4	1.1	0.9	0.9	0.8	0.9	0.7	1	1.8	1.9	1.2
Plei Ku	2.9	2.9	2.7	2.1	2.0	2.9	2.8	3.3	1.9	2.0	3.1	3.2	2.7
Dac To	1.1	0.9	1.1	0.9	0.9	1.1	0.7	0.8	0.6	0.7	1.2	1.3	0.9
Ban Ma Thuat	5.1	4.5	3.7	2.6	1.5	1.4	1.4	1.3	1.3	2.1	3.5	4.5	2.7

Source: Institute of Water Resource Planning

Annex 5 ANNUAL RAINFALLS AT SOME STATION (mm)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Kon Tum	0.7	10.0	25.3	86.3	231	275	275	312	284	173	47.2	7.3	1730
Plei Ku	3.9	5.6	2.9	80.0	238	366	375	490	383	208	70	11.5	2260
Dac to	2.3	8.4	48	87	235	295	312	430	282	153	57	12	1920
BMT	4.0	1.8	24.9	86.4	244.6	188.4	258	316.6	301.5	253.8	79.9	16	1870.7
Giang Son	0.4	4.5	17.1	101.9	216.1	250.9	268.6	297.6	299.1	260	131.3	40	1887.5
M'Drak	33.7	15.8	32.3	77.7	171.9	119.5	124.0	106.0	214.8	430.2	412.8	197.1	1935.7
Duc Xuyen	1.2	5.7	27.0	105.1	238.9	279.9	279.1	302.2	311.2	235.3	97.0	18.1	1900.8
Bridge 14	2.2	4.3	15.9	83.1	253.4	244.8	231.3	267.6	291.4	238.0	83.8	13.6	1728.3
Ban Don	1.1	3.8	23.8	102.7	213.5	243.8	238.3	248.3	256.2	203.0	75.1	12.6	1622.0

Source: Institute of Water Resource Planning

Annex 6 MAXIMUM 1-DAY & 3-DAY RAINFALLS AT SOME STATIONS (mm)

STATION	Maximum 1-day rainfall		Maximum 3-day rainfall	
	X mm	Date	X mm	Date
Dak Glei	197.4	2/11/1996	266.6	2/11-4/11/1996 2/8-
Dak To	163.5	3/8/1996	285.1	4/8/1996 17/9-
Trung nghia	134.9	18/9/1996	272.3	19/9/1996
Sa Thay	286.0	18/9/1996	320.8	
Kon Tum	141.0	18/9/1996	301.0	17/9-19/9/1996
Dak To ve	159.0	2/11/1996		
Krong Bong			417,6	23-25/X/1992 22-
Buon Ho	190,6	23-X-1992 23-X-	196.5 219	24/X/1992 23-
Giang Son	141,4	1992 23-X-1992	192,6	25/X/1992 22-
Duc Xuyen	106,4 99,4	24-X-1992 23-X-	256,2	24/X/1992 22-
Lak	142 140,4	1992 23-X-1992	291,5	24/X/1992 23-
Buon Ma Thuat				25/X/1992

Source: Institute of Water Resource Planning

Annex 7 CHARACTERISTICS OF AVERAGE FLOW IN MANY YEARS AND VARIATION OF ANNUAL FLOW OF SOME STATIONS

Station	River	Catchment area (km ²)	Mbq (l/s/km ²)	Mmax (l/s/km ²)	Year	Mmin (l/s/km ²)	Year	Mmax Mbq	Mmax Mmin
Giang Son	Krong Ana	3180	21.4	37.22	1981	10.51	1983	1.74	3.54
Duc Xuyen	Krong Kno	3080	33.1	47.17	1996	20.80	1995	1.43	2.27
Bridge 14	Srepok	8670	25.5	41.15	1996	17.82	1991	1.61	2.31
Ban Don	Srepok	10700	24.1	37.50	1996	16.93	1991	1.56	2.22
Dak Bla	Dak Bla	2968	32.6	48.7	1996	18.1	1977	1.49	1.81

Source: Institute of Water Resource Planning

Annex 8 BIGGEST FLOODS IN THE REGION AT STATIONS

Station	River	Catchment area (km ²)	Q _{max} (m ³ /s)	M _{flood} (m ³ /s.km ²)	Time
Dak Bla	Dak Bla	2968	4320	1.46	X/1972
			3620	1.22	3/XI/1996
Trung Nghiiia	Krong Po Ko	3320	2540	0.77	6/IX/1994
			2440	0.73	3/XI/1996
Giang Son	Krong Ana	3180	1620	0.51	22/XI/1998
Duc Xuyen	Krong Kno	3080	4020	1.31	10/X/2000
Bridge 14	Srepok	8610	3600	0.42	12/X/2000
Don village	Srepok	10700	3310	0.31	4/X/1993

Source: Institute of Water Resource Planning

Annex 9 FLOOD PEAK DISCHARGES IN CORRESPONDING TO DESIGNED FREQUENCIES

Station	Catchment area (km ²)	Period	Q _{max} (m ³ /s)	Cv	Cs	Q _{max} p% (m ³ /s)			
						0,1%	1%	5%	10%
Dak Bla	2968	1976-2001	1551	0.5	1.20	5340	4000	3030	2585
Giang Son	3180	1977-2000	550	0.80	2.00	3221	2140	1418	1114
Duc Xuyen	3080	1978-2000	1110	0.85	2.50	7491	4732	2970	2263
Bridge 14	8610	1976-2000	1100	0.85	3.00	8033	4863	2920	2173
Don village	10700	1977-1998	1484	0.50	2.00	5851	4070	2880	2380
Krong Buk	478	1976-1998	259	0.38	0.16	595	507	432	393
Krong Bong	788	1977-1987	310	0.62	1.35	1134	804	574	473
Buon Hô	178	1977-1987	21.5	0.62	2.40	110	72	48	38

Source: Institute of Water Resource Planning

Anex 10 STATICSTICAL CHARACTERISTICS OF TOTAL FLOOD DISCHARGE OF PERIODICAL FLOOD AT DIFFERENT LOCATIONS (mil. m³)

Station	Period	Kind	Mean discharge (10 ⁶ m ³)	Cv	Cs	Wp % (10 ⁶ m ³)			
						1%	2%	5%	10%
Kon Tum Song Dak Bla	1977- 2001	W1max	81.0	0.52	1.84	230	201	164	136
		W3max	157.6	0.43	1.06	365	332	285	248
		W5max	210.6	0.40	0.62	444	410	362	322
		W7max	261.4	0.40	0.41	536	499	445	399

Source: Institute of Water Resource Planning

Annex 11 STATISTICAL CHARACTERISTICS OF TOTAL FLOOD DISCHARGE OF PERIODICAL FLOOD AT DIFFERENT LOCATIONS (mil. m³)

Station	Period	Kind	Mean discharge (10 ⁶ m ³)	Cv	Cs	Design features (10 ⁶ m ³)			
						1%	2%	5%	10%
Giang Son	1977-2000	W1max	46.0	0.82	2.10	184	156	120	94
		W3max	130.0	0.75	1.80	472	407	321	257
		W5max	200.0	0.69	1.75	681	590	470	380
		W7max	260.4	0.67	1.75	868	753	602	488
		W10max	338.0	0.62	1.20	1000	887	737	617
		W15max	447.4	0.60	1.50	1345	1183	968	802
Duc Xuyen	1978-2000	W1max	73.9	0.80	2.40	299	251	191	147
		W3max	169.1	0.80	2.80	705	584	434	329
		W5max	235.9	0.75	2.80	936	779	583	445
		W7max	296.0	0.70	3.0	1130	937	699	534
		W10max	374.1	0.65	3.0	1353	1127	848	653
		W15max	488.3	0.60	3.20	1685	1402	1054	815
Bridge 14	1977-2000	W1max	92.0	1.0	3.0	462	377	271	198
		W3max	265.0	0.95	3.0	1278	1044	755	554
		W5max	415.0	0.90	3.0	1918	1571	1142	844
		W7max	560.0	0.80	3.0	2363	1947	1432	1074
		W10max	740.5	0.75	3.0	2976	2460	1822	1378
		W15max	1010	0.65	2.70	3584	3014	2300	1794

Source: Institute of Water Resource Planning

Annex 12 MEASUREMENT RESULT OF LOW FLOW AT SOME STATIONS

Station	River	Catchment area Km ²	Monthly low flow					Daily low flow				
			Mtb L/s/km ²	Mmax L/s/km ²	Year	Mmin L/s/km ²	Year	Mtb L/s/km ²	Mmax L/s/km ²	nam	Mmin L/s/km ²	Year
Buon ho		178	7.27	12.30	81	3.54	78	5.38	8.71	85	2.64	78
Bridge 42		458	4.18	11.62	85	0.59	95	1.58	5.55	82	0	77
Krong Bong		788	6.82	12.40	82	3.49	83	4.54	6.45	82	2.64	77
Giang Son	Krong Ana	3180	4.31	8.17	94	1.77	83	2.87	5.63	94	1.11	83
Duc Xuyen	Krong Kno	3080	8.49	12.53	85	4.51	86	5.91	9.38	94	3.03	86
Bridge 14	Sre pok	8610	6.42	9.57	85	3.11	98	4.75	7.04	82	1.56	98
Don village	Sre pok	10700	5.83	10.37	82	2.56	98	3.70	8.64	82	1.14	98
Dak Nong		280	4.02	7.61	94	1.89	81	1.77	3.37	89	0.36	83
Dak Bla	Dak Bla	2968	10.8	15.9	97	5.8	83	8.0	11.6	97	4.7	77,98
Sa Binh		6732				10					7.42	83
Trung Nghia						7.53					4.06	88
Dak Kâm		154				3.7	77				0.65	80

Source: Institute of Water Resource Planning

Annex 13 EXISTING LAND USE IN SUB-AREA 7V IN 2001 (ha)

No	Land use	3 Provinces of CH	Sub-area 7V			
			Total	Dak Lak	Gia Lai	Kon Tum
	Total areas	4468794	3038400	1529511	642323	866568
I	Agricultural lands	990620	676385	400935	188650	86800
	Annual crop lands	442279	264465	157997	55995	50473
A	Rice & subsidiary crops	104572	70110	45993	15388	8729
	Double crops	37980	26566	14709	7101	4756
	Single crop	66592	43544	31284	8286	3974
B	Uplands	144372	72130	23813	24057	24260
C	Other annual crop lands	193336	122225	88192	16550	17484
	Miscellaneous garden	65578	47958	19475	22598	5886
	Perennial croplands	477089	359819	219610	109996	30213
	Grazing	3968	2946	2920	26	0
	Fishery area	1706	1197	933	36	228
II	Forestry lands	2452469	1649892	813900	286150	549842
III	Special-use lands	115893	85145	42889	29059	13197
IV	Residential areas	26881	18965	11387	4556	3022
V	Non-used lands	882932	608013	260400	133907	213706
	Flat non-used lands	51792	38028	22407	13283	2337
	Hilly non-used lands	750002	518390	204797	113277	200317
	Water surface areas	4528	4314	4050	249	16
	Other non-used lands	76610	48746	29146	8563	11037

Source: Synthesis of land inventory data in 2001 (by districts) of Gia Lai, Dak Lak and Kon Tum provinces.

Annex 14 VARIATION OF SOWN AREAS IN 1995 –2001 PERIOD (ha)

No	Crop	3 provinces of CH		Sub-area 7V	
		1995	2001	1995	2001
Total grown areas		535539	908812	350928	609050
A	Annual crops	301414	426548	187623	254971
I	Food crops	175319	238136	112726	139041
1	Rice	139938	148282	93809	95514
a	Winter-spring rice	25095	41720	17977	24783
b	Autumn rice	114843	106562	75832	70731
2	Maize	35381	89854	18917	43527
II	Powder tuber crops	38660	44968	20962	26736
1	Cassava	29139	36474	15788	22129
2	Sweet potato	9091	6371	4852	3391
3	Others	430	2123	323	1216
III	Bean	37484	61397	19325	33814
IV	Short-term industrial crops	49951	82047	34609	55379
1	Groundnut	22522	21426	17468	16765
2	Sesame	1882	5298	72	248
3	Sugar cane	10625	23900	5285	9908
4	Cigarette	1509	1351	0	41
5	Cotton	1827	14600	1725	13746
6	Others	11586	15472	10060	14671
B	Perennial crops	234125	482264	163305	354079
I	Perennial industrial crops	227860	474385	159332	348609
1	Coffee	158001	354470	114239	259974
2	Rubber	45335	96457	36634	80174
3	Tea	2063	1108	1770	966
4	Pepper	1143	8096	394	3118
5	Cashew	20787	13857	6182	4286
6	Others	9836	397	113	91
II	Fruit trees	6265	7879	3973	5470

Source: Synthesis from Statistical Yearbooks of Gia Lai, Dak Lak and Kon Tum Provinces

Annex 15 ALLOCATION OF DIFFERENT CROP AREAS (1000 ha)

Crops	2001				2010			
	Total	Dak Lak	Gia Lai	Kon Tum	Total	Dak Lak	Gia Lai	Kon Tum
Year round rice	95.51	52.09	24.35	19.07	117.08	62.48	32.71	21.89
Winter rice	24.78	15.87	5.22	3.70	44.32	23.26	10.79	10.27
Summer rice	70.73	36.23	19.13	15.37	72.56	39.44	21.33	11.79
Maize	43.53	35.25	4.28	4.00	63.85	48.50	6.37	8.98

Source: Plan of the shift in agriculture-forestry production pattern of Central Highlands

Annex 16 ALLOCATIONS OF SHORT-TERM INDUSTRIAL TREES (1000 ha)

Crops	2001				2010			
	Total	Dak Lak	Gia Lai	Kon Tum	Total	Dak Lak	Gia Lai	Kon Tum
Sugarcane	9.91	5.81	0.60	3.50	15.98	10.20	0.91	4.87
Cotton	9.35	9.35	0.00	0.00	25.00	25.00	0.00	0.00
Peanut	16.77	13.43	2.95	0.38	27.19	23.57	3.61	0.00

Source: Plan of the shift in agriculture-forestry production pattern of Central Highlands

Annex 17 ALLOCATIONS OF LONG TERM INDUSTRIAL TREES (1000 ha)

Crops	2001				2010			
	Total	Dak Lak	Gia Lai	Kon Tum	Total	Dak Lak	Gia Lai	Kon Tum
Coffee	259.97	183.31	62.85	13.81	208.6	141.5	54.3	12.8
Rubber	80.17	19.40	46.81	13.96	137.6	36.7	64.6	36.4
Tea	0.97	0.07	0.86	0.04	1.5	0.2	1.3	0.0
Pepper	3.12	1.89	1.19	0.04	5.3	2.9	2.1	0.3
Cashew	4.29	3.64	0.56	0.08	14.6	10.9	2.4	1.3

Source: Plan of the shift in agriculture-forestry production pattern of Central Highlands

Annex 18 LIST OF TOURIST ESTABLISHMENTS IN 7V SUB-AREA

No.	Locations	Province
I	National park	
	Yok Don	Dak Lak
II	Natural conservatory	
	Chu Yang Sinh	Dak Lak
	Chu MoRay	Kon Tum
	Kon Ka Kinh	Gia Lai
	Kong Cha Rang	Gia Lai
	Ngoc Linh	Kon Tum
	Lak lake	Dak Lak
III	Tourist attractions	
	DRay Sap waterfall	Dak Lak
	Trinh nu waterfall	Dak Lak
	Dray H Linh	Dak Lak
	Lak lake	Dak Lak
	Bien Ho lake	Gia Lai
	Ia Ly reservoir	Kon Tum

Source: Overview of Vietnam tourism

Annex 19 LIST OF HYDRO-POWER CASCADES ON THE MAIN FLOWS OF THE SE SAN AND SREPOK RIVERS

No.	Works	Catchment area (Km2)	Nlm (MW)	Eo (GMH)	Note
I	Se san river basin		1743	8226	
	Upper Kon Tum	350	220	945	Expected 2010
	PLei KRong	3224	100	675	Expected 2010
	YaLy	7455	720	3650	Existing
	Se san 3	7795	273	1127	Under construction
	Se san 3 A	8084	100	481	Under construction
	Se san 4	9326	330	1.348	Expected 2010
II	Se RePok river basin		694	3329	
	Duc Xuyen	1100	58	196	
	Buon Tua Srah	2930	85	335	Expected 2010
	Chu Bong KRong	3860	23	88	Expected 2010
	Buon Kuop	7980	280	1372	Expected 2010
	DRay HLinH	8880	28	194	Existing
	SRePok 3	9410	180	931	Expected 2010
	SRePok 4	10700	40	213	

Source: EVN

Annex 20 LIST OF SOME SPECIAL FORESTS IN SUB-AREA 7V

Forest	Province	Type of forest	Area (ha)	Year of recognition
Chu Mon Ray	Kon Tum	National park	48 658	1982
Yok Don	Dac Lac	National park	115 545	1991
Chu Yang Sin	Dac Lac	National park	54 227	1986
Chu Mom Ray	Kon Tum	Natural conservatory	48 658	1982
Ea So	Dac Lac	Natural conservatory	22 000	
Ngọc Linh Kon Tum	Kon Tum	Natural conservatory	41 424	1986
Ho Lak	Dac Lac	Cultural-traditiona-environmental conservatory	12 744	1986
Ea So	Dac Lac	Natural conservatory	22 000	
Kon Cha Rang	Gia Lai	Natural conservatory	24 000	1986
Kon Ka Kinh	Gia Lai	Natural conservatory	41 710	1986

Source: UNDP