SOCIALIST REPUBLIC OF VIETNAM

DATA COLLECTION SURVEY ON WATER RESOURCES MANAGEMENT IN CENTRAL HIGHLANDS

FINAL REPORT

Main Report

April 2018

Japan International Cooperation Agency (JICA)

Nippon Koei Co., Ltd.

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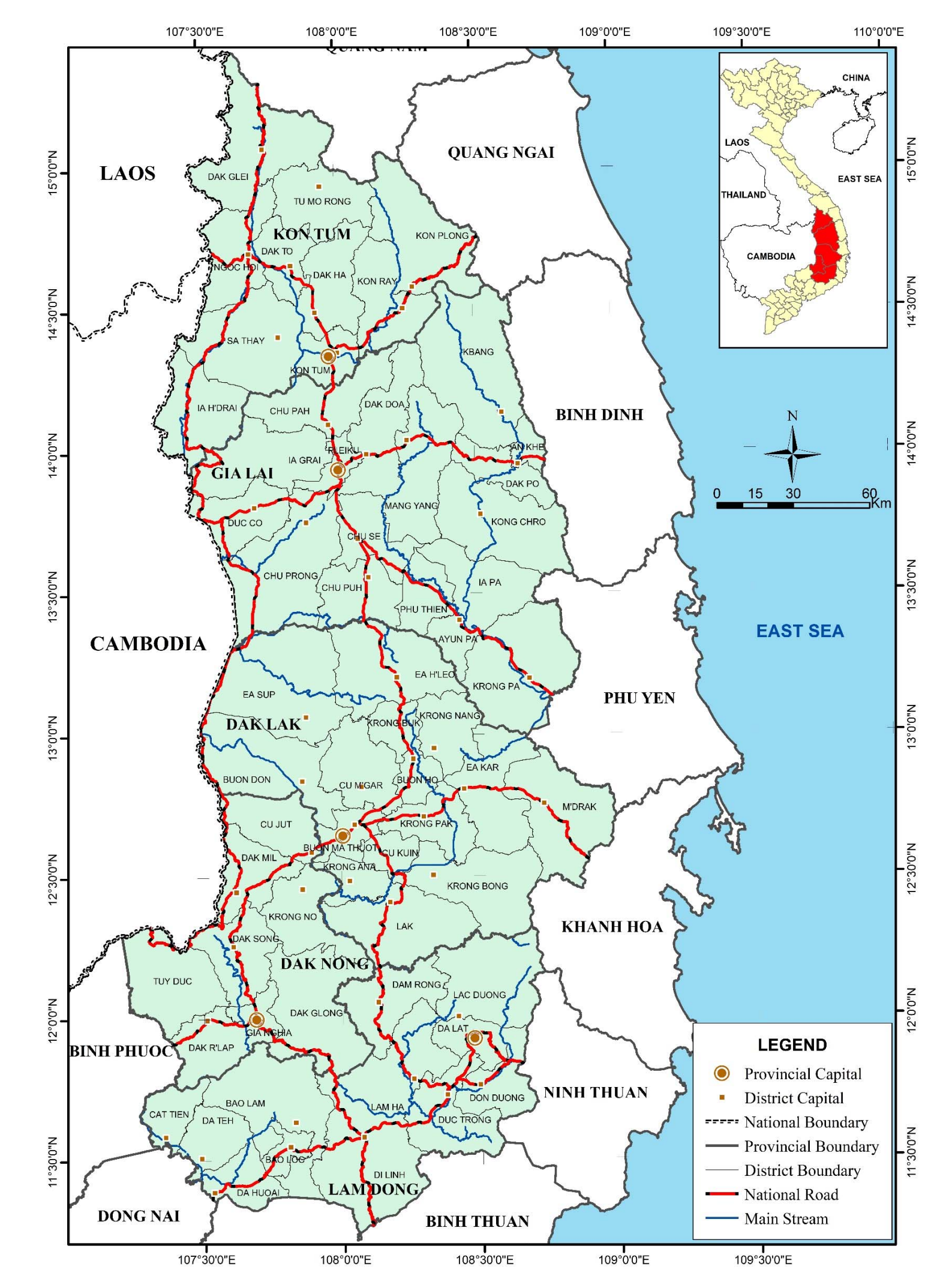
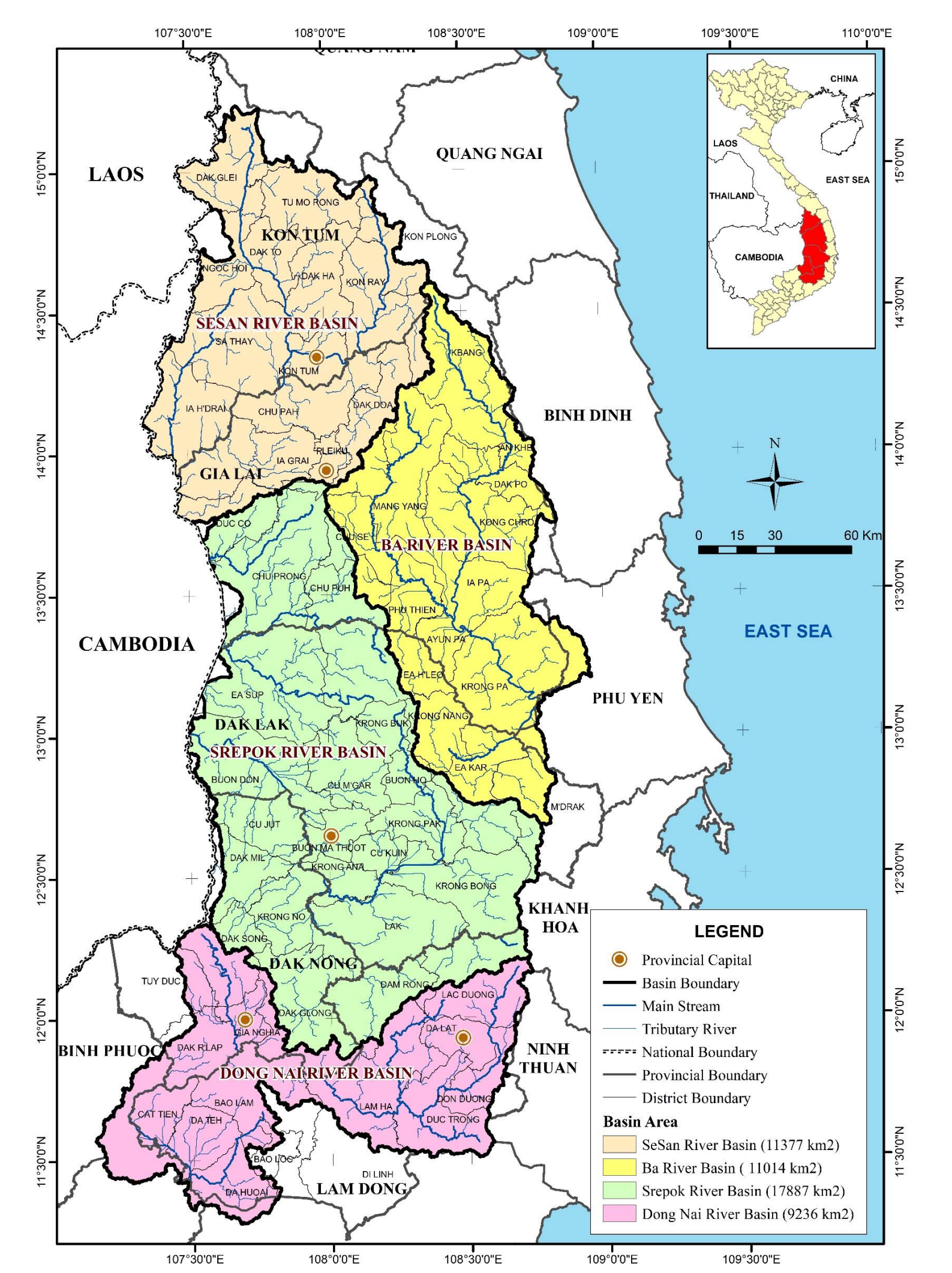


Location Map of Central Highlands



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Source: JICA Study Team

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Source: JICA Study Team

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Source: JICA Study Team

Summary

1. Background and Objectives

Attributed to El Niño weather event, the provinces of Central Highlands, Central and South coastal areas, and the Mekong River Delta were severely affected by the drought from the end of 2015 to 2016 and resulting in extended saltwater intrusion. According to the data released by the Ministry of Agriculture and Rural Development (MARD), agriculture land was damaged in the Central and South coastal areas and Central Highlands, out of which, paddy yields of 40,000 ha dropped and other perennial and annual crops of 12,000 ha faced water shortage. The level of water in the reservoirs and dams for hydropower generation sharply declined from 20% to 50% of their design storage capacity in the above regions, among which Central Highlands saw approximately 200 small-scale reservoirs drying up.

Along with the immediate actions for food aid and water supply by the Government of Vietnam (GOVN), United Nations (UN) agencies, and MARD called for urgent assistances worth USD 4.85 million to foreign diplomatic missions in Vietnam from bilateral and international development partners. The Government of Japan (GOJ) agreed with the GOVN to assess damages and losses caused by the drought in Central Highlands and examine medium- and long-term countermeasures. The Japan International Cooperation Agency (JICA), in response, decided to conduct the Data Collection Survey on Water Resources Management in Central Highlands, in which the experiences and lessons collected in the past projects and studies for rural and agricultural development, disaster prevention, water resource development, and climate change are to be reflected best and most.

The objective of the Study is to collect and assess the existing data and information in the Central Highlands necessary for water resources management, specifically agricultural water management, based on the request from MARD and the five provinces of the Central Highlands and the past JICA assistance. The study result shall contribute preparation of medium- and long-term disaster prevention measures.

2. Policy on Natural Disasters, Agriculture and Rural Development, and Water Resources Management in Vietnam

Socioeconomic Development Strategy (SEDS) for the Period of 2011-2020

Vietnam has a ten-year strategy from 2011 up to 2020, the Socioeconomic Development Strategy (SEDS), in which promotion of human resources/skills development, improvement of market institutions, and infrastructure development were targeted. There have been two five-year development plans in the period to realize SEDS: Socioeconomic Development Plan (SEDP) 2011-2015 and SEDP 2016-2020. The first five-year plan intended to achieve high quality and sustainable economic growth, improve living standards of ethnic minorities, strengthen environmental protection; and mitigate and prevent adverse impacts caused by climate change. SEDP 2011-2015, however, saw a slower growth in the country's gross domestic product (GDP), and bigger budget deficit than expected as a result. Achievements in forest cover were far below their targets in all five provinces, among which Dak Lak and Dak Nong experienced huge losses. The second five-year plan has been implemented since 2016 to accelerate the reforms to achieve the target set in SEDS.

National Target Program (NTP) on New Rural Development (NRD)

The NTP for new rural development is intended to build new-style rural areas for lifting living standards, developing socioeconomic infrastructure, and achieving economic reform and production models, to combine agricultural development with that of urban areas, and to create a democratic, equal, and stable rural society imbued with traditional cultural identities. Under the programme, basic infrastructures such as roads, electricity, clean water, schools, and medical stations shall be developed to meet the local needs. By 2020, at least 50% of all communes throughout the country are expected to meet the criteria of new-style rural commune, and each province is encouraged to have at least one district completing the criteria

of new-style rural district. In Central Highlands, 123 communes and one district have already reached the criteria, as of 2016.

Strategy on Agriculture and Rural Development for 2011-2020

The overall objectives of the strategy are: 1) to ensure a comprehensive agricultural development towards modernization, 2) to construct new rural infrastructure, link agriculture with other sectors, ensure stable rural society, protect ecological environment, strengthen political system in rural areas; and 3) to improve the living standard, create fast and lasting changes in difficult areas, and allocate trained farmers for production. Under the second five-year period, 2016-2020, agricultural development towards a comprehensive, modern, sustainable, and large-scale commodity production, rural development associated with industrialization and urbanization, income increase and improvement of basic conditions of rural living and environmental protection are targeted. As for Central Highlands, 1) develop large-scale area of perennial industrial crops with high quality, develop the processing industry to add values to annual crop productions, establish major wholesale markets at international level, 2) develop livestock with high quality to meet domestic demand, 3) protect the protection forests, special-use forests, and develop the non-timber forest products, develop aquaculture, and develop traditional craft villages, and 4) poverty alleviation for ethnic minorities are proposed.

National Strategy on Water Resources to 2020

The overall objectives are: 1) to protect, efficiently exploit, sustainably develop national water resources, 2) to take initiative in prevention, mitigation, and minimization of water hazards, 3) to create a multi-sectoral water economy, and 4) to cooperate efficiently by harmonizing the interests of countries sharing water sources with Vietnam. The strategy specifies the issues on water pollution and over-exploitation of the Dong Nai River, and water resources development and flood protection in Central Highlands.

National Strategy for Natural Disaster Prevention, Response, and Mitigation to 2020

The strategy states specific objectives: 1) capacity enhancement for disaster forecast, 2) integration of plans for disaster prevention, response, and mitigation with development plans, 3) capacity development in disaster prevention, response, and mitigation for field staff and more than 70% of population living in disaster-prone areas, 4) relocation from disaster-prone area to safe area, 5) adequate investment for construction and procurement of infrastructure and facility and for human resources development, 6) construction of storm shelters for boats and ships, and 7) assurance of offshore fishing boats possessing communication equipment. As for Central Highlands, proactive approach is applied as: 1) to define and map vulnerable areas in flash floods and landslides, 2) to establish plans of land use, residence, evacuation, cropping, and exploitation of natural resources, 3) to develop warning and communication system at commune level, 4) to construct/improve infrastructure for landslide and flash flood prevention, flood discharge capacity expansion, and flood and drought control, and 5) to strengthen the cooperation with bordering countries in disaster forecasting, warning, searching, and rescuing.

3. Current Condition of the Five Provinces in Central Highlands and Natural Disasters

Climate Condition

Central Highlands is in the tropical climate zone except for the mountainous area that belongs to the temperate zone. Unlike other parts of Vietnam, the region has four distinct seasons. The climate conditions in the five provinces are summarized as follows:

Table S.1 Climate Condition of the Five Provinces

Province	Temperature (˚C)		Annual Rainfall (mm)	Wind Velocity (m/sec)		Humidity (%)		Sunshine Hours (hours)	
	min – max	(ave.)		min – max	(ave.)	min – max	(ave.)	min – max	(ave.)
Kon Tum	19.1 – 24.6	(22.5)	1,816	0.49 - 1.07	(0.77)	71.34 - 89.62	(80.99)	111 – 269	(191)
Gia Lai	22.7 – 28.4	(26.0)	1,606	0.90 - 1.89	(1.43)	70.81 - 85.58	(78.93)	147 – 268	(203)
Dak Lak	21.2 – 26.2	(23.8)	1,843	1.55 - 4.46	(2.65)	71.75 - 88.82	(81.59)	152 – 271	(206)
Dak Nong	19.9 – 24.7	(22.6)	1,687	1.19 - 2.33	(1.76)	74.63 - 87.83	(82.80)	132 – 218	(176)
Lam Dong	16.1 – 19.8	(18.3)	1,860	1.30 - 3.00	(1.96)	76.85 - 89.56	(84.56)	129 – 242	(181)

Note: The table represents those from several meteorological observatory stations in each province.
Source: JICA Study Team, based on rainfall observation data by NHMS/MONRE.

The latest climate change scenario updated by the Vietnam Institute of Meteorology, Hydrology, and Climate Change in 2015 estimated that average temperature at the end of 21st century will rise between 1.7 and 2.4 ˚C under medium emission scenario, and reach 4˚C under high emission scenario. They project heavier rainfall in the rainy season while rainfall decreases in the dry season, resulting in 5% to 15% increase in annual rainfall. The increase is not only annual rainfall but the rainfall intensity too.

Natural Condition

Central Highlands lies on plateaus elevated from 500 m to 1,500 m, mountains from 500 m to 2,400 m, and lowlands and plains including valley from 140 m to 500 m. The topography of the region slopes gradually from the east down to the west. There are three kinds of soils, Ferric Acrisols, Rhodic Ferralsols, and Humic Acrisols, all of which are suitable for agriculture and forestry sector. The region locates one of the most ancient belts in southern part of Vietnam consisting of Kon Tum, Srepok, and Da Lat belts. They belong to a large-scale structure of the Truong Son orogenic belt of Indochina block. The basement and cover rocks are Archean-Proterozoic and Early to Middle Paleozoic, respectively.

The aquifers in Central Highlands are categorized into two groups: porous and fissure aquifers. The porous aquifer group consists of i) Aquifers in Holocene sediments, ii) Aquifers in Pleistocene sediments, and iii) Aquifers in Neogene sediments. The fissure group consists of i) Aquifers in Middle Pleistocene basalt, ii) Aquifers in Pliocene-Pleistocene basalt, iii) Aquifers in Upper Cretaceous sediments, iv) Aquifers in Lower Middle Jurassic sediments, and v) Aquifers in Neoproterozoic metamorphic formations. Among them, Pleistocene and Pliocene-Pleistocene basalts are the most productive and important aquifer for their large distribution, thickness, high availability, and quality.

River Basins

Central Highlands is divided mainly into four river systems of the Se San River, Ba River, Srepok River, and Dong Nai River. The outline of those river basins is as follows:

Table S.2 Outline of the Four River Basins in Central Highlands

River Basin	Catchment Area (km^2)/1	Elevation (m)	Daily specific Discharge (m^3/sec/100 km^2)		Largest Discharge (m^3/sec)
			Annual Average	Six-month Flow/2	
Se San	11,377	129 – 2,390	2.1 – 3.3	2.1	3,500 (2009) at Kon Tum
Ba	10,779	86 – 1,745	0.8 – 1.5	1.0	1,620 (2016) at An Khe
Srepok	17,887	140 – 2,409	0.8 – 2.5	1.8	3,220 (2000) at Ban Don
Dong Nai	9,236	92 – 2,280	2.1 – 2.6	2.6	147 (2006) at Dak Nong

Note: /1: catchment area within Central Highlands only. /2: In other words, it indicates "50% exceedance of daily discharge", the bottom line discharge amount recorded more than 180 days in a year.
Source: JICA Study Team, IUCN, based on discharge observation data by HMS/MONRE.

Demographic Features

The population and administrative units of five provinces in Central Highlands are summarized as follows:

Table S.3 Administration and Population of Central Highlands in 2016

Item	Unit	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
Geographical area	km^2	9,674	15,511	13,030	6,509	9,783
Population in 2016	person	507,818	1,417,259	1,874,459	609,595	1,285,943
Share of rural population	%	64.4	70.1	75.6	84.8	60.8
Population density	person/km^2	52	91	143	94	131
Administration unit at the district level and above	No.	10	17	15	8	12
City	-	1	1	1	0	2
Town	-	0	2	1	1	0
District	-	9	14	13	7	10
Communes under city, town, and district (total)	No.	102	222	184	71	147

Source: Provincial Statistical Yearbook 2016

Ethnic minorities share 36.4% of total population in Central Highlands, and the largest rate of ethnic minority population is found in Kon Tum at 54.9%. Poverty incidence in Central Highlands is at 15.3% on average, the worst poverty rate is found in Kon Tum at 23.0%. To Central Highlands, there are large number of people migrated from outside provinces, among which those in rural areas of Kon Tum and Dak Nong far excessed. Migrations of the rest three provinces mostly occurred within their provinces.

Land Use

The present land use in Central Highlands is summarized as follows. In all five provinces, the cropped area and residential area keep increasing, which made forestry land decreased. In Gia Lai and Dak Lak, deforested area was at around 20% of the total forest area during 2012 to 2016.

Table S.4 Land Use Condition of the Five Provinces

Classification	Kon Tum		Gia Lai		Dak Lak		Dak Nong		Lam Dong		Total	
	km^2	%	km^2	%	km^2	%	km^2	%	km^2	%	km^2	%
Annual Crop	1,355	14.0	3,322	21.4	2,099	16.0	975	14.9	198	2.0	7,950	14.5
Perennial Crop	789	8.1	1,874	12.1	1,066	8.1	1,112	17.0	1,314	13.4	6,155	11.2
Residential Land	148	1.5	485	3.1	3,389	25.8	276	4.2	235	2.4	4,533	8.3
Forestry Land	6,639	68.5	7,996	51.4	4,343	33.0	3,997	61.3	5,208	53.1	28,182	51.5
Water Surface	6	0.1	215	1.4	580	4.4	54	0.8	38	0.4	892	1.6
Others	760	7.8	1,658	10.7	1,682	12.8	108	1.7	2,815	28.7	7,023	12.8
Total	9,698	100.0	15,549	100.0	13,158	100.0	6,522	100.0	9,808	100.0	54,735	100.0

Source: MONRE

Agricultural Status

Coffee and rubber are major perennial industrial crops grown throughout Central Highlands. The cropped area for coffee remains constant or slightly increased in five provinces except for Dak Nong from 2012 to 2016. Coffee production increased in Gia Lai, Dak Nong, and Lam Dong. The average coffee yield is around 2.3 ton/ha. Significant expansion is observed in pepper cultivation in Gia Lai, Dak Lak, and Dak Nong for both area and production. Kon Tum, Gia Lai, and Dak Lak export rubber, and all provinces export coffee, among which Dak Lak exports the most (209.578 ton as of 2016). Compared with the rest of the provinces, the groundwater irrigation for coffee and pepper production in Gia Lai and Dak Lak is high at 44.0% and 39.5%, respectively. Kon Tum exports processed wood and Lam Dong exports flowers.

As for annual crops, rice, maize, and cassava are commonly found and paddy and maize are cultivated twice a year in all provinces. The winter-spring paddy and summer-autumn paddy area and production in Kon Tum, Dak Nong, and Lam Dong are constant. In Gia Lai and Dak Lak provinces, the cropped area and production of winter-spring paddy decreased while those of summer-autumn paddy continuously increased. The cropped area and production of sweet potato in Dak Lak and Dak Nong increased in recent years. Gia Lai and Dak Lak provinces expand the cassava area and production under increasing demand for its exportation.

As for the perennial crops, the planting and harvesting seasons are different among the five provinces. Of which, the planting is usually conducted in the rainy season (from May to August) while the harvesting varies in the dry season. However, a different pattern is found in Lam Dong Province as the planting and harvesting are continuously made.

The five provinces recommend farmers to introduce short-growing and drought tolerant varieties of annual crops for mitigating drought damages. As for perennial crops, the provinces recommend applying water

saving irrigation, inter-cropping fruit trees, and covering vegetation to reduce evaporation. Not to plant in dry area is a recommended countermeasure as well for drought damage mitigation.

There is a significant difference of net income between annual crops and perennial crops. Farmers are shifting gradually from annual crops to perennial crops in the slope field to obtain more benefits, for which, they need fund for initial investment and irrigation water supply.

Unlike the national tendency, income from agriculture, forestry, and fishery means are important to the local people of the region. Among the five provinces, people in Dak Lak and Dak Nong depend on the agriculture sector to a large extent. Dak Nong people averagely owe 59.1% of their monthly income to the agriculture sector. Dak Lak people earn VND 1,988,000 monthly per person, nearly half of which is from agriculture. On the contrary, Kon Tum, where all kinds of GPDP figures are the lowest among all five provinces, has the least share of agriculture due to its poor quality of soil and low agricultural productivities.

Domestic consumption and trade at local markets share about half, while the remaining half is traded at the outside markets in Central Highlands except Kon Tum where approximately 75% of agricultural products are consumed internally. The amount and share of the investment in the agriculture sector are outstanding in Dak Lak, and they have strong needs for domestic consumption and local markets. Lam Dong's economy is sustained not only by the agriculture sector but also by industry and service sectors represented by processing and manufacturing, wholesale and retail motor vehicles, transportation and storage, and accommodation and food service activities.

Infrastructure Development (Irrigation and Flood Protection)

1) Current Conditions

There are 751 provincial irrigation systems covering 152,244 ha and 1,398 district-managed systems covering 74,970 ha existing in five provinces as of 2016. The average irrigation area is 203 ha/system in the provincial system and 54 ha/system in the district system. The cropping intensity is 191% in the provincial systems and 189% in the district systems, which are higher than the national average of 174% for both. The irrigation development of potential irrigable area in Central Highlands is 86% on average. Comparing with the whole nation's potential area at 69%, irrigation development in five provinces is advance. The cropping intensity per season varies by system and province. In the dry season, the cropping intensity of provincial and district systems are limited at around 84% and 93%, respectively. As for flood protection infrastructure, the nine projects have been planned and partially implemented. The construction of dike did not prevail in Central Highlands. The 13 reservoirs of the total 74 major reservoirs have flood control function.

2) Operation & Maintenance

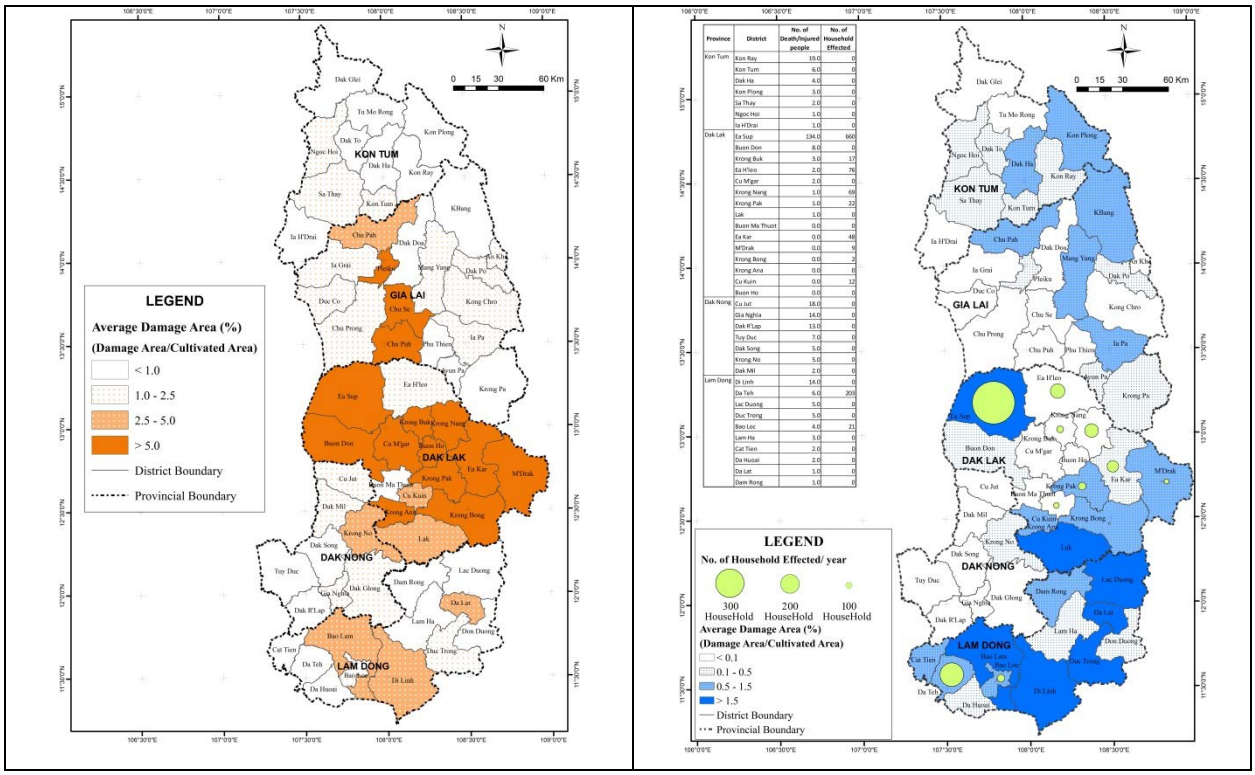
The Irrigation Management Company (IMC) is the organization managing large-scale irrigation systems at the provincial level in Central Highlands. Small-scale irrigation systems are managed by the District Peoples Committee (DPC), private firms, cooperatives, etc. Number of operation and maintenance (O&M) staff, covering area, O&M and rehabilitation cost vary by irrigation systems. Average area covered by one O&M staff is 156 ha/person at the provincial systems and 105.3 ha/person at the district systems. Annual O&M cost per hectare including staff salary is VND 1.4 million/ha/year at the provincial systems and VND 1.1 million/ha/year at the district systems. These O&M staff and O&M cost are still short for maintaining the system function and delivery of irrigation water.

In Central Highlands, 105 water user groups (WUGs) were organized covering 5,452 ha. The percentage of service area covered by WUGs of the total area of both provincial and district irrigation systems are limited at 2.8%. Since the irrigation facilities are scattered in the widespread rural areas in Central Highlands, the local government authorities could not properly manage all of the systems by their limited number of staff. Degradation of irrigation facilities and farmers' overuse of irrigation water were common. Farmers' active participation in the O&M of the irrigation systems, through participatory irrigation management (PIM), is necessary for sustainable irrigation development.

Natural Disasters and Impact by the Drought 2015/16

Vietnam suffers various types of natural disasters almost all year around. While storms and floods occur most frequently in the country, droughts cause the most negative affects among all. Although it was only five drought events occurred in the last 26 years from 1991 to 2016, these cost USD 7.4 million in total among which the biggest damages and losses were caused by the one in the end of 2015 worth USD 6,750,000.

Droughts and floods often occur in Central Highlands. Assessing the long-term trend, the severest drought that hit the region happened in 2004/2005 and the heaviest rainfall was recorded in 1999 with flood peak discharge of 1,110 m3/sec at Ban Don Station of the Srepok River. Drought is a natural disaster that hits the region most severely and the drought affected area has become larger year after year. The damage by flood is also serious, while the affected area by other disasters shows insignificant trend. The annual average of drought and flood impacts during 2010 to 2016 are mapped as follows:



Source：JICA Study Team

Figure S.1 Disaster Map in Central Highlands (Average of 2010-2016)
(Left: Drought; Right: Flood)

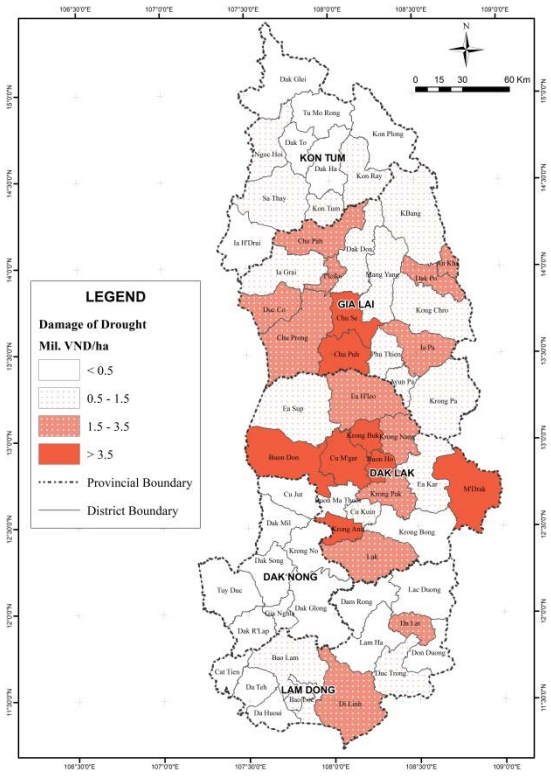
The prolonged drought started from 2014 summer to 2016 spring damaged thousands of hectares of the cropped areas in Central Highlands. The impact on the perennial crops was more serious than that on annual crops except for Gia Lai Province. The damaged areas of perennial and annual crops by the drought are evaluated as follows:

Table S.5 Cropped Area Damaged by Drought 2015/16 in Central Highlands

(Unit: ha)

Crop Type	Unit	Central Highlands	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
Perennial Crop	ha	140,630	2,533	12,748	76,755	18,126	30,469
	%/1	13.7	2.7	5.8	25.8	9.6	13.4
Annual Crop	ha	38,575	1,661	17,808	17,867	399	840
	%	4.4	2.2	7.4	5.6	0.4	0.7
Total	ha	179,206	4,194	30,556	94,622	18,525	31,309
	%	9.4	2.5	6.7	15.3	6.2	8.8

Note: /1: Percentage of cropped area damaged out of the total cropped area.
Source: Statistical Book of Provinces



Source: JICA Study Team

Figure S.2 Disaster Map of Drought in Central Highlands in 2015/16

Natural disasters in Central Highlands have been affected by the present land use, agricultural and socioeconomic conditions, and climate change. The land use in the region have changed in the recent five years: residential area and cropped area (both of annual and perennial crops) increased and forest area decreased accordingly. The high migration rates especially in Kon Tum and Dak Nong accelerate expansion of residential and cropped areas. Those trends tend to increase surface discharge and decrease rechargeable groundwater. According to the assessment by the National Research Project KC08-05, the total potential exploitation reserves of groundwater in Central Highlands is around 5,400 MCM/day. Comparison between 2001 and 2010 revealed that the volume of groundwater consumption in the region became bigger, especially in Kon Tum and Gia Lai provinces. The poor maintenance and development of infrastructure have led the disaster damages more serious due to frequent isolation of rural areas in flood season and domestic water shortage in drought period.

The Steering Committees for Natural Disaster Prevention and Control were organized at the provincial and district levels in Central Highlands. There are 122 members appointed from Department of Agriculture and Rural Development (DARD), Department of Natural Resources and Environment (DONRE), Department of Transportation (DOT), Department of Construction (DOC), Department of Health (DOH), Department of Labour, Invalids and Social Affairs (DOLISA), Department of Planning and Investment (DPI), Department of Finance (DOF), chairpersons of mass organizations, etc., in the provincial level. This number in district level is more than 1,400 people. They are responsible for the preparation and implementation of disaster prevention and recovery works at the provincial and district level. The regular and specific activities of the committees varied in five provinces depending on available provincial budget. However, the general issues are limited budget, degraded irrigation facilities, lack of equipment for early warning of disasters, etc. (Ref. AT 3.6.1)

In accordance with SEDP 2011-2015, each province developed its own infrastructure development plan sector by sector, in which priority projects were nominated. All five provinces of Central Highlands regarded their infrastructure development as tractions for economic growth. Accomplishments of Gia Lai, Dak Nong, and Lam Dong in irrigation infrastructure were far less than their plans both in system and area. Kon Tum almost achieved their targets. Dak Lak has achieved (or almost achieved) their targets in all sectors, whereas their GPDP did not grow as expected, which gives an implication that the infrastructure development in the province from 2011 to 2015 did not contribute to their economic activities in an efficient and effective manner.

The five provinces have their priority projects to improve the living standard of people covering irrigation, water supply, flood protection, road, industry, electricity, etc. However, the scopes of priority projects are not completely matched with the current situation relating to water resources management and disaster prevention. All districts in each province are targeted, while the number and project cost per district differs by provinces. In terms of flood protection, the number and budget is less than 1% of the total investment in Central Highlands, even in the seriously damaged provinces such as Dak Lak and Lam Dong. Dak Lak has the highest potential to implement irrigation development among the five provinces, but the province does

not plan to develop them by 2020. Lam Dong prepared the most ambitious plan for irrigation development, but it needs more resources than the current level.

In conclusion, infrastructure in Central Highlands has not yet developed enough to deal with the present situation, particularly development plans of irrigation sector, which need due consideration to be carried out.

4. Assessment on Water Resource and Utilization in the Five Provinces

Outline of Water Balance Study

Water balance study was conducted to assess water resources availability and demand in the five provinces, all of which are vulnerable and prone to water shortage in Central Highlands. Three scenarios were assessed in the study: i) drought event in 2015 to 2016, ii) dry year, and iii) wet year. The water balance study on the scenario of drought in 2015 to 2016 was conducted to assess the drought damage from the viewpoint of water balance. Through the water balance study and assessment on those scenarios of dry and wet years, the situation of water availability and shortage were captured. Those results were utilized to prepare directions for water resources and disaster managements.

Surface water resources were computed by the Soil and Water Assessment Tool (SWAT) model, whereas "Darcy's Law GW Model" and "MODFLOW Model" were applied to estimate groundwater resources. The water demand in the Study considered five different water requirements, i.e., irrigation, domestic, livestock, fishery, and industry. CROPWAT 8.0 Model was used to estimate the crop water requirement. The water balance simulation model of each river basin was developed and assessed by the Water Evaluation and Planning (WEAP) Model.

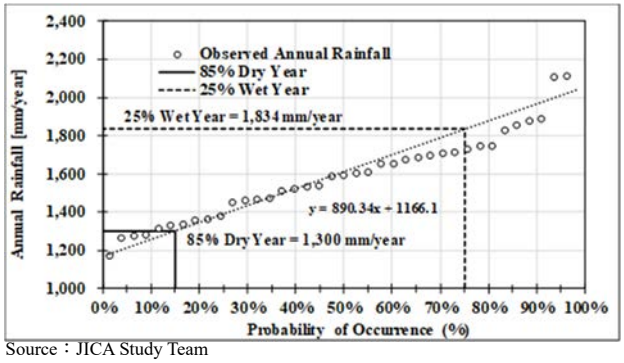
Definitions of Dry and Wet Years

The 85% probability of occurrence year of long-term annual rainfall records for dry year and the 25% probability of occurrence year for wet year are commonly used in Vietnam. Table S.6 shows the periods when the amount of annual rainfall at 85% dry year and 25% wet year were recorded in the four river basins in Central Highlands.

Table S.6 Dry and Wet Years of River Basin

River Basin	85% Dry Year	25% Wet Year
Se San	2015 May - 2016 April	2005 May to 2006 April
Ba	1994 May - 1995 April	1986 May to 1987 April
Srepok	2012 May - 2013 April	1988 May to 1989 April
Dong Nai	2011 May - 2012 April	2015 May - 2016 April

Source：JICA Study Team

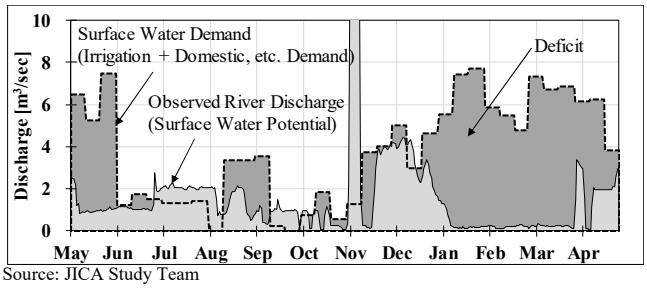


Source：JICA Study Team

Figure S.3 Definition of Dry and Wet Years

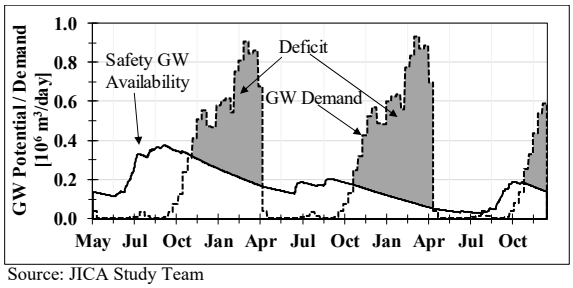
Concept of Water Availability

Figure S.4 shows a schematic image of surface water availability. When the surface water demand exceeds the stream flow, deficit of water demand will occur. Figure S.5 shows a schematic image of the "safety groundwater availability". The availability of groundwater is defined as the average of its inflow and outflow in this study. A safety factor of 0.5 is taken into account when defining the safety groundwater availability by considering aquifer characteristics, status of groundwater exploitation, and requirement of groundwater management of the area. When the groundwater demand is bigger than its safety availability, deficit of water demand will occur.



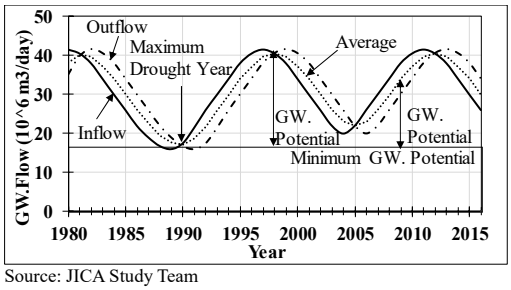
Source: JICA Study Team

Figure S.4 Schematic Image of Surface Water Availability



Source: JICA Study Team

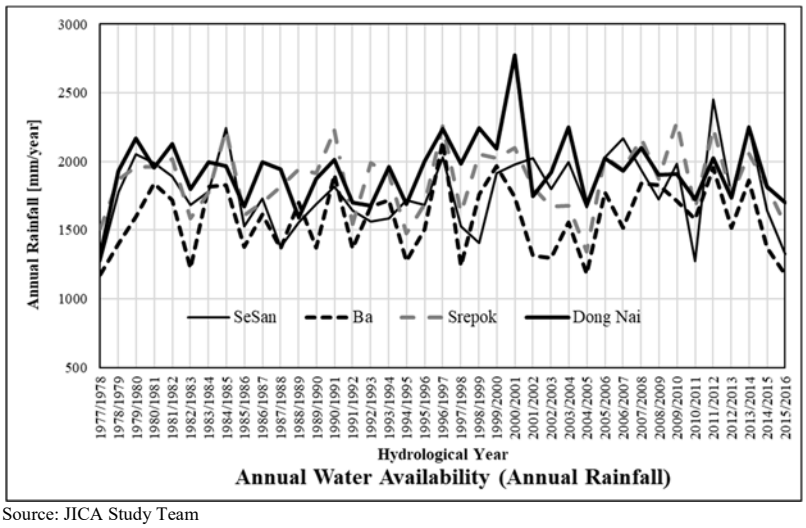
Figure S.5 Schematic Image of Safety Groundwater Availability



Source: JICA Study Team

Figure S.6 Conceptual Diagram of Groundwater Availability in the Project

Water availability in Central Highlands for long-term was estimated based on rainfall data for all stations in this area. In four river basins, the Thiessen Polygon Method was applied for computing the annual basin mean rainfall for each catchment. The average water availability for long-term in Central Highlands is from 1,584 mm/year in the Ba River to 1,934 mm/year in the Dong Nai River. The observed basin annual rainfall data shows that there is repetitive occurrence of floods and droughts at an interval of four to five years. In general, annual rainfall tends to increase in four basins since 1977. However, there are significant temporal fluctuations in all basins. The coefficients of variation1 in all four basins are greater than or equal to 13%, of which highest index is seen in the Ba River basin at 16%. (Ref. AT 4.1.18 and Figure 4.1.10). This phenomenon causes difficulty in water management in Central Highlands. Based on this rainfall data, the surface water and groundwater availability was calculated using SWAT Model for surface water and GW Model for groundwater.



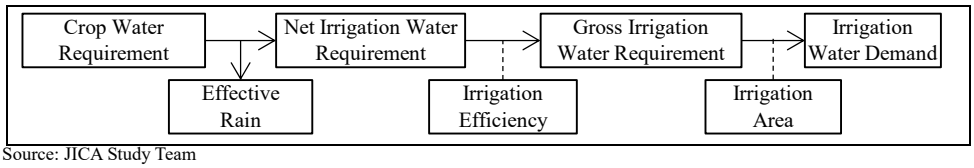
Source: JICA Study Team

Figure S.7 Annual Water Availability

Sequence and Basis of Water Demand Estimation

After calculation of the crop water requirement, the following steps were taken for estimation of the irrigation water demand:

[1] The coefficient of variation (CV) is a measure of relative variability. It is the ratio of the standard deviation to the average.



Source: JICA Study Team

Figure S.8 Diagram of Calculation of Irrigation Water Demand

The domestic water demand was estimated with population and unit water requirement, volume of water consumption per capita. The industrial water demand was estimated per district based on the provincial statistical data and interview survey results with the Department of Industry and Trade (DOIT) and industrial parks in five provinces. The water demands of aquaculture and livestock were estimated by multiplying unit water requirement with head numbers of livestock and areas used for aquaculture and summing them up.

In Central Highlands, it is surface water and groundwater that satisfy local water demands. The JICA Study Team made an assumption of the rates of each water source exploited by purpose based on the results of field survey and interview survey, statistical data, etc., as follows:

Table S.7 Rates of Irrigation Water Demand from Surface Water and Groundwater

(Unit: %)

Crop	Kon Tum		Gia Lai		Dak Lak		Dak Nong		Lam Dong	
	SW	GW	SW	GW	SW	GW	SW	GW	SW	GW
Coffee	60.5	39.5	60.5	39.5	56.0	44.0	56.0	44.0	100.0	0.0
Pepper	60.5	39.5	60.5	39.5	56.0	44.0	56.0	44.0	60.5	39.5
Other Perennial Crops	100.0	0	100.0	0	100.0	0	100.0	0	100.0	0
Annual Crops	100.0	0	100.0	0	100.0	0	100.0	0	100.0	0

Note: Rubber and cassava are not included as they are not irrigated in Central Highlands.
Source: JICA Study Team based on the report of the Institute of Geology.

Table S.8 Rates of Non-irrigation Water Demand from Surface Water and Groundwater

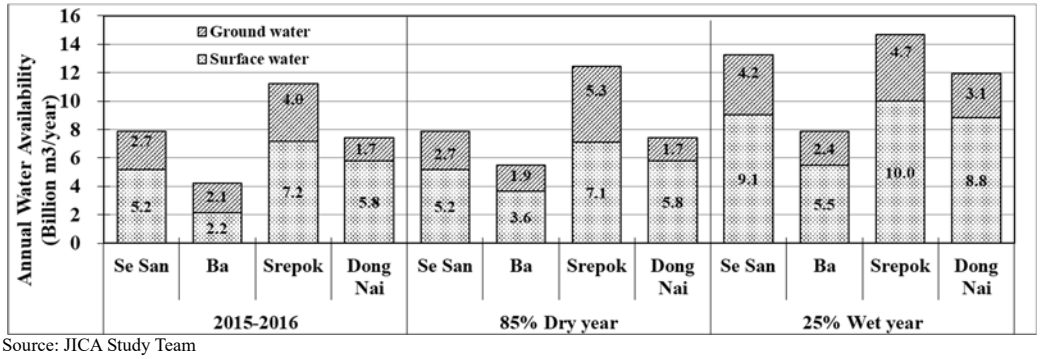
(Unit: %)

Water Demand	Domestic	Industry	Livestock	Aquaculture
% of Surface Water Demand	23 - 92	80	23 - 92	100
% of Groundwater Demand	8 - 77	20	8 - 77	0

Source: JICA Study Team based on the report of the Institute of Geology.

Water Balance in 2015/16

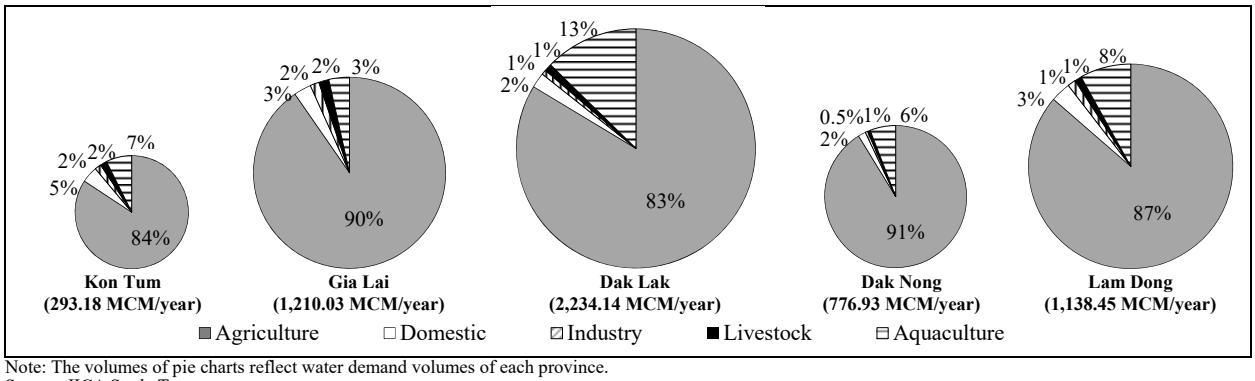
Surface and groundwater availability in Central Highlands were estimated at 20,280 MCM/year and 10,483 MCM/year in 2015/16, respectively.



Source: JICA Study Team

Figure S.9 Estimated Water Availability in Central Highlands

In five provinces of Central Highlands, agricultural water demand shared between 83% and 91% of the total water demand in 2015/16. The ratios of domestic, industrial, and livestock water demand were less than that of aquaculture water use. The proportions of water demands are as follows:



Note: The volumes of pie charts reflect water demand volumes of each province.
Source: JICA Study Team

Figure S.10 Share of Water Demand by Sector in 2015/16

During the drought period of 2015/16, surface water demand was estimated at 4,483 MCM/year and groundwater demand at 1,175 MCM/year in Central Highlands. Groundwater demand in Dak Lak Province was 530 MCM/year that accounts 45% of the total demand in Central Highlands. The surface water demand in Dak Lak Province was approximately 38% of the total.

The surface water shortage mostly occurred in Dak Lak, Dak Nong, and Lam Dong in 2015/16, among which Dak Lak Province had the severest surface water shortage. Krong No District in Dak Nong Province faced high water shortage. In Lam Dong Province, the south end part of Da Lat City, Lam Ha and Duc Trong districts had heavy surface water shortages.

Table S.9 Water Shortage in Central Highlands in 2015/16

Province	(A) Water Shortage (MCM/year)			(B) Water Demand (MCM/year)			(C)=(A)/(B) Water Shortage %		
	Total	SW	GW	Total	SW	GW	Total	SW	GW
Kon Tum	9.49	8.11	1.38	293.18	236.10	57.09	3.2	3.4	2.4
Gia Lai	74.02	19.52	54.50	1,210.03	911.82	298.21	6.1	2.1	18.3
Dak Lak	586.41	328.53	257.89	2,234.15	1,704.32	529.83	26.2	19.3	48.7
Dak Nong	64.98	37.34	27.64	776.93	508.14	268.78	8.4	7.3	10.3
Lam Dong	130.84	130.63	0.22	1,143.19	1,122.13	21.06	11.4	11.6	1.0
Total	865.74	524.12	341.63	5,657.48	4,482.52	1,174.96	15.3	11.7	29.1

Note: Total water demand and water shortage are not the same value as with the river basin's total due to some parts of areas in the provinces that are not included in the four river basins.
Source: JICA Study Team

Table S.10 Results of Water Balance in Central Highlands in 2015/16

River Basin	Catchment Area (km^2)	Water Source	Water Availability	Water Demand (MCM/year)						Water Balance (Shortage)
				Domestic	Industrial	Live Stock	Fishery	Agriculture	Total	
Se San	11,377	Surface Water	5,162	12.1	6.3	4.0	18.4	370.4	411.2	-8.7
		Groundwater	2,733	5.5	1.6	2.2	0.0	148.1	157.4	-19.2
		Total	7,895	17.6	7.9	6.2	18.4	518.5	568.7	-27.9
Ba	10,779	Surface Water	2,162	10.0	7.3	7.3	51.7	677.1	753.3	-50.6
		Groundwater	2,075	8.2	1.8	5.7	0.0	161.5	177.3	-71.0
		Total	4,238	18.2	9.1	13.0	51.7	838.6	930.5	-121.6
Srepok	17,887	Surface Water	7,181	18.3	10.9	10.3	222.9	1,598.4	1,860.8	-320.6
		Groundwater	4,020	21.2	2.9	11.1	0.0	587.8	623.0	-232.0
		Total	11,201	39.4	13.7	21.4	222.9	2,186.2	2,483.7	-552.7
Dong Nai	9,236	Surface Water	5,774	19.1	10.0	5.4	67.8	918.8	1,021.1	-116.8
		Groundwater	1,654	8.9	2.5	2.7	0.0	118.8	132.9	-13.7
		Total	7,428	28.0	12.5	8.1	67.8	1,037.6	1,153.9	-130.4
Total	49,278	Surface Water	20,280	59.3	34.5	27.1	360.8	3,564.7	4,046.4	-496.7
		Groundwater	10,483	43.8	8.8	21.7	0.0	1,016.2	1,090.5	-335.9
		Total	30,762	103.2	43.2	48.8	360.8	4,580.9	5,136.9	-832.6

Source: JICA Study Team

Water Balance in Dry and Wet Years

1) Purpose of Water Balance Study in Dry and Wet Years

Water balance study in the dry and wet years was intended to simulate the water balance in the dry and wet years that will likely occur in the future. The meteorological and hydrological conditions experienced in the dry and wet years and the water demand and land use conditions under 2015/16 were taken in this study. By this study, the areas (by sub-basin and by district) where the imbalance water availability will likely occur and the degrees and amounts of water shortages could be quantitatively assessed.

Through the water balance assessment in dry and wet years of each river basin, the areas where water shortages occur in dry or wet years may be identified. The areas where water shortage occurs were also be identified even in wet year conditions. It is possible to estimate quantitatively how much water shortage in

each sub-basin and district based on each year's condition. The main purpose of the simulation of the water balance in the dry year is as follows:

i) Identify areas quantitatively where water shortages occur when more serious drought occurs than during the drought of 2015/16 (or normal year) by using current water demand and land use.

ii) Estimate quantitatively the total water balance in dry year for four river basins by sub-basin or for province by district at probability of dry year occurring once every 6.7 years (85% probability occurrence).

While, the main purpose of simulation of the water balance in the wet year is as follows:

i) Identify areas quantitatively where water shortages occur even in the year of comparatively abundant annual rainfall by using current water demand and land use of 2015/16.

ii) Estimated total water balance in wet year condition for four river basins by sub-basin or for province by district at the probability of wet year occur once every four years (25% probability occurrence).

iii) Identify areas where flood damage may occur in the high surface water availability areas in wet year and it is possible to estimate and forecast quantitatively these flood damage areas.

2) Availability of Water Resources in Dry and Wet Years

Total surface water availability in Central Highlands in dry years was estimated at 22.7 billion m3/year and wet years at 33.4 billion m3/year. Total groundwater potential in Central Highlands in dry and wet years were estimated at 11.6 billion m3/year and 14.3 billion m3/year, respectively. The surface water availability is high along the middle and downstream of main river channel. The groundwater availability in dry and wet years are high along the main river channel.

3) Water Demand in Dry and Wet Years

Surface water demands in Kon Tum and Dak Nong provinces are not high compared with the other provinces. Dak Lak Province has the highest surface water demand. The groundwater demand in Kon Tum and Lam Dong provinces was relatively low compared with other provinces. Dak Lak Province has the highest groundwater demand. Gia Lai and Lam Dong provinces have relatively high groundwater demand in the dry year.

4) Results of Water Balance in Dry and Wet Years

According to the study results, the water resources were totally not enough even in wet years in all river basins. It means that Central Highlands is suffering from chronic water shortage. To overcome such serious situation, the measures for enhancing water availability and reducing water demand, particularly irrigation water demand, are required.

Surface water shortage occurred in the eastern and southern parts of Central Highlands. The north and eastern part of Gia Lai Province faced surface water shortage even in wet year. Very serious surface water shortage occurred in south-eastern and north-western part of Dak Lak Province even in wet year. Some areas in the north-eastern part of Dak Nong Province suffered from surface water shortage. In Lam Dong Province, south-eastern part faced heavy surface water shortages even in wet year.

Groundwater shortage occurred in the middle and western part of Central Highlands, especially in Dak Lak and Gia Lai provinces. The groundwater shortage occurred in the western part of Gia Lai Province even in wet year. Heavy groundwater shortages were observed in several districts of Dak Lak even in wet year. In Kon Tum, Dak Nong and Lam Dong provinces, heavy groundwater shortages did not occur in dry and wet years.

There found similar tendencies in the dry years to the drought year of 2015/16. However, the water shortages which some areas suffered from in the dry years were more serious than those in the drought of 2015/16. An imbalance between water demand and water availability occurred in the areas where water shortages were observed. In these areas, water savings especially irrigation water are needed.

According to estimation of surface water availability in wet year, the flood-affected areas are presumed in all provinces in Central Highlands. Serious damages on households and cropped areas were recorded at the districts of Dak Lak and Lam Dong provinces in the recent seven years. Upstream of the Se San River basin, which is located in the eastern part of Kon Tum Province and upstream of Ba River Basin, which is located in the north-eastern part of Gia Lai Province faced high risk of flood. Downstream of Srepok River basin in the north-western part of Dak Lak Province especially in Ea Sup District faces very high risk of flood damage. Also, the upstream of Srepok River basin, which is located in the south-eastern part of Dak Lak Province had high risk of flood. Downstream of the Dong Nai River basin in the south part of Lam Dong Province faced very high risk of flood.

5) District Classification

Among all five provinces, Dak Lak Province had the most serious water shortage in both surface and groundwater, amounting to 362 MCM/year in total in the dry year in which, six districts faced severe shortage more than 25.0 MCM/year. In Lam Dong, two districts have serious surface water shortage in the dry years for the total demand at 128 MCM/year. Based on the above assessment, the respective districts in the five provinces were classified by the volume of water shortage as follows:

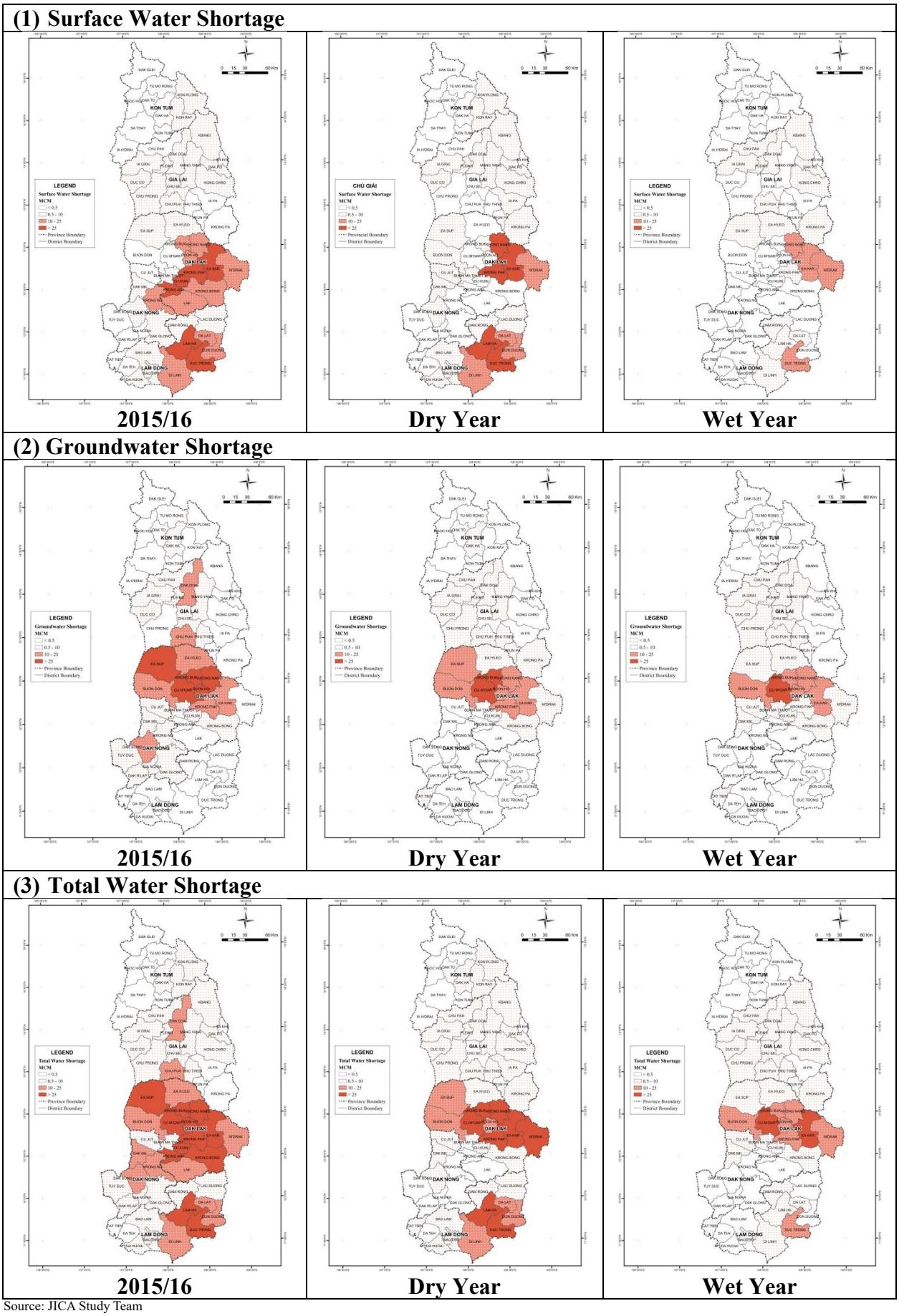
Table S.11 Number of Districts by Water Shortage in Dry and Wet Year

(Unit: No. of Districts)

Year	Province	< 0.5 MCM/Year			0.5~10 MCM/Year			10~25 MCM/Year			>=25 MCM/Year		
		Surface Water	Ground -water	Total (both)	Surface Water	Ground -water	Total (both)	Surface Water	Ground -water	Total (both)	Surface Water	Ground -water	Total (both)
Dry Year	Kon Tum	8	9	7	2	1	3	0	0	0	0	0	0
	Gia Lai	7	7	3	10	10	14	0	0	0	0	0	0
	Dak Lak	6	3	2	5	4	4	1	6	3	3	2	6
	Dak Nong	5	8	5	3	0	3	0	0	0	0	0	0
	Lam Dong	2	11	1	5	1	6	3	0	3	2	0	2
	Total	28	38	18	25	16	30	4	6	6	5	2	8
Wet Year	Kon Tum	10	10	10	0	0	0	0	0	0	0	0	0
	Gia Lai	8	7	3	9	10	14	0	0	0	0	0	0
	Dak Lak	9	2	2	3	7	5	3	5	6	0	1	2
	Dak Nong	8	6	6	0	2	2	0	0	0	0	0	0
	Lam Dong	7	11	6	4	1	5	1	0	1	0	0	0
	Total	42	36	27	16	20	26	4	5	7	0	1	2

Source: JICA Study Team

On the other hand, flood-affected areas are hypothetically assessed on the basis of water balance study on wet year scenario and records of flood damage occurred in Central Highlands in the recent seven years. The specific discharge obtained by water availability analysis in the wet year scenario indicated that Ea Sup District in Dak Lak Province is one of the most vulnerable areas in the region where flood damages were significant in the recent seven years. To confirm the validity of the assessment, further investigation and enhancement of monitoring system of meteo-hydrological observation are indispensable.



Source: JICA Study Team

Figure S.11 Water Shortage in Central Highlands

Disaster Risk of Provinces and Districts

1) Disaster Risk Assessment of Five Provinces

Based on the assessment of water resources in Central Highlands, the JICA Study Team evaluated the disaster risks of five provinces. The risks were classified as very high, high, moderate, or low as follows:

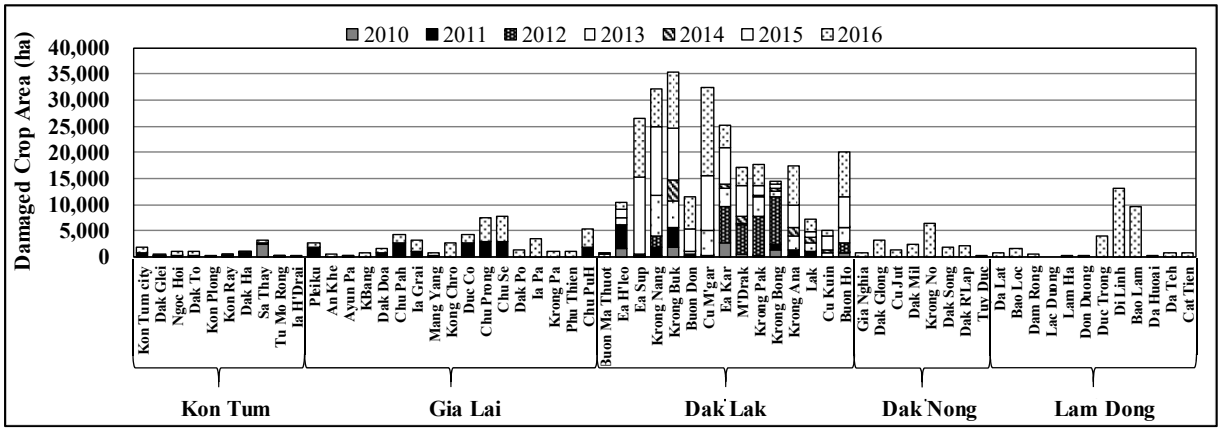
Table S.12 Risk Class of Five Provinces

Province	Risk Class	
	Drought	Flood
Kon Tum	Low	Moderate
Gia Lai	Moderate	Moderate
Dak Lak	Very high	High
Dak Nong	Low	Low
Lam Dong	High	Very high
Central Highlands	High	High

Note: This assessment is based on the actual damages occurred from 2010 to 2016
Source: JICA Study Team

2) Drought and Damage

The districts' status on damaged crop area by drought is shown in Figure S.12. Dak Lak Province faced serious crop damage by drought. It is assumed that excessive demand was caused by the uncontrolled development of groundwater underway.

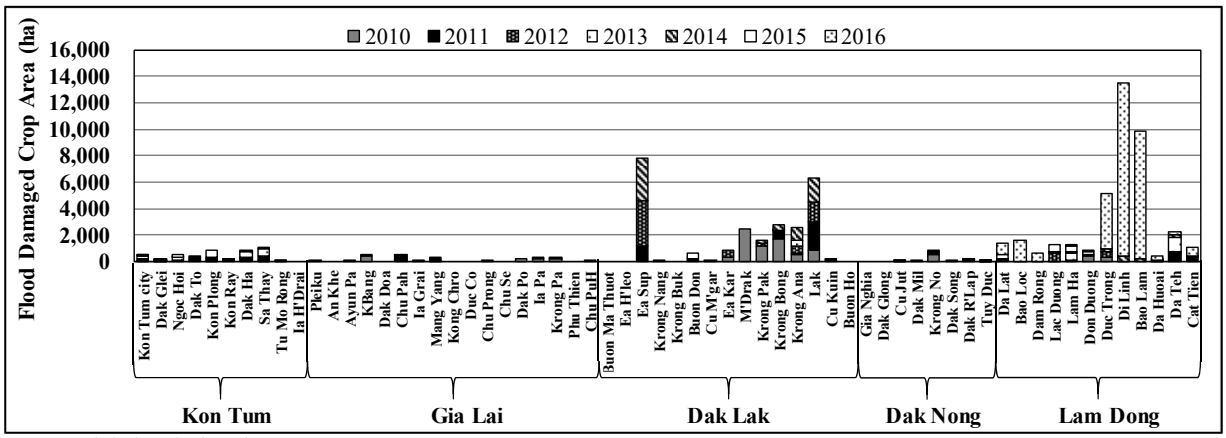


Source: Statistical Book of Provinces

Figure S.12 Damaged Crop Area by Drought in Central Highlands (2010-2016)

3) Flood Damage

Although the flood-affected areas were observed in all provinces in Central Highlands, serious damages on households were recorded at the districts of Dak Lak and Lam Dong. In Lam Dong Province, which is located in the Dong Nai River basin, the 2016 flood caused the most damages in the recent seven years. The province in fact lacks proper countermeasures to mitigate flood damages.



Source: Statistical Book of Provinces

Figure S.13 Damaged Crop Area by Flood in Central Highlands (2010-2016)

4) Necessity of Detailed Survey in Selected Districts

While the JICA Study Team conducted the water balance study based on the water demand at the district level and water availability at the sub-basin level. However, these data need to be captured in smaller resolution to analyse their specific local contexts. Furthermore, for prioritizing the project plans prepared by the five provinces, the detailed survey shall be implemented by the JICA Study Team to grasp the development needs at the commune level and identify the necessary scope of works of the projects based on the site conditions.

Since the study area is too large to visit and investigate thoroughly, the JICA Study Team long-listed 13 districts from five provinces by considering the results of reviewing the features of districts on water shortage. The JICA Study Team short-listed seven districts from the 13 districts in consideration of seriousness of water shortage and disaster damages of droughts and floods as follows:

Table S.13 Selected Districts to Conduct Detailed Survey by Water Shortage and Flood

Province	District	Year	Water Shortage (MCM/year)			Average Damage Area (%) 2010-2016 *1)		Evaluation of Risks				Selected District
			Total	SW	GW	Drought	Flood	SW	GW	Drought	Flood	
Kon Tum	Kon Plong	2015/16	6.55	6.55	0	0.51	1.44	X	-	-	X	-
		Dry Year	6.55	6.55	0							
		Wet Year	0	0	0							
	Kon Ray	2015/16	1.35	1.28	0.06	0.53	0.23	X	-	-	X	-
		Dry Year	1.35	1.28	0.06							
		Wet Year	0	0	0							
	Dak Ha	2015/16	1.21	0	1.21	0.68	0.52	-	X	-	XX	Selected
		Dry Year	1.21	0	1.21							
		Wet Year	0.43	0	0.43							
Gia Lai	Chu Puh	2015/16	24.06	4.88	19.18	6.67	0.04	X	XX	XXX	-	Selected
		Dry Year	9.35	0.00	9.35							
		Wet Year	9.69	3.83	5.86							
	Dak Doa	2015/16	11.98	1.72	10.27	0.84	0	X	XX	-	-	-
		Dry Year	9.52	1.45	8.07							
		Wet Year	6.78	2.29	4.49							
Dak Lak	Cu M'Gar	2015/16	44.61	0.18	44.43	6.79	0.03	-	XXX	XXX	-	-
		Dry Year	33.62	0.23	33.39							
		Wet Year	42.52	0.21	42.31							
	Ea Kar	2015/16	83.60	63.60	20.00	5.44	0.18	XXX	XXX	XX	X	Selected
		Dry Year	90.05	66.57	23.48							
		Wet Year	34.31	19.65	14.66							
	Ea Sup	2015/16	30.36	2.87	27.48	8.65	2.56	X	XXX	XXX	XXX	Selected
		Dry Year	22.82	2.66	20.15							
		Wet Year	9.24	6.76	2.48							
Dak Nong	Krong No	2015/16	19.9	18.46	1.45	1.82	0.26	XX	X	X	X	Selected
		Dry Year	0.05	0.05	0							
		Wet Year	0.09	0.09	0							
	Dak Song	2015/16	17.89	7.34	10.55	0.59	0.01	X	XX	-	-	-
		Dry Year	3.33	3.33	0							
		Wet Year	0	0	0							
Lam Dong	Lam Ha	2015/16	27.15	27.15	0	0	0.36	XX	-	-	X	-
		Dry Year	27.15	27.15	0							
		Wet Year	5.23	5.23	0							
	Di Linh	2015/16	16.46	16.46	0	3.75	3.88	XX	-	XX	XXX	Selected
		Dry Year	16.46	16.46	0							
		Wet Year	4.09	4.08	0							
	Duc Trong	2015/16	37.67	37.67	0	2.21	2.57	XXX	-	XX	XXX	Selected
		Dry Year	37.67	37.67	0							
		Wet Year	21.19	21.19	0							

Note: 1) Average damaged cropped area per total cultivated area (ha/ha=%) during 2010 to 2016.
"SW" means surface water, "GW" means groundwater. "X" means moderate risk, "XX" means high risk and "XXX" means very high risk. Gray colored cells are the main purpose of the field survey.
Source: JICA Study Team

In those areas, the JICA Study Team conducted the field survey to: i) interview the concerned government officers and rural residents including farmers to obtain additional information on the actual constraints and their development needs, ii) reconnaissance at the area that is seriously and frequently impacted by disasters and struggling with water shortage to assess the technical feasibility and economical and environmental issues of the planned projects in the areas.

5. Water Resources Utilization and Management Plan

Issues

Through analyzing the causes leading to water shortage, drought, flood, and other disasters, eight issues were identified, namely: (i) water demand, (ii) water utilization, (iii) natural condition, (iv) infrastructure, (v) farmers' livelihood, (vi) O&M of irrigation systems, (vii) observation and monitoring of water resources, and (viii) observation and monitoring of water resources for surface water and groundwater.

Development Directions for Water Resources Management and Disaster Prevention

Based on the current status of and issues on water resources management of the provinces, the JICA Study Team proposed directions for the five provinces as follows:

Table S.14 Direction and Strategy for Water Resources Management

Disaster	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
Drought Risk	Level 1. Low	Level 2. Moderate	Level 4. Very High	Level 1. Low	Level 3. High
Flood Risk	Level 2. Moderate	Level 2. Moderate	Level 3. High	Level 1. Low	Level 4. Very High
Common Countermeasure	• Promote total management of water use • Water saving irrigation • Optimize land use and crops' cultivation • Enhance monitoring system on climate and hydrology • Enhance monitoring system of groundwater exploitation and promote water saving measures • Establish water balancing assessment and early alarming system in the local area • Relocate residents from flood-prone area • Establish coordination system for domestic and industrial water use • Optimize forest management for recharging groundwater				

Source: JICA Study Team

The development directions and necessity and urgency of those countermeasures were assumed to differ among the five provinces and disaster-prone areas, the JICA Study Team conducted the site survey at the representative drought and flood prone areas for further assessment and concretization of priority projects.

Through the site survey, the JICA Study Team found that the needs of farmers have significant urgency and locality and current priority project plans are not satisfactorily matched with them. While the provinces focused on structural development, the JICA Study Team considered implementation of non-structural development in parallel with the structural one. Moreover, the maturity of the priority projects concerned for the period of 2020 onward is not enough.

While urgent countermeasures for mitigating disaster damages should be immediately realized in short and mid-terms with the provincial budget, the large-scale project could be implemented with technical and economic feasibility. In conclusion, preparing development directions based on the study results were deemed to be more realistic and useful for Central Highlands rather than the prioritization of the existing priority projects.

In order to ensure the immediate implementation of disaster prevention projects, the JICA Study Team set the following basic strategies:

1) Initiatives of project planning and implementation shall be taken by the provinces in Central Highlands.
2) The projects to be planned shall be implemented basically by the provincial budget and resources through reallocation of available budget.
3) Attraction and participation of private investment shall be promoted considering the benefits of local residents and farmers.

Based on the results of the study, the JICA Study Team assessed the necessary countermeasures and effects and organized the following four development directions (Ref. Figure S.14):

1) Irrigated Agricultural Modernization
2) Strengthening Farmers' Organization for Sustainable Irrigation Management
3) Community-based Rural Livelihood Improvement in Flood-prone Area
4) Community-based Monitoring for Effective Utilization of Local Water Resources

Socioeconomic Situation

1) Water shortage (15.3% shortfall in water demand in 2015/16 *1)
2) Urbanization (8.28% of residential land in the region *2)
3) Rapid population increase (2009~2013 = +1.65 %/year *3)
4) People (immigrants) live in flood-vulnerable area
5) Unstable livelihood in the flood-prone areas

Source:
*1: JICA Study Team
*2: MONRE
*3: General Statistics Office of Vietnam / Statistical Yearbook of Vietnam

(1) Water Demand

1) Water demand has been increased in all sectors (total water demand in 2015/16 was 5,657 million m^3/year *1).
2) The irrigation water shares more than 80% of the total demand.
3) Water demand for agriculture is not controlled and efforts for

(2) Water Utilization

1) No effective control in groundwater use.
2) Farmers' knowledge on crop water requirement is limited and overuse of irrigation water has prevailed.
3) No effective water sharing.

(3) Natural Condition

1) Deforestation (lost nearly 14% of the forest area (about 400,000 ha) in 2012 to 2016*3).
2) Climate change (average temperature rise to 1.7 ~ 2.4°C at the end of the 21st century from 2015. Annual rainfall will increase 2~10% and rainfall intensity will increase in the rainy season and dry season rainfall will decrease*2).

(4) Infrastructure

1) Limited flood control facility and flood evacuation preparation (only 12 flood projects in the mid-term investment project 2016-2020).

(5) Farmers' Livelihood

1) Farmers' financial constraints for investing water saving facilities.
2) Limited improvement of farming technologies and crop diversification.
3) Low quality and low sales prices of agricultural products.

(6) O & M of Irrigation Systems

1) Limit of IMC and PPC's financial and human resources.
2) No organizational or collective actions for O&M.
3) Uncertainness of demarcation of responsibility between IMC and farmer's organizations.

(7) Observation and Monitoring of Water Resources

1) Limited real-time meteorological (17 stations) / hydrological (16 stations) (MH) observation.
2) Limited flood forecasting and warning system.

(8) Observation and Monitoring of Water Resources (Surface and Groundwater)

1) Insufficient collection of meteorological and hydrological (MH), groundwater level data and records on dam/reservoir (74 major reservoirs) operation.
2) There have been no water resource monitoring activities for assessing water availability and estimating water shortage in the catchment area.

(1) (2) (5)

Countermeasures

1) Prepare guidelines for introducing water saving facilities and O&M of pipeline system.
2) Implement the Training of Trainer (TOT) for DARD and district staff on irrigated agricultural modernization.
3) Repair and rehabilitate canals with lining and piping, introduce water saving facilities at farmers' level and develop or rehabilitate small-scale reservoirs and ponds.
4) Develop access road to reduce transportation cost.
5) Promote collaboration between farmers and private sectors through contract farming.
6) Train farmers to improve farming technology and marketing activities.
7) Disseminate appropriate varieties (short growing period, drought tolerant) and water saving cropping pattern.
8) Conduct water balance analyses, share the results with districts, communes, and farmers and coordinate them to minimize peak irrigation water demand.

Effects

1) Capacity of staff on agricultural extension and irrigation in the target districts is enhanced.
2) Investments by traders, local enterprises, organic promotion companies, etc., for improving farming technology, marketing, etc. are promoted.
3) Irrigation system and access road are developed.
4) Quality of products and farming technology are improved.
5) Water demand in peak dry season is decreased and risk of water shortage is mitigated.

Direction #1: "Irrigated Agricultural Modernization"

(1) (2) (6)

Countermeasures

1) Prepare provincial policy on support of farmers for sustainable O&M of irrigation systems.
2) Prepare guidelines for farmers to reduce overuse of surface and groundwater.
3) Monitor groundwater utilization.
4) Implement O&M trainings for DARD and district staff.
5) Provide guidance training to farmers on irrigation scheduling and O&M of irrigation facilities.
6) Organize farmers' water user groups and strengthen their roles and functions.
7) Promote utilization of water saving facilities and improve farming technologies in cooperation of the private sectors.

Effects

1) Capacity of DARD and district staff on O&M of irrigation sysrtems is enhanced.
2) Farmers' participation in water management and O&M of irrigation facilities are extended and enhanced.
3) Appropriate irrigated farming is executed under the cooperation of the private sectors.

Direction #2: "Strengthening Farmer's Organizations for Sustainable Irrigation Management"

(3) (4) (7)

Countermeasures

1) Prepare guideline for participatory approach on prevention of flood damages.
2) Prepare and implement TOT programs for district staff, village people, community groups, and Steering Committee for Disaster Prevention and Control.
3) Increase technical capacity of DONRE and the National Center for Hydro-Meteorological Forecasting (HMF) for flood forecasting and analysis.
4) Linkage with MH monitoring at sub-basin level.
5) Upgrade tools and sources for communication and sharing information up to village level.
6) Promote private investment and cooperation between private sectors and villagers for establishing MH monitoring system and information dissemination.
7) Assess existing land use plan and make necessary revision, and relocate residents in flood-prone areas.
8) Introduce livelihood improvement program in the flood-prone areas.

Effects

1) MH data are monitored and assessed and warning and evacuation systems including shelters for emergency are established.
2) Flood forecasts and analyses are conducted, and the useful information are shared with districts, communes, and villagers.
3) All relevant sectors participate in real-time MH monitoring system, its O&M, early warning system for flood and evacuation.
4) Local people's livelihood in the flood-prone area are stabilized and improved.

Direction #3: "Community-based Rural Livelihood Improvement in Flood-prone Area"

(1) (2) (8)

Countermeasures

1) Assess the existing data on MH, GW, and locally monitored information on water resources.
2) Prepare guidelines and systems for water resources monitoring and assessment activities, including linkage with wider area water resources assessment information, water balance assessment, early drought warning system and information dissemination to districts, communes, farmer groups (FGs), and villagers.
3) Prepare and implement training program for establishing monitoring and assessment systems (O&M of MH, GWL monitoring systems, and dam/reservoir operation).
4) Promote business matching activities between private firms and districts/FGs.
5) Enhance collaboration between villagers and private sectors and encourage private investments in introducing MH and GWL monitoring systems.

Effects

1) Water resources are well monitored and assessed locally for valid water resources utilization.
2) Drought forecasts and analyses are conducted and the results are shared with districts, communes, and villagers for reduction of drought damages.
3) Capacity of district and commune staff is enhanced.
4) Private participation in early warning system for drought is established.

Direction #4: "Community-based Monitoring for Effective Utilization of Local Water Resources"

Figure S.14 Outline of Development Directions for Water Resources Management and Disaster Prevention in Central Highlands

In terms of infrastructure development, specific works are proposed on the basis of the four development directions above at selected locations. Flood protection works shall be limited at critical areas based on the flood analysis since the protection work in large scale is not viable in terms of economic efficiency, social, and environmental considerations. As the disaster mitigation measures, road maintenance to prevent isolation of rural areas and development of water supply system to secure domestic water are recommended.

6. Conclusion

Provinces' Action Plans for Preparatory Works

Based on the four development directions, the five provinces respectively prepared their action plans for preparatory works necessary to implement the development projects for disaster prevention. The five provinces stated the objectives, the development directions related to each objective, and detailed activities to achieve it with organizations in charge and time frame. Their plans commonly consisted of five steps: (i) Study on the need for investment, current conditions and problems, (ii) Select the target-site area based on the regulated land use, environment, social and resettlement impacts, damaged area, affected people and frequency of natural disasters, (iii) Identify technology and method applied in the project, (iv) Study preliminary plans, and (v) Estimate total budget with fund sources. The Survey team reviewed the plans and advised the provinces to concretize their plans practically considering the time frame and fund sources.

Recommendation

Of the four development directions, the two development directions, i.e. "Irrigated Agricultural Modernization" and "Community-based Monitoring for Effective Utilization of Local Water Resources", are considered as priority development based on the actual situation of rural area and local need for disaster prevention measures. Available local fund and scheme of ODA for two development directions will accelerate drought prevention in the Central Highlands.

The two development directions consist of institutional and infrastructural development and require investment not only from public sector but also from private sector. Considering emergency and sustainability of development project for disaster prevention, immediate and continuous investment are necessary. Due to the complex and time-consuming procedure to apply ODA in Vietnam, it is recommended for farmers to coordinate with private firms through private investment with sharing benefit, contract farming, etc. Local government and agencies, such as PPCs, DARDs, DPIs, etc. in the five provinces, shall support them to establish a kind of platform for coordinate.

For promoting "Irrigated Agricultural Modernization", infrastructural development to disseminate water saving irrigation, such as drip and sprinkler irrigation, is necessary. In addition, rural road connecting farm and market is also necessary to reduce transportation cost and attract private investment. While some of advance farmers in the Central Highlands have already introduced water saving irrigation, most of farmers as well as provincial and district staff in charge of irrigation and agricultural extension are not familiar with the irrigation method. Therefore, guidelines, manuals, and training programs to introduce, operate, and manage the irrigation system shall be prepared.

In order to develop "Community-based Monitoring for Effective Utilization of Local Water Resources", enhancement of monitoring system both of infrastructure and organization is required. Through reviewing the monitored data on meteorology and hydrology and analyzing water balance in the Central Highlands, an early warning system on drought and preparation and dissemination of guidelines on early alarming to districts, communes, farmers and residents in rural area shall be urgently made. The monitoring system could be jointly established under collaboration with potential private investors who have technologies and investment plans.

SOCIALIST REPUBLIC OF VIETNAM
DATA COLLECTION SURVEY ON WATER RESOURCES MANAGEMENT IN CENTRAL HIGHLANDS

FINAL REPORT

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List of Abbreviation

ADB	:	Asian Development Bank
AR5	:	5th Assessment Report
DARD	:	Department of Agriculture and Rural Development
DOC	:	Department of Construction
DOF	:	Department of Finance
DOIT	:	Department of Industry and Trade
DONRE	:	Department of Natural Resources and Environment
DOT	:	Department of Transport
DPC	:	District People's Committee
DPI	:	Department of Planning and Investment
DR	:	District Road
E	:	El Niño
EM-DAT	:	The Emergency Events Database
El.	:	Elevation
GDP	:	Gross Domestic Production
GHG		Greenhouse Gas
GPDP	:	Gross Provincial Domestic Production
GoJ	:	Government of Japan
GoV	:	Government of Vietnam
GW	:	Groundwater
HH	:	Household
HMS	:	Hydro-Meteorological Service
ICD	:	International Cooperation Department (MARD)
ID	:	Irrigation Division
IMC	:	Irrigation Management Company
IPCC	:	Intergovernmental Panel on Climate Change
IPS	:	Inter-censual Population and Housing Survey
IUCN	:	International Union for Conservation of Nature
JICA	:	Japan International Cooperation Agency
JICA HQ	:	JICA Head Quarter
L	:	La Niña
MARD	:	Ministry of Agriculture and Rural Development
MONRE	:	Ministry of Natural Resources and Environment
NTP	:	National Target Program
NGO	:	Non-governmental Organization
Nos	:	Number
NP	:	National Park
NR	:	Nature Reserve
NRD	:	New Rural Development
O&M	:	Operation and Maintenance
ODA	:	Official Development Assistance
pcu	:	Passenger Car Unit
PIM	:	Participatory Irrigation Management
PR	:	Provincial Road
RCP 4.5	:	Representative Concentration Pathways 4.5W/m^2
RCP 8.5	:	Representative Concentration Pathways 8.5W/m^2
SEDP	:	Socioeconomic Development Plan
SEDS	:	Socioeconomic Development Strategy
SW	:	Surface Water
TA	:	Technical Assistance
TBD	:	To be determined
UCL	:	Universite catholique de Louvain
UN	:	United Nations
UNDP	:	United Nations Development Programme
USD	:	United States Dollar
USAID	:	United States Agency for International Development
VAT	:	Value Added Tax
VND	:	Vietnamese Dong
VS	:	Versus
WSa	:	Wildlife Sanctuary
WB	:	World Bank
WUOs	:	Water User Organizations

Measurement Units

Length

mm = millimeter(s)
cm = centimeter(s) (cm = 10 mm)
m = meter(s) (m = 100 cm)
km = kilometer(s) (km = 1,000 m)

Extent

cm^2 = square centimeter(s) (1.0 cm × 1.0 cm)
m^2 = square meter(s) (1.0 m × 1.0 m)
km^2 = square-kilometer(s) (1.0 km × 1.0 km)
ha = hectare(s) (10,000 m^2)
Acre = 0.4047 hectare(s) (4,047 m2)

Volume

cm^3 = cubic centimeter(s) (1.0 cm × 1.0 cm × 1.0 cm, or 1.0 ml)
m^3 = cubic meter(s) (1.0 m × 1.0 m × 1.0 m or 1.0 kl)
L = liter (1,000 cm^3)
MCM = million cubic meter(s)

Weight

g = gram(s)
kg = kilogram(s) (1,000 grams)
ton(s) = metric ton(s) (1,000 kg)

Time

sec = second(s)
min = minute(s)
hr = hour(s)

Others

° = degree
°C = degrees Celsius
% = percent

Currency

US$ = United State dollar(s)
JPY = Japanese yen(s)
VND = Vietnamese Dong(s)

CHAPTER 1 BACKGROUND OF THE SURVEY

1.1 Background

Severe drought caused by the impact of El Niño at the end of 2015 struck Central Highlands (Kon Tum, Gia Lai, Dak Lak, Dak Nong, and Lam Dong), where most of the provinces show higher poverty incidence. The Ministry of Agriculture and Rural Development (MARD) reported that productivity has decreased in 40,000 ha of rice field; and 12,000 ha of crop field were damaged by the drought. Water storage in dams and reservoirs declined at 10% to 50% of the design storage capacity and about 200 small-scale reservoirs were dried up in the five provinces in Central Highlands. In order to overcome the damage of the drought, the United Nations (UN) and MARD called for an emergency assistance worth USD 4.85 million to the embassies in Vietnam, World Bank (WB), Asian Development Bank (ADB), Japan International Cooperation Agency (JICA), the United States Agency for International Development (USAID), and other relevant organizations. The Government of Vietnam (GoV) also provided emergency aid such as food (5,221 ton) and water (2 MCM via water trucks).

Under the abovementioned situation, the Government of Japan (GoJ) agreed with the GoV to assess the medium- to long-term countermeasures for mitigation of drought and flood damage in Central Highlands through maximum utilization of the implemented projects and studies for rural and agriculture development, disaster prevention, water resource development and resilience measures against climate change. Based on the above agreement, the Data Collection Survey on Water Resources Management in Central Highlands was prepared by JICA.

1.2 Objective and Scope

The objective of the Survey is to assess the medium- and long-term disaster prevention countermeasures in the target five provinces of Central Highlands covering water resources management project, especially for agricultural water management, on the basis of the past JICA assistance, demand of the five provinces and information and data to be collected. The Survey Team implemented the works as follows:

Table 1.2.1 Contents of Work

Stage of Survey	Period of the Survey	Items of the Survey
1. Preparatory work in Japan	Late in March, 2017	• Discussion with JICA HQ • Collection and analysis of existing data • Preparation of Inception Report (Draft) • Preparation and submission of asset management and O&M capacity checklist
2. Work in Vietnam Phase-1	Middle of April to Middle of September 2017	• Discussion on Inception Report • Data collection, site survey and assessment • Data collection for water balance study • Preliminary water distribution assessment in dry period • Preliminary water distribution assessment in wet period • Preliminary assessment of water distribution (dry and wet period) • Assessment on priority measures for water resources management focusing on agricultural water • Preparation of Progress Report and discussion
3. Work in Vietnam Phase-2	Late in October 2017 to February 2018	• Continuation of data collection and assessment • Site survey for prioritizing projects/ plans • Preparation of Draft Final Report and discussion • Preparation of Final Report (draft)
4. Final work in Japan	March 2018	• Preparation and submission of Final Report

Source: JICA Study Team

1.3 Activities Made from Commencement to Date (January 2018)

(1) Preparatory Work in Japan

In the preparatory works in Japan, the JICA Study Team reviewed the existing and available information and data covering the agricultural policies and programs, natural conditions, statistics of agricultural production and trade, land use, irrigation and other infrastructure development, the reports of the studies,

the related projects under JICA and other donors. Those information and data were utilized for the preparation of the Inception Report of this Survey.

(2) Work in Vietnam Phase-1

The JICA Study Team started the Phase-1 work from April 11, 2017 in Vietnam. At the beginning of the Phase-1 work, the JICA Study Team discussed with JICA and MARD separately, to explain the contents of the Inception Report on April 12, 2017. After the discussion, the inception workshop was held in Buon Ma Thuot in Dak Lak Province with the target five provinces on April 19, 2017. Through the discussion in the workshop, the JICA Study Team explained about the purpose, method, and expected output of the Survey to the five provinces and ensured cooperation by the provinces. Before and after the workshop, the JICA Study Team conducted a field survey in Central Highlands to collect data and information from April 17 to May 5, 2017. The JICA Study Team continued the data collection and assessment throughout the Phase-1 work in parallel with the analysis of the collected data. The results of the data assessment and analysis under Phase-1 were compiled in the Progress Report to be submitted at the end of September 2017. After the submission, a meeting with the representatives of the five provinces in Da Lat, Lam Dong Province will be held to present the Progress Report and to request further cooperation for additional site survey in Central Highlands to be conducted from late October to the middle of November 2017.

(3) Work in Vietnam Phase-2

The JICA Study Team started the additional site survey in the Phase-2 work from October 29 to November 12, 2017 to find local and actual needs for drought and flood prevention. Based on the result of the survey, the projects and plans prepared by the five provinces were assessed. According to the assessment, the JICA Study Team prepared outlines of the four development directions: “Irrigated Agricultural Modernization”, “Strengthening Farmer’s Organization for Sustainable Irrigation Management”, “Community-based Rural Livelihood Improvement in Flood-prone Area”, and “Community-based Monitoring for Effective Utilization of Local Water Resources”. These outlines were provided to the five provinces with guidance to make an action plan for the preparatory work of the projects. The results of the above works under Phase-2 were explained by the JICA Study Team and discussed with MARD and the five provinces at the Wrap-up workshop held in Da Lat in Lam Dong Province on February 5, 2018. Based on the discussion in the workshop, the result of the study was compiled in the draft final report to be submitted in the middle of February 2018.

(4) Wrap-up Work in Japan

The JICA Study Team started the wrap-up work in Japan from the middle of February to the middle of March 2018. After receiving the comments on the draft final report from MARD and five provinces of Central Highlands, the JICA Study Team revised the draft final report based on their comments. Finally, the final report was prepared and submitted to JICA in the middle of March 2018.

CHAPTER 2 POLICY ABOUT NATURAL DISASTERS, AGRICULTURE AND RURAL DEVELOPMENT, AND WATER RESOURCES MANAGEMENT IN VIETNAM

2.1 Current Condition of Natural Disasters

2.1.1 Condition of Natural Disasters

Vietnam has a long land extending north to south at the east edge of Indochina Peninsula. The country has a long coastal line facing the East Sea and its topography is complicated and generally hilly and mountainous except for major deltas. Due to such diversified characteristics of topography and geography, regional differences in climate and disaster are observed. Vietnam suffers various types of natural disasters occurring almost all year-round. While flood and storm are the disasters occurring most frequently in the country, drought brings the most serious damage. In the last 26 years, although the drought event occurred only five times, the annual economic damage was more than USD 50,000 on average. Furthermore, the damage by the drought in 2015 to 2016 was USD 6,750,000, that was the largest damage in the period.

Table 2.1.1 Natural Disaster in Vietnam (1991-2016)

Disaster	1991-2000	2001-2010	2011	2012	2013	2014	2015	2016
Flood								
No.	16	39	3	1	6	0	2	4
Damage (USD '000)	1,136,000	2,282,000	219,002	30,000	78,500	0	204,000	161,280
Drought								
No.	2	2	0	0	0	0	1	0
Damage (USD '000)	407,000	242,120	0	0	0	0	6,750,000	0
Landslide								
No.	4	2	0	0	0	0	0	0
Damage (USD '000)	2,300	0	0	0	0	0	0	0
Storm								
No.	29	29	2	3	4	3	1	4
Damage (USD '000)	1,374,355	2,944,750	0	342,800	1,474,230	10,700	0	685,157
Others								
No.	3	6	0	0	0	0	0	1
Damage (USD '000)	0	0	0	0	0	0	0	0
Total								
No.	54	78	5	4	10	3	4	9
Damage (USD '000)	2,919,655	5,468,870	219,002	372,800	1,552,730	10,700	6,954,000	846,437

Source: EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) - CRED, D. Guha-Sapir - www.emdat.be, Brussels, Belgium

2.2 Policy of Agricultural and Rural Development and Water Resources Management in Vietnam

2.2.1 Vietnam's Socioeconomic Development Strategy (SEDS) for the Period of 2011-2020

The Government of Vietnam has a 10-year strategy for its socioeconomic development from 2011 to 2020. There are two plans in the given period: Socioeconomic Development Plan (SEDP) 2011-2015 and SEDP 2016-2020.

The contents of these two plans, and accomplishments up to 2016 are given in the following two tables. Overall, the average gross domestic product (GDP) growth between 2011 and 2015, and up to 2016 was slower than expected, and consumer price index (CPI) did not increase that much. The budget deficit was bigger than what was anticipated, while public and national debts were lower from 2011 to 2015.

Table 2.2.1 National Development Plan in SEDP 2011-2015 and Achievements

Indicator	Unit	Target in SEDP 2011-2015	Achievement 2011-2015
1. Economic Target			
Average GDP growth	%/year	6.5-7.0	5.9 /_1
Share of investment budget in GDP	%	33.5-35.0	31.2
Trade deficit	%	10.0	<5.0
Budget deficit	%	4.5	5.0
Decrease in energy consumption based on GDP	%/year	2.5-3.0	6.6
Share of high-tech products of the total industrial production	%	30.0	18.4
Increase in technological innovation rate	%/year	13.0	13.5
Increase in labor productivity	%	29.0-32.0	22.0
Public debts	%	65.0	61.3
Government's outstanding debts	%	50.0	48.9
National debts	%	50.0	41.5
Increase in consumer price index	%	5.0-7.0	1.5-2.5
2. Social Target			
Creation of jobs within 5 years	million jobs	8.0	7.8
Urban unemployment of working age	%	<4.0	<4.0
Share of trained laborers by 2015	%	55.0	51.6
Increase of real income of the population by 2015	times	2.00-2.50	2.85-2.90
Reduction in poverty rate	%/year	2.0 /_2	2.0 /_3
Housing floor area per house	m^2/house	22	22
House floor area per person	m^2/person	26	26
Population growth rate	%/year	1.0	1.0
No. of doctors per 10,000 people	No. of doctor	8	8
No. of patient beds per 10,000 people	No. of bed	23	24
3. Environmental target			
Forest cover by 2015	%	42.0-43.0	40.7
Share of establishments applied adequate treatment technology	%	85.0	92.5

Note: /_1: Average GDP growth at 6.24% in 2011, 5.25% in 2012, 5.42% in 2013, 5.98% in 2014, and 6.68% in 2015
/_2: 4%/year for poor districts and extremely difficulty communes /_3: 4% for poor districts
Source: Resolution No. 10/2011/QH13 dated November 8, 2011

Table 2.2.2 National Development Plan in SEDP 2016-2020 and Status in 2016

Indicator	Unit	Target in SEDP 2016-2020	Status in 2016
1. Economic Target			
Average GDP Growth	%/year	6.5-7.0	6.2
Share of investment budget in GDP	%	32.0-34.0	32.5
Budget deficit by 2020	%	4.8	/_1
Decrease in energy consumption based on GDP	%/year	1.0-1.5	1.5
Increase in labor productivity by 2020	%	5.0	5.3
Increase in consumer price index	%	5.0	4.7
Urbanization rate by 2020	%	38-40	/_1
GDP per capita	USD/person	3,200-3,500	2,215
Share of industry and services production in GDP	%	85.0	73.1
2. Social Target			
Urban unemployment of working age by 2020	%/year	4.0	3.2
Share of trained laborers	%	65-70	53
Reduction in poverty rate	%/year	1.0-1.5 /_2	1.3-1.5 /_3
No of doctors per 10,000 people by 2020	No. of doctor	9.0-10.0	8.4
No of patient beds per 10,000 people by 2020	No. of bed	26.5	26.8
3. Environmental Target			
Forest cover	%	42.0	41.2
Share of establishments applied adequate treatment technology	%	85	86

Note: /_1: No statistics for 2016, /_2: 4% for poor districts and communes /_3: 4% for poor districts
Source: Resolution no. 142/2016/QH 13 dated on April 12, 2016

2.2.2 National Target Program on New Rural Development

(1) Background

The National Target Program (NTP) on the New Rural Development (NRD) was approved by Decision No. 800/QD-TTg dated June 4, 2010. This program is to be implemented over the 9,071 communes for the period of 2010-2020.

In order to implement Resolution No. 100/2015/QH13 dated November 12, 2015 of XIII National Assembly on approval of investment instruction for National Target Programs in 2016-2020, the Prime Minister has issued the National Target Program on New Rural Development in 2016-2020. This program has been approved by the Prime Minister on August 16, 2016 in Decision No. 1600/QD-TTg.

(2) Objectives

The objectives of NTP on NRD are the following:

- Develop the rural economy to improve the spiritual and material lives of rural people;
- Develop the rural areas according to plans, linking agriculture to rapid development of industry, services, and urban areas;
- Modernize the socioeconomic infrastructure – preservation of the cultural characteristics and improvement of the intellectual standard of people;
- Ensure eco-environment that is green, clean, and beautiful; and
- Increase the quality of political system operation - good governance.

As its specific targets, 20% of all communes are expected to achieve full new rural criteria set by 2015, and 50% of all communes will reach new rural criteria by 2020.

(3) Criteria

The NTP promotes rural development at the commune level to achieve the status of a New Rural Commune based on the national set of 19 criteria on NRD based on the Prime Minister Decision No. 1980/QD-TTg dated October 17, 2016[1] as follows:

Table 2.2.3 Criteria of NTP on NRD

Planning	Economic - Social Infrastructure	Economic Activities and Production Organization	Culture - Society - Environment	Political System
1. Planning	2. Road 3. Irrigation 4. Electricity 5. Schools 6. Cultural facilities and infrastructure 7. Rural trade infrastructure 8. Information and communication 9. Residential houses	10. Incomes 11. Poor households 12. Employed labors 13. Production organizations	14. Education and training 15. Health cares 16. Culture 17. Environment and food safety	18. Political system and access to legal system 19. Defense and security

Source: Decision No. 1980/QD-TTg

The NTP has been implemented in the five target provinces. From 2011-2016, the Central Highland provinces have mobilized more than VND 90 trillion for implementing the NTP, of which VND 2,295 billion from the central budget and the remaining from organizations, businesses, credit fund, and local people's contribution. Up to now, more than 100 communes and one district in the Central Highland provinces have met the New Rural Development criteria, especially Lam Dong which has 45 communes and one district of Don Duong[2]. Ministry of Agriculture and Rural Development (MARD) is coordinating as the central government, while the Department of Agriculture and Rural Development (DARD) and local administrative units are implementing.

2.2.3 Strategy on Agriculture and Rural Development for 2011-2020

(1) Background

The Strategy on Agriculture and Rural Development for 2011-2020 was approved by MARD; Plan No. 3310/BNN-KH dated October 12, 2009.

(2) Objectives and Target

The overall objectives are shown as below:

1) Develop a comprehensive agriculture towards modernization, sustainability, large-scale commodity production, productivity, quality, efficiency, competitiveness, and ensuring food security for both short and long terms;
2) Construct new rural areas with modern economic infrastructure, consists of (i) economic structures and production developing sectors of agriculture, industry, services, and urban planning, (ii) stable rural society, rich in national cultural characteristics, enhanced intellect,

[1] This decision is replaced to Decision No. 491/QD-TTg dated September 16, 2009 on issuance of the national set of 19 criteria on NRD

[2] http://www.nhandan.com.vn/xahoi/tin-tuc/item/31733002-tay-nguyen-co-hon-100-xa-dat-chuan-nong-thon-moi.html

protection of the ecological environment, and (iii) strengthening political system in rural areas under the leadership of a party; and

3) Improve the living standard and create fast changes in difficult areas through provision of trainings to farmers in production.

The strategy states the specific objectives for two five-year periods. The objectives of the new period 2016-2020 are: (i) agricultural development towards a comprehensive, modern, and large-scale commodity production, and sustainability; (ii) rural development associated with the process of industrialization and urbanization of the country; and (iii) increase income and improvement of basic living conditions of the rural residents and environmental protection. The target strategies are set below.

- Sustained agricultural growth rate at an annual average of 3.5%-4% is ensured;
- Structure of agricultural production and rural economy is transformed according to market demand, as well as livestock, fisheries, and forestry productions are to be developed;
- Rural labors are to be moved largely out of the agriculture sector for structural change of the industries and are allowed that agricultural labor can become about 30% of the total labor (70% of labor is engaged in other industries);
- At least 50% of the rural communes achieve new rural standard. The income of rural residents is increased by 2.5 times compared with 2010-2011; and
- Forest coverage is increased to 43%-45%, protecting biodiversity, ensuring inland and near shore fishing to regenerate and develop, overcoming pollution in agricultural production, recovery and mitigation of natural disasters, epidemics, and adverse impacts of climate change.

(3) Strategic Orientation Related to Water Resources Management

- Construction of the irrigation system is optimized to save water; water user organizations (WUOs) of farmers, local communities, and investors are developed to protect, manage, and operate efficiently the irrigation systems and water, raise the efficiency of design capacity utilization to over 90%; increase disaster prevention capacity and adapt to climate change;
- Significant funds for operations and maintenance (O&M) and development works are effectively being used to improve water use efficiency;
- Ensure the demand for water supply for agricultural production, people's life and economic sectors; 100% of rural residents have access to clean water (60 liters/person/day); ensure sufficient water for industrial development, water for service; and
- The program of NRD with the criteria is implemented and is consistent with the characteristics of each region giving importance to the more difficult communes in the mountainous, border, capes areas, and the islands.

(4) Strategic Orientation for Central Highlands Related to Agricultural and Rural Development

For Central Highlands, the following are proposed:

1) Strategic orientation for agricultural development: To develop large-scale areas of specialized crops with high-quality such as coffee, rubber, and cashew, develop high quality flowers and vegetables in Da Lat, raise pigs, buffalos, and cows, protect the protected forests, special-use forests, and develop the non-timber forestry, develop aquaculture in the rivers, streams, and reservoirs; and develop traditional craft villages.
2) Crop production:
    - Develop the national specialized farming areas for the production of industrial crops: coffee, cashew, pepper, rubber, tea, and wooden furniture for export;
    - Develop specialized commodity corn areas for feed production;
    - Develop hi-tech flowers and vegetables;
    - Develop the processing industry to add value to the main crop productions; and

- Build up some major agricultural wholesale markets to directly trade with international markets.

3) Livestock:

- Develop cattle (buffalo, cow for meat, cow for milk) with high quality to meet domestic demand.

4) Forestry:

- Protect special-use forests in combination with ecotourism development; and
- Transfer some poor forest areas to develop industrial crops.

5) Rural development:

- Develop household economy to alleviate poverty among ethnic minorities; and
- By 2020, 60% of the communes will meet the criteria of the New Rural Development Program.

2.2.4 National Strategy on Water Resources to 2020

(1) Background

The National Strategy on Water Resources to 2020 was prepared by Ministry of Natural Resources and Environment (MONRE) and approved by Decision No. 81/2006/QD-TTg on April 14, 2006.

(2) Objectives

The overall objectives are as follows:

- Protect, efficiently exploit and sustainably develop national water resources on the basis of an integrated and unified management in the period of accelerated national industrialization and modernization;
- Take initiative in the prevention, mitigation and minimization of harms caused by water;
- Create a multi-sectoral water economy gradually in line with the socialist-oriented market economy; and
- Raise cooperation efficiency, harmonize the interests of countries sharing water sources with Vietnam.

The five specific objectives, i.e. i) protection of water resources, ii) exploitation and use of water resources, iii) development of water resources, iv) minimization of harms caused by water, and v) improvement of water resource management capacity are also stated in the strategy.

(3) Strategy in the Target Area

The strategy specifies the issues on water pollution and over-exploitation of the Dong Nai River and water resources development and flood protection in Central Highlands.

(4) Organization of Implementation

The implementing organization is MONRE, who is responsible in organizing and directing the implementation of contents of the strategy and to guide and urge relevant agencies to elaborate and organize the implementation of programs, plans, schemes, and projects.

2.2.5 National Strategy for Natural Disaster Prevention, Response and Mitigation to 2020

(1) Background

The National Strategy for Natural Disaster Prevention, Respond and Mitigation to 2020 was prepared by MARD and approved by Decision No. 172/2007/QD-TTg on November 16, 2007.

(2) Objectives

The overall objective of the strategy is to minimize the impact on human life and properties, natural resources, cultural heritages, environment and national defense. Following specific objectives are also stated in the strategy:

- Enhance capacity in forecasting disaster;
- Integrate plans for disaster prevention, response, and mitigation with development plans;
- Develop capacity regarding disaster prevention response, and mitigation for all local staff engaged in the field and for more than 70% of the population living in disaster prone areas;
- Relocate people living in disaster prone areas to safety areas;
- Ensure adequate investment for construction of infrastructure and facility, for procurement of equipment, and for human resources development in order to deal with disaster search;
- Improve dike and embankment system to enhance flood-resistant capacity;
- Construct storm shelters for boats and ships; and
- Ensure offshore fishing boats and ships in possession of communication equipment.

(3) Approach to Central Highlands

The responsibilities and solutions for each region are also stipulated in the strategy. An approach of "proactive prevention of natural disaster" is applied to Central Highlands consisting of:

- Define and map the areas vulnerable to flash floods and landslides;
- Establish plans of land use, residence, evacuation, cropping, and exploitation of natural resources;
- Develop warning and communication system to the commune level;
- Construct/improve infrastructure for preventing landslides and flash floods, for expanding flood discharge capacity, and for controlling both flood and drought; and
- Strengthen the cooperation with border countries in disaster forecasting, warning, search, and rescue.

(4) Implementing Organization

The Central Steering Committee Natural Disaster Prevention and Control is acting as the inter-sectoral coordinator assisting the Government of Vietnam (GoV) in organizing, directing and administering the prevention of, response to, and remediation of consequences of natural disasters nationwide. The committee consists of: i) the Minister of Agriculture and Rural Development as the chairperson, ii) Deputy Minister of Agriculture and Rural Development as the permanent vice-chairperson, iii) Vice-chairperson of the Government Office as the vice-chairperson, and iv) Permanent Vice-chairperson of the National Committee for Search and Rescue as the vice-chairperson. The chairperson can invite other leaders of related agencies based on the work requirements.

CHAPTER 3 CURRENT CONDITION OF THE FIVE PROVINCES IN CENTRAL HIGHLANDS AND NATURAL DISASTERS

3.1 Climatic Condition and River Basins

3.1.1 River Basins in Central Highlands

The flow condition of the rivers in Central Highlands is divided mainly into four drainage systems; namely, i) Se San River, ii) Ba River, iii) Srepok River and iv) Dong Nai River as follows (Ref. AT 3.1.1 and AT 3.1.2):

Table 3.1.1 River Basins in Central Highlands

River Basin Name	Catchment Area in Central Highlands (km^2)	Provinces in Central Highlands
Se San	11,377	Kon Tum, Gia Lai
Ba	10,779	Gia Lai, Dak Lak
Srepok	17,887	Gia Lai, Dak Lak, Dak Nong
Dong Nai	9,236	Dak Nong, Lam Dong
Total	55,016	

Note: The figure shows the watershed area in Central Highlands. Some areas located in other provinces are included.
Source: JICA Study Team

(1) General

1) Se San River Basin

The Se San River flows through central Vietnam and north-east Cambodia. It is a major tributary of the Mekong River. The total area of the Se San River catchment is 18,943 km^2, in which 7,566 km^2 (about 40%) is located in Cambodia and 11,377 km^2 (60%) is in Vietnam. The total length of the Se San River is 462 km. The source of the Se San River starts from Ngoc Linh Mountain in Kon Tum Province. The Se San catchment mainly includes the provinces of Kon Tum and Gia Lai in Vietnam. Annual rainfall of the basin varies from 1,700 mm/year to 3,000 mm/year in the area of Vietnam and from 1,700 mm/year to 2,400 mm/year in the area of Cambodia. The rainy season is from May to October and the flood season is from July to November. The source of the river basin is the Ngoc Linh Mountain range which has an annual rainfall of over 1,290 mm/year. The river flows south-westward and joins some tributaries in the upper catchment. The water resource of Se San River basin has a high potential of hydropower and irrigation development. The features of the basin are as follows:

Table 3.1.2 Features of the Se San River Basin

Items	Country	
	Cambodia	Vietnam
Basin Area (km^2)	7,566	11,377 [1)]
Basin Length (km)	130	140
Basin Width (km)	90	120
River Length (km)	225	237
Elevation Range (m)	56 – 1,434	129 – 2,390
Average Elevation (m)	273	778
Average Slope (deg.)	6	10
Provinces	Ratanakiri, Stung Treng	Gia Lai, Kon Tum
Population (2012)	95,600	896,810
Population Density (pers./km^2)	13	80
Average Precipitation (mm)	1,965	1,2874 [2)]
Average Temperature (°C)	22.6	19.3
Major Protected Areas	Virachey NP	Chu Mom Ray NP, Bac Plei Ku NR, KonKaKinh NP, Ngoc Linh (Kon Tum) NR

Note: 1) The figure shows the watershed area in Central Highlands. Some areas located in other provinces are included.
NP: National Park; NR: Nature Reserve
Sources: IUCN (International Union for Conservation of Nature), 2): JICA Study Team

2) Ba River Basin

The source of the Ba River is located in Kon Tum Province and flows into the East Sea in Tuy Hoa, Phu Yen Province. It has the largest river valley area in central Vietnam with a total basin area of 13,900 km^2 and a total length of 374 km. The total catchment area of the Ba River in Central Highlands is 10,779 km^2. The Ba River basin makes up parts of Dak Lak Province, around half of Gia Lai Province and parts of Kon Tum Province. The main tributaries are Hinh River and Ayun River. The source of the Ba River comes from

the Ngoc Linh Mountain in Kon Tum Province. The flood season of Ba River occurs from July to November. The features of the basin are as follows:

Table 3.1.3 Features of the Ba River Basin in Central Highlands

Items	Value
Basin Area (km^2)	10,779
River Length (km)	322
Elevation Range (m)	86 – 1,745
Average Elevation (m)	778
Average Slope (%)	15
Provinces	Gia Lai, Kon Tum, Dak Lak
Average Precipitation (mm)	1,676
Average Temperature (°C)	23.3

Note: The figure shows the watershed area in Central Highlands. Some areas located in other provinces are included.
Source: JICA Study Team

3) Srepok River Basin

The Srepok River is a river that flows through central Vietnam and northeast Cambodia. It is a major tributary of the Mekong River. The total area of the Srepok River catchment is 30,900 km^2, in which 12,780 km^2 (about 40%) is in Cambodia, and 18,162 km^2 (60%) is in Vietnam. The total length of Srepok River is 425 km. The source of Srepok River starts from the Annamite Mountains in Vietnam. The Srepok Basin covers the provinces of Dak Nong, Dak Lak, Lam Dong and Gia Lai. The catchment area is generally mountainous. The water resource of Srepok River basin has a high potential for hydropower and irrigation development. Annual rainfall of the basin varies from 1,000 mm to 2,500 mm in the area of Vietnam. The rainy season occurs during May to October and the flood season occurs from July to November. The features of the basin are as follows:

Table 3.1.4 Features of the Srepok River Basin

Items	Cambodia	Vietnam
Basin area (km^2)	12,780	17,887
Basin length (km)	180	150
Basin width (km)	160	220
River length (km)	265	160 (Srepok only)
Elevation range (m)	45–1,081	140–2,409
Average elevation (m)	218	525
Average slope (deg.)	2.4	6.8
Provinces	Mondulkiri, Ratanakiri, Stung Treng, Kratie	Dak Lak, Dak Nong, Gia Lai, Lam Dong
Major towns	Lumphat	Dak Mil (Dak Min), Buon Ma Thuot
Population (2012)	128,074	2,139,470
Pop. density (pers./km^2)	10	118
Average precipitation (mm)	1,569	1,575
Average temperature (°C)	23.2	21.2
Protected areas	Lomphot NP, Nsok PF, Mondulkiri PF, Phnom Prich WS, Pnom Namlear WS	Bi Dup-Nui Ba NR, Chu Hoa NR, Chu Yang Sin NR, Dak Mang NR, Ho Lak, Nam Ca NR, Nam Nung NR, Ta Dung NR

Note: The figure shows the watershed area in Central Highlands. Some areas located in other provinces are included.
NP: National Park; NR: Nature Reserve; PF: Protected Forest; WS: Wildlife Sanctuary
Source: IUCN (International Union for Conservation of Nature)

4) Dong Nai River Basins

The Dong Nai River has its source located in the southwest of Dak Nong Province and the northeast of Lam Dong Province and flows into the East Sea. The total basin area is about 37,400 km². The total catchment area of Dong Nai River catchment in Central Highlands is 9,236 km^2. The Dong Nai River has a length of 470 km. The basin covers most of the territorial areas of Lam Dong, Binh Phuoc, Binh Duong, Tay Ninh, Dong Nai, Ho Chi Minh City, parts of Dak Nong, Long An, Ba Ria–Vung Tau, Binh Thuan, and Ninh Thuan provinces (11 provinces and cities in total). The Dong Nai River basin is shaped like tree branches, of which Dong Nai is the main stream, flowing in from the northeast to the southwest direction. The river flows eastward and joins some tributaries in the upper catchment. The main river flows into Dong Nai and La Nga Rivers on the left bank of Dong Nai river and Be, Ho Chi Minh City and Vam Co on the right bank of Dong Nai River. The basin has 266 rivers and streams with length of over 10 km each. The basin has several dams and reservoirs such as Da Nhim (Don Duong), Dai Ninh, Dong Nai 2, Dong Nai 3 and Dong Nai 4. After the construction of the Tri An hydropower plant and Dau Tieng reservoir, the water flow increases by 4 to 5 times during the dry season and decreases by 50% in the flood season. The rainy season occurs from May and ends in October that produces rainfall accounting for 85% of the total annual rainfall. The river has several perennial tributaries from the western mountains. The Dong Nai River basin

has a tropical monsoon climate comprising of two seasons mainly rainy and dry seasons. The features of the basin are as follows:

Table 3.1.5 Features of the Dong Nai River Basin in Central Highlands

Items	Value
Basin Area (km^2)	9,236
River Length (km)	337
Elevation Range (m)	92 - 2,280
Average Elevation (m)	865
Average Slope (%)	17
Provinces	Dak Nong, Lam Dong
Average Precipitation. (mm)	1,975
Average Temperature (°C)	22.0

Note: The figure shows the watershed area in Central Highlands. Some areas located in other provinces are included.
Source: JICA Study Team

(2) Runoff Characteristics

1) Se San River Basin

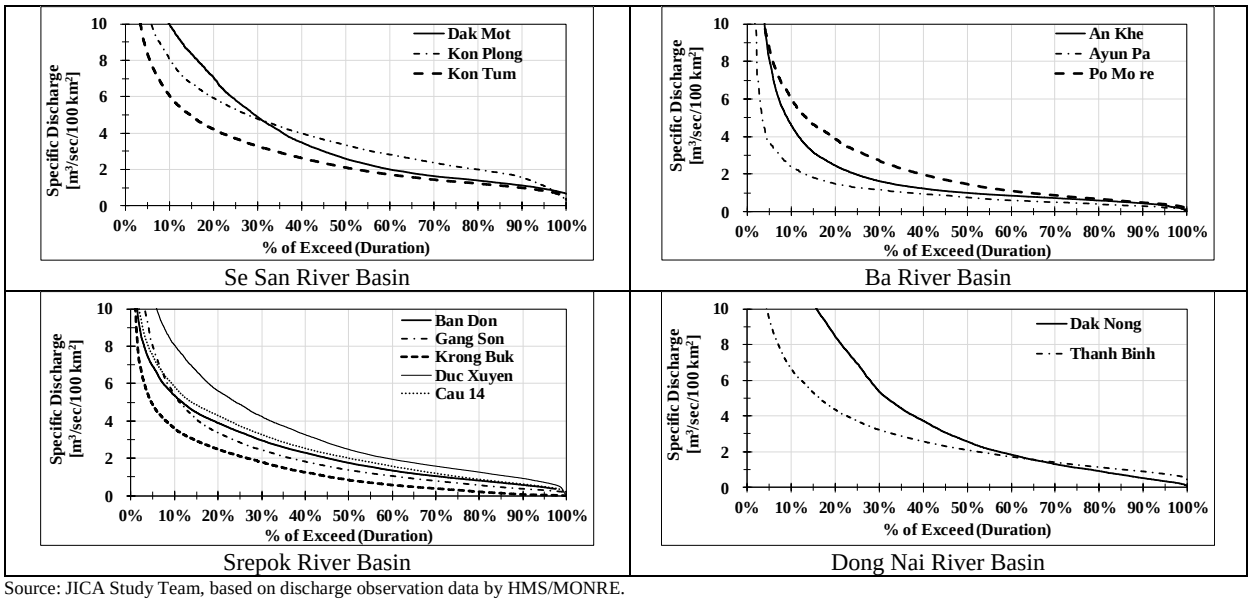
The Hydro-Meteorological Service (HMS) MONRE is mainly operating the following four registered hydrological stations in the Se San River basin. Runoff characteristics of the river basins in Central Highlands are summarized below.

Table 3.1.6 Runoff Characteristics of River Basin in Central Highlands

Station Name	Catchment Area (km^2)	River Basin	Longitude	Latitude	Measurement Factor	Dependable Discharge [m^3/sec]			
						50%	85%	90%	95%
Dak Mot	1,640	Sesan	107°46'00"	14°45'00"	Water Level, Discharge, Rainfall	42.5	20.6	18.3	15.3
Kon Plong	965	Sesan	108°08'00"	14°28'00"	Water Level, Discharge, Rainfall	32.3	17.5	14.9	10.5
Kon Tum	3,056	Sesan	108°01'40"	14°22'37"	Water Level, Discharge, Rainfall	64.4	34.0	30.1	25.2
Dak To	580	Sesan	107°50'53"	14°42'13"	Water Level, Rainfall	-	-	-	-
An Khe	1,368	Ba	108°40'00"	13°57'35"	Water Level, Discharge, Rainfall	13.7	7.1	6.0	4.4
AyunPa	6,914	Ba	108°27'00"	13°31'00"	Water Level, Discharge, Rainfall	51.6	23.0	20.0	14.0
Po Mo Re	311	Ba	108°21'00"	14°02'00"	Water Level, Discharge, Rainfall	4.6	1.8	1.5	1.2
Cau 14	8,610	Srepok	107°36'00"	12°57'00"	Water Level, Discharge, Rainfall	173.0	63.7	53.2	41.1
Giang Son	3,020	Srepok	108°12'00"	12°30'00"	Water Level, Discharge, Rainfall	41.4	13.7	11.1	8.8
Krong Buk	527	Srepok	108°23'48"	12°45'12"	Water Level, Discharge, Rainfall	4.4	0.7	0.3	0.2
Bản Đôn	11	Srepok	107°44'00"	12°54'00"	Water Level, Discharge, Rainfall	186.0	73.2	60.4	46.8
Duc Xuyen	2,620	Srepok	107°59'00"	12°18'00"	Water Level, Discharge, Rainfall	65.0	28.4	24.1	18.5
Thanh Binh	294	Dong Nai	108°18'00"	11°46'00"	Water Level, Discharge, Rainfall	6.2	3.0	2.6	2.2
Dak Nong	300	Dong Nai	107°41'16"	12°00'03"	Water Level, Discharge, Rainfall	7.7	2.1	1.6	1.0
Dai Ninh	1,848	Dong Nai	108°18'34"	11°39'57"	Water Level, Rainfall	-	-	-	-

Source: JICA Study Team, based on observed discharge by HMS/MONRE.

The flow duration curves of specific discharge at m^3/sec/100 km^2 of the basin by series of all available observation records show that the annual average daily specific discharge was from 2.1 m^3/sec/100 km^2 to 3.3 m^3/sec/100 km^2 and the daily discharges of less than 64 m^3/sec (2.1 m^3/sec/100 km^2) were recorded for six months at the Kon Tum station.



Source: JICA Study Team, based on discharge observation data by HMS/MONRE.

Figure 3.1.1 Flow Duration Curve of Specific Discharge

2) Ba River Basin

The HMS, MONRE is mainly operating the following four registered hydrological gauging stations in the Ba River basin. The flow duration curves of the specific discharge show that the annual average daily specific discharge was from 0.8 m^3/sec/100 km^2 to 1.5 m^3/sec/100 km^2 and the daily discharges of less than 13.7 m^3/sec (1.0 m^3/sec/100 km^2) were recorded for six months at the An Khe station.

3) Srepok River Basin

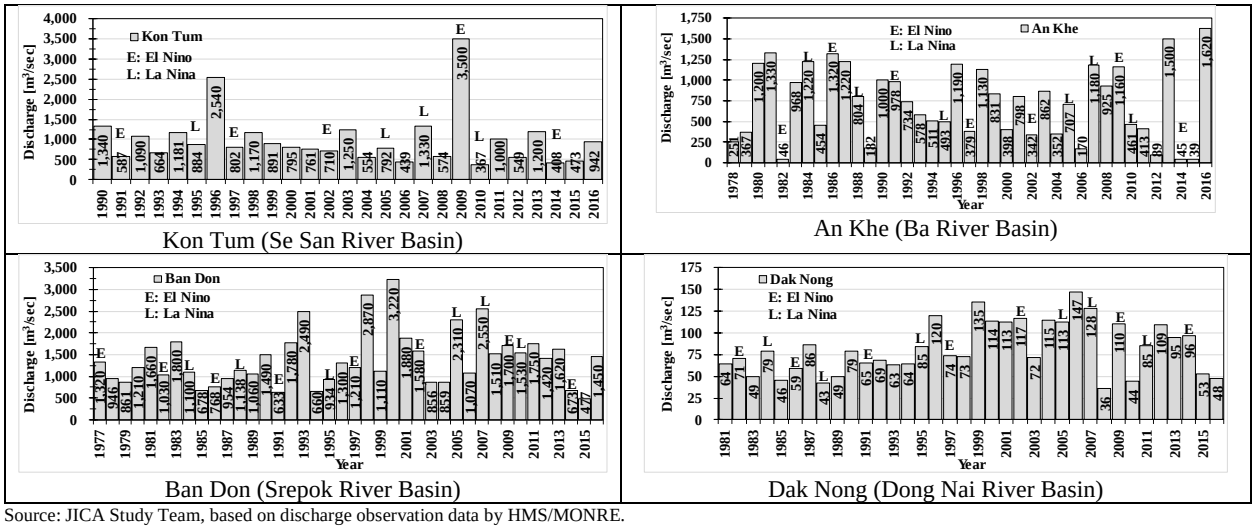
The HMS, MONRE is mainly operating the following five registered hydrological stations in the Srepok River basin. The flow duration curves of the specific discharge (m^3/sec/100 km^2) of the basin by series of all available observation records show that the annual average daily specific discharge was from 0.8 m^3/sec/100 km^2 to 2.5 m^3/sec/100 km^2 and the daily discharges of less than 186 m^3/sec were recorded for six months at Ban Don station.

4) Dong Nai River Basin

The HMS, MONRE is mainly operating the following three registered hydrological gauging stations in the Dong Nai River basin in Central Highlands. The flow duration curve shows that the annual average daily specific discharge was from 2.1 m^3/sec/100 km^2 to 2.6 m^3/sec/100 km^2 and the daily discharges of less than 7.7 m^3/sec (2.6 m^3/sec/100 km^2) were recorded for six months at the Dak Nong station.

(3) Flood Discharge

The observation of the water level at Kon Tum gauging station in the Se San River basin was commenced and recorded since 1990. The maximum flow mainly occurs in the months of June to August (11%) and September to November (80%). Flood flows exceeding 2,500 m^3/sec occurred on October 24, 1996 at 2,540 m^3/sec and September 19, 2009 at 3,500 m^3/sec at the Kon Tum station. The largest flood discharge of 3,500 m^3/sec was recorded during the famous "El Niño" in 2009.



Kon Tum (Se San River Basin) | An Khe (Ba River Basin)

Ban Don (Srepok River Basin) | Dak Nong (Dong Nai River Basin)

Source: JICA Study Team, based on discharge observation data by HMS/MONRE.

Figure 3.1.2 Annual Maximum Daily Discharge

The observation of discharge at An Khe gauging station in Ba River basin was commenced and recorded since 1978. The maximum flow mainly occurs in the months of June to August at 5% and September to November at 92%. Flood flows exceeding 1,500 m^3/sec occurred on November 5, 2013 at 1,500 m^3/sec and December 6, 2016 at 1,620 m^3/sec at the An Khe station. The largest flood discharge of 1,620 m^3/sec was recorded in 2016.

The observation of discharge at the Ban Don station in Srepok River basin was commenced and recorded since 1977. The maximum flow mainly occurs in the months of June to August at 23% and September to November at 78%. Flood flows exceeding 2,800 m^3/sec occurred on November 13, 1988 at 2,870 m^3/sec and October 4, 2000 at 3,220 m^3/sec at the Ban Don station.

The observation of the water level at Dak Nong gauging station in the Dong Nai River basin was commenced and recorded since 1981. The maximum flow mainly occurs in the months of June to August (53%) and September to November at 47%. Flood flows exceeding 125 m^3/sec occurred on July 18, 1997 at 135 m^3/sec, October 1, 2006 at 147 m^3/sec and August 6, 2006 at 128 m^3/sec at the Dak Nong station. The largest flood discharge of 147 m^3/sec was recorded in 2006.

The probable flood peak discharges in the four basins were evaluated. In Se San River basin, the recorded maximum flood peak discharge of 3,500 m^3/sec is equivalent to more than the probability of once in 200 years. In Ba River basin, the recorded maximum flood peak discharge of 1,620 m^3/sec is equivalent to more than the probability of once in 50 years. The recorded maximum flood peak discharge in the Srepok River basin of 3,220 m^3/sec is also equivalent to more than the probability of once in 50 years as well. In the Dong Nai River basin, the recorded maximum flood peak discharge of 147 m^3/sec is equivalent to more than the probability of once in 20 years. The probable flood peak discharge in Central Highlands is shown as follows.

Table 3.1.7 Probable Flood Peak Discharge in Central Highlands

River Basin	Province	Station	Catch. Area (km^2)	Peak Q (m^3/sec) / Specific Q (m^3/sec/100km^2)	Return Period (Years) 5	10	20	30	50	80	100	150	200	400	Estimated Formula
Se San	Kon Tum	Kon Tum	3,056	Peak Disch.	1,611	1,976	2,327	2,529	2,781	3,012	3,121	3,319	3,460	3,798	Gumbel
				Specific Q	52.7	64.7	76.1	82.8	91.0	98.6	102.1	108.6	113.2	124.3	
Ba	Gia Lai	An Khe	1,368	Peak Disch.	1,160	1,354	1,509	1,586	1,671	1,740	1,770	1,820	1,852	1,921	GEV
				Specific Q	84.8	99.0	110.3	115.9	122.1	127.2	129.4	133.0	135.4	140.4	
Srepok	Dak Lak	Ban Don	10,600	Peak Disch.	1,969	2,426	2,910	3,209	3,608	3,996	4,189	4,554	4,825	5,521	Log.Pearson Type-3
				Specific Q	18.6	22.9	27.5	30.3	34.0	37.7	39.5	43.0	45.5	52.1	
Dong Nai	Dak Nong	Dak Nong	300	Peak Disch.	106	124	142	152	164	176	181	191	198	215	Gumbel
				Specific Q	35.3	41.4	47.2	50.6	54.8	58.6	60.4	63.7	66.1	71.7	

Source: JICA Study Team, based on discharge observation data by HMS/MONRE.

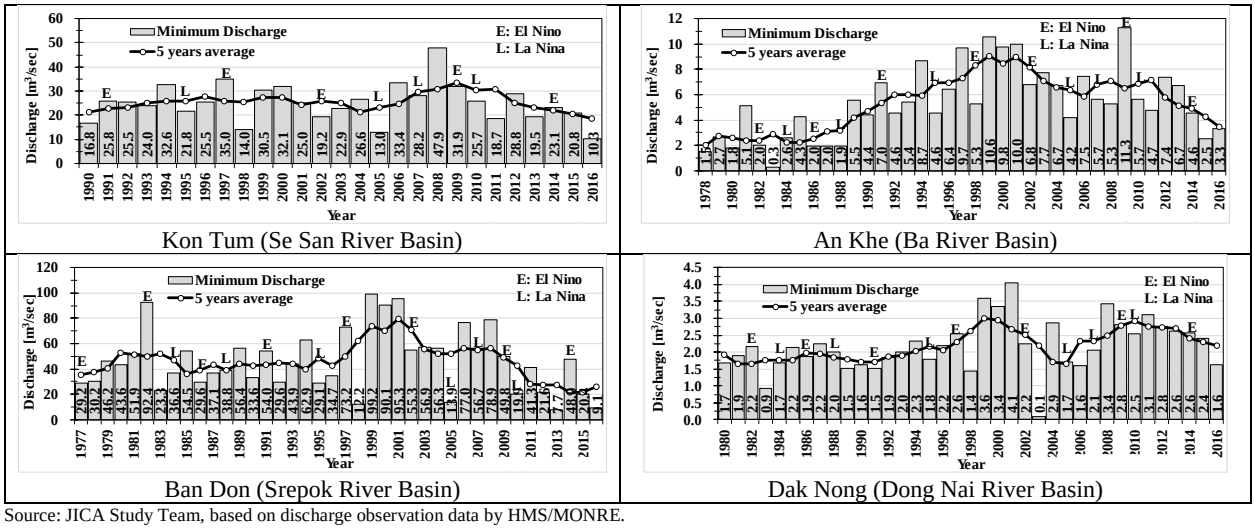
(4) Annual Minimum Discharge

The annual minimum discharge generally occurs in the period of December to June. The low flows observed at the following stations are small and there is an apparently declining trend as follows:

Table 3.1.8 Trend of Annual Minimum Discharge

River Basin	Station	Minimum Discharge Occurred Period	Recent Declining Trend
Se San	Kon Tum	December to June	Since 2009
Ba	An Khe	December to June	Since 2001
Srepok	Ban Don	December to June	Since 2001
Dong Nai	Dok Nong	December to June	Since 1999

Source: JICA Study Team



Source: JICA Study Team, based on discharge observation data by HMS/MONRE.

Figure 3.1.3 Annual Minimum Daily Discharge

3.1.2 Reservoirs

There are a total of 74 major reservoirs and dams that have the effective capacity of more than 0.5 MCM in Central Highlands. There are 13 reservoirs in the Se San River basin, 11 in the Ba River basin, 34 in the Srepok River basin and 16 in the Dong Nai River basin (Ref. AT 3.1.5).

3.1.3 Climate Condition

(1) General

Vietnam is located in both a tropical and temperate zone. It is characterized by strong monsoon influences, but at same time has a considerable amount of sun, high rate of rainfall and high humidity. In addition, Central Highlands located near the tropics and in the mountainous areas is endowed with a temperate climate.

The monsoon climate also influences to the changes of the tropical humidity. In general, in Vietnam, there are two seasons, i.e. the cold season occurs from November to April and the hot season which occurs from May to October. There are essentially four distinct seasons, which are most evident in Central Highlands i.e. spring, summer, autumn and winter. Every year, there are 100 rainy days and the average rainfall is 1,150 mm to 2,900 mm in Central Highlands. The humidity ranges around 82%. The annual average temperature ranges from 18^{o}C to 26^{o}C. The area located near the tropics and the mountainous area has a slightly cooler and more temperate climate.

Under the influence of the monsoons and the complicated topography, the climate in Vietnam always changes in either year, between the years, or between the areas. The climate in Vietnam is also under disadvantage of weather threats such as typhoons. There are 6 to 10 storms and tropical low-pressure area in a year. This in turn causes floods and droughts, both threatening the life and the agriculture in Vietnam. Central Highlands tends to be the same as the southern part of Vietnam but can be cooler and is especially freezing in winter caused by the winter monsoon.

(2) Rainfall

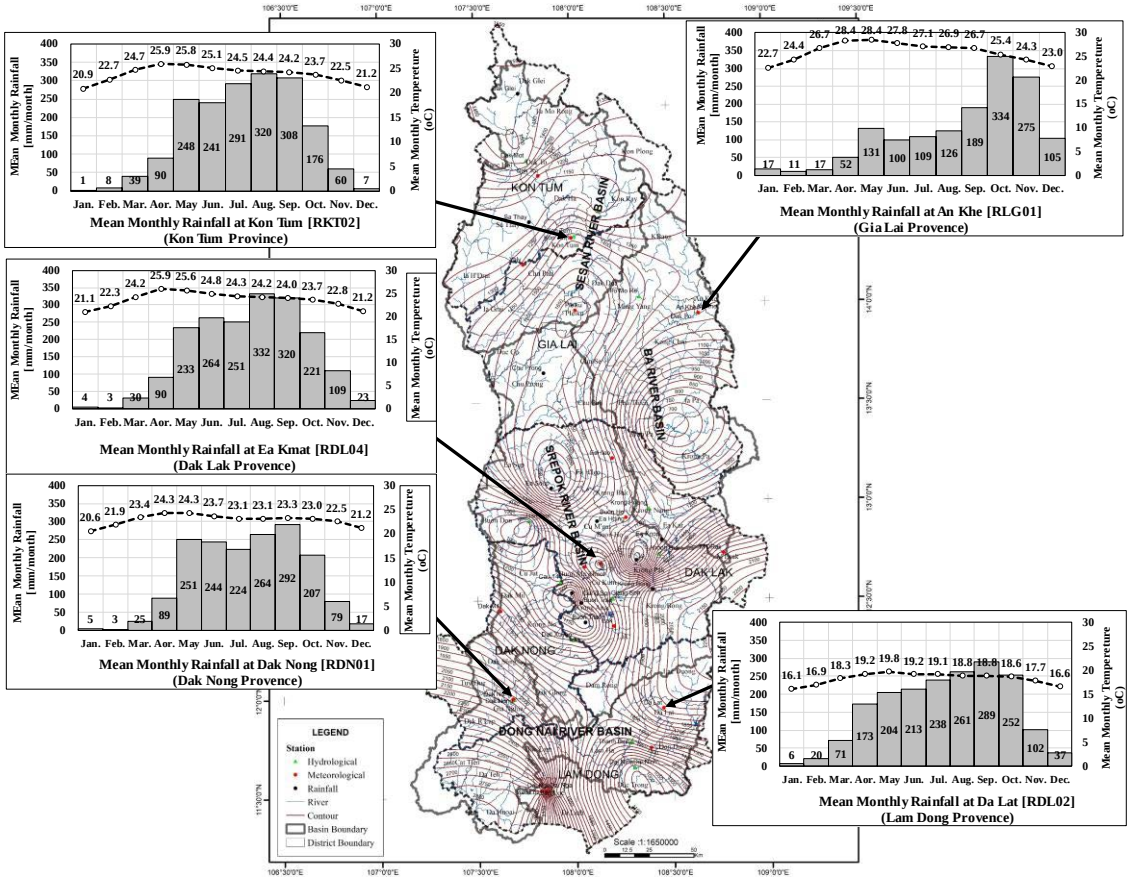
a) Long-term Trends of Annual Rainfall

Droughts and floods are common features of the climate in Central Highlands. Both these extremes are due to major rainfall anomalies and can cause great difficulty for agriculture as well as people. The annual rainfall at Ea Kmat station, which is located in Dak Lak Province of the Srepok River basin, shows the repetitive occurrence of floods and droughts at an interval of 4 to 5 years. Taking into account the standard deviation of the records, the flood year is broadly defined as the annual rainfall of more than 2,300 mm/year while the drought year is defined when the annual rainfall is less than 1,600 mm at Ea Kmat station. The 5-year average of the annual rainfall also shows that the dry spell continued for 2002 to 2005 as well as in 1982 and 1984/1985, resulting in the severest drought during 2004/2005. The heaviest historical rainfall was recorded in October 30, 1999, when the flood peak discharge of 1,110 m3/sec was recorded at Ban Don station of the Srepok River basin. Long term annual rainfall variation at Central Highlands is shown in Figure 3.1.5. The Isohyetal map of the mean annual rainfall in Central Highlands is shown in AT 3.1.8.

b) Seasonal and Monthly Rainfall and Temperature

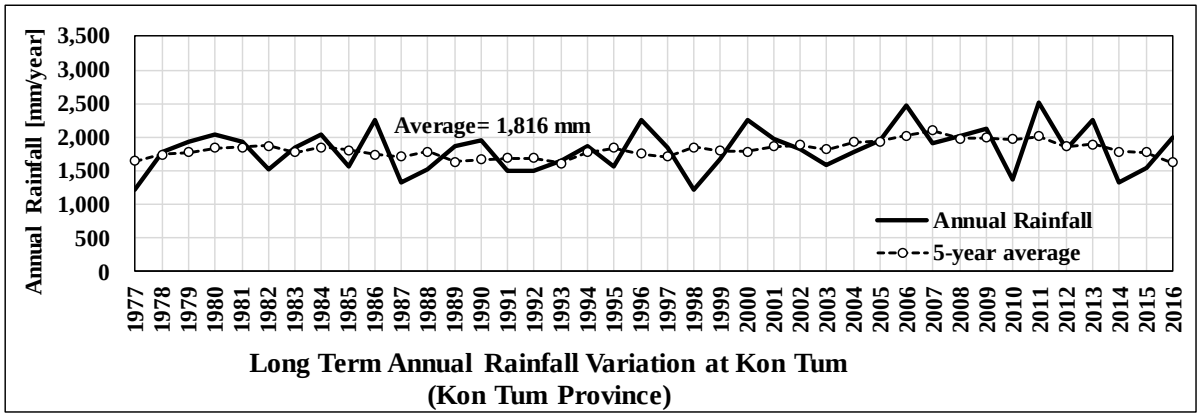
As revealed by the monthly rainfall figures, the dry season receives limited rains mainly during the seasons of November to April[1]. In Central Highlands, the pattern of monthly rainfall is characterized by the masking effect of the monsoon with a distinctive dry season from November to April as follows:

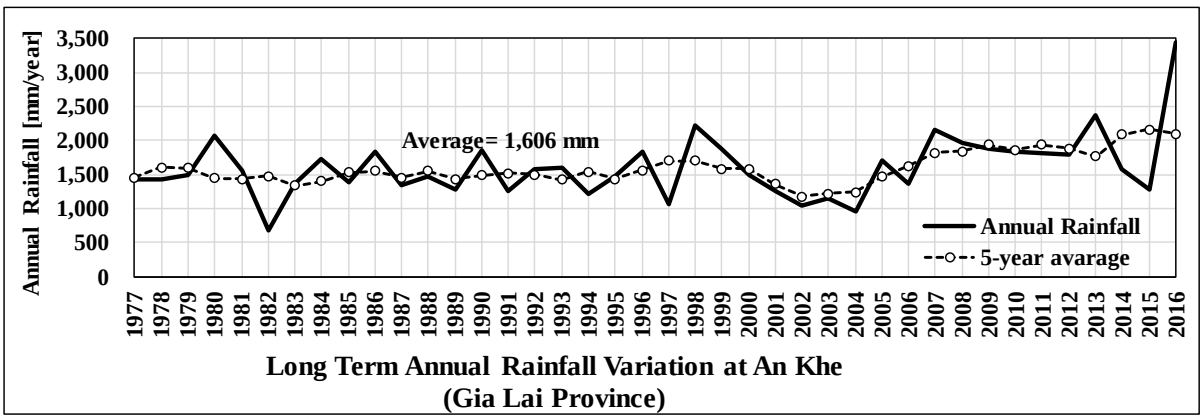
[1] Dry and rainy seasons of the JICA Study are based on “Master Plans on Social Economic Development in the period 2016-2020” and “Irrigation Development Plans” of the 5 provinces.



Source: JICA Study Team, based on rainfall observation data by HMS/MONRE.

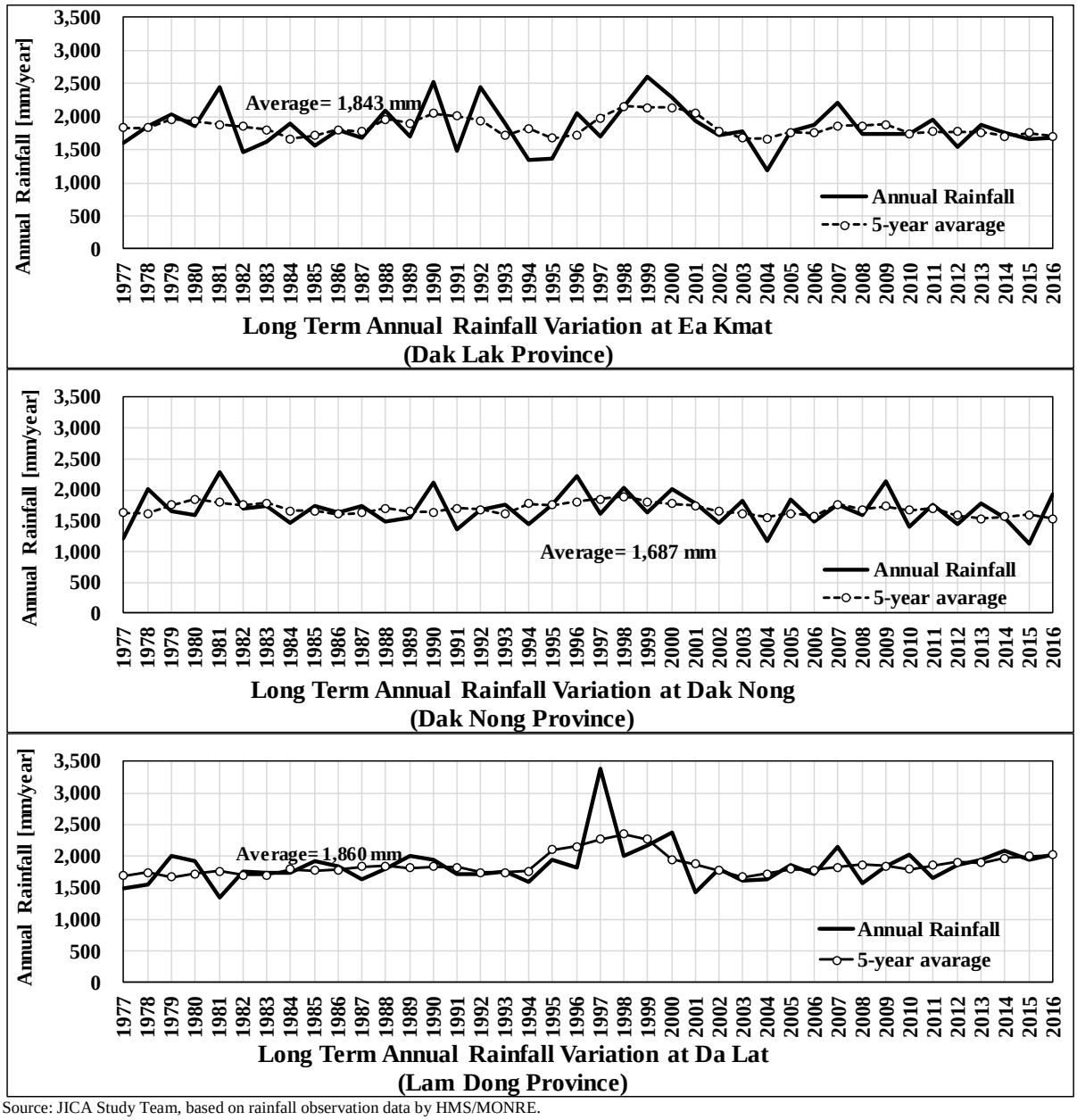
Figure 3.1.4 Mean Monthly Rainfall and Temperature in Central Highlands





Source: JICA Study Team, based on rainfall observation data by HMS/MONRE.

Figure 3.1.5 Long Term Annual Rainfall Variation in Central Highlands (1/2)

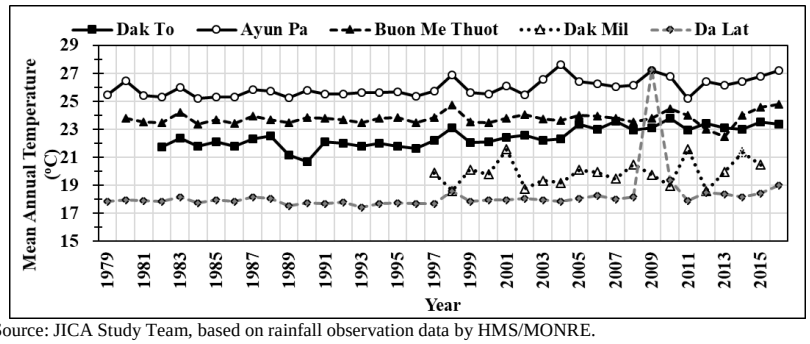


Source: JICA Study Team, based on rainfall observation data by HMS/MONRE.

Figure 3.1.5 Long Term Annual Rainfall Variation in Central Highlands (2/2)

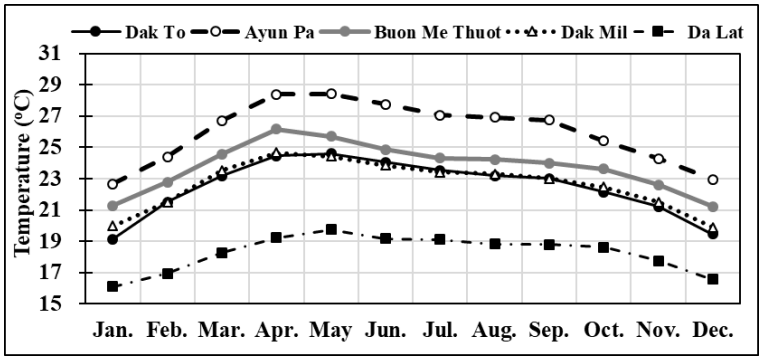
(3) Temperature

High mean annual temperature occurred in the drought year of 2015/2016 in Central Highlands. The maximum mean monthly temperature occurred in April while the minimum mean monthly temperature occurred in January. Because the meteorological station of Da Lat in Lam Dong Province is located in high altitude of 1,472 m above msl, the mean annual temperature measured is 18.3 ^{o}C while the minimum and maximum monthly temperature is in the range of 16.1 ^{o}C to 19.8 ^{o}C. Meanwhile, in the Ayun Pa station, at 144 m above msl, in Gia Lai Province, the mean annual temperature is 26.0 ^{o}C while the minimum and maximum monthly temperature is in the range of 22.7 ^{o}C to 28.4 ^{o}C. Long-term mean annual temperature and mean monthly temperature of typical meteorological station are shown as follows:



Source: JICA Study Team, based on rainfall observation data by HMS/MONRE.

Figure 3.1.6 Long Term Mean Annual Temperature in Central Highlands

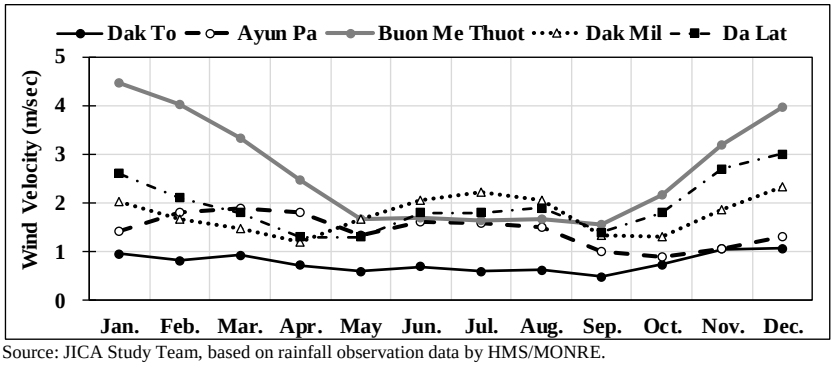


Source: JICA Study Team, based on rainfall observation data by HMS/MONRE.

Figure 3.1.7 Mean Monthly Temperature in Central Highlands

(4) Wind Velocity

The annual average daily wind speed records show the distinctive variance among Central Highlands. The wind velocity reduces in summer from April to September and increases in winter from October to March. The wind velocity record at Buon Me Thuot in Dak Lak Province shows two to four times the recorded data at Dak To in Kon Tum Province. There is no significant change of mean monthly wind velocity, as both are relatively low at Dak To in Kon Tum Province as follows:

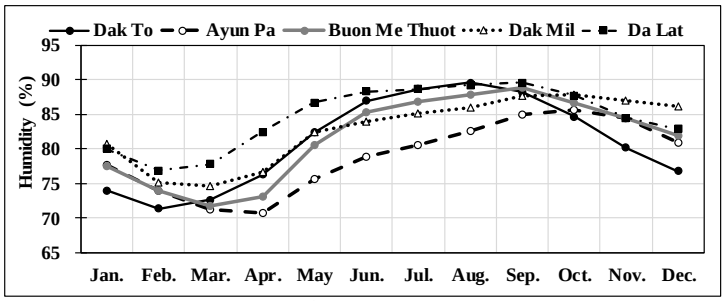


Source: JICA Study Team, based on rainfall observation data by HMS/MONRE.

Figure 3.1.8 Mean Monthly Wind Velocity in Central Highlands

(5) Humidity

Mean monthly humidity in Central Highlands is shown in Figure 3.1.9. Low humidity occurs from March to April and high humidity occurs from May to October in the rainy season. The humidity data gathered from Da Lat in Lam Dong Province is higher than other stations while the data in Ayun Pa in Gia Lai Province is lower than other stations, especially in the rainy season as follows:

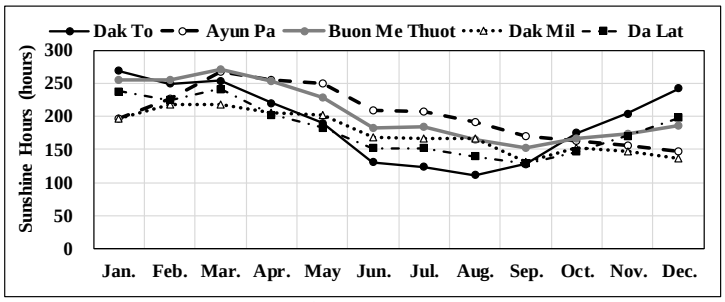


Source: JICA Study Team, based on rainfall observation data by HMS/MONRE.

Figure 3.1.9 Mean Monthly Humidity in Central Highlands

(6) Sunshine Hours

Mean monthly humidity in Central Highlands is shown as follows. Low sunshine hours occur from June to December while high sunshine hours begin from January to May in the dry season:

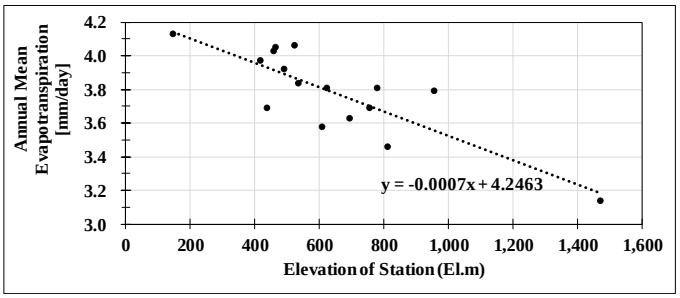


Source: JICA Study Team, based on rainfall observation data by HMS/MONRE.

Figure 3.1.10 Mean Monthly Sunshine Hours in Central Highlands

(7) Evapotranspiration

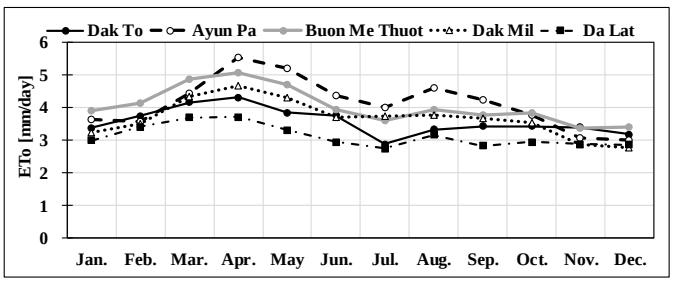
The estimation of evaporation rates from the water surface is an essential issue for the water resources development in Central Highlands. The evaporation rates are also essential for studies on crop water requirements and its management. Annual evapotranspiration rates are known to be proportional to the altitude. There is a high negative correlation of evaporation with altitude for the area. The regression analysis was made based on the available annual evapotranspiration data and is shown as follows.



Source: JICA Study Team, based on rainfall observation data by HMS/MONRE.

Figure 3.1.11 Annual Evapotranspiration VS Altitude

In general, the highest monthly evapotranspiration in the area estimated occurs in April and the lowest occurs in December as seen as follows.



Source: JICA Study Team, based on rainfall observation data by HMS/MONRE.

Figure 3.1.12 Mean Monthly Evapotranspiration in Central Highlands

3.1.4 Climate Change

The Vietnam Institute of Meteorology, Hydrology and Climate Change, and MONRE publishes updated climate change and sea level rise scenarios on its website. The updating of such climate change and sea level rise scenarios was determined in the national strategy on climate. The most updated information about behavior and tendency of climate change in the past and the climate change and sea level rise scenarios in the 21st century of Vietnam was presented. Vietnam built the first climate change scenario in 2009 and updated the scenario in 2012 and again in 2015 subsequently.

A comparison between the 2012 and 2015 scenarios shows that climate change has been taking place faster. For example, according to the 2015 scenarios, under the medium emissions scenario[2], average temperature rise was recorded from 1.3 ºC to 1.7 ºC in the middle of the 21st century and from 1.7 ºC to 2.4 ºC at the end of the century. This rise is much lower than the forecast level in 2012 which was predicted to to have a rise of 3 ºC. Nevertheless, under the high emissions scenario[3], temperature rise at the end of century is expected to reach 4 ºC, while the forecast in 2012 is only 3.7 ºC.

The rainfall indicator differs strongly between the climate change scenario in 2012 and in 2015. Rainfall increase as forecasted in 2012, ranges from 2% to 10%, but the scientists projected it to be around 5% to 15%. High rainfall increases during the rainy season, while rainfall tends to decrease during the dry season. Hence, drought and floods would become more complicated. According to the scientists, climate change and sea level rise scenarios show some uncertainties as they depend on the determination of GHG (greenhouse gas) concentration scenarios, limited knowledge about global and regional climate systems, ice melting and methods used in developing scenarios. Thus, the scenarios shall be frequently updated.

It is necessary to implement this project by phases i.e., determining the priority level based on actual needs and available resources in each phase for the selection of the most appropriate scenarios. Climate change and sea level rise scenarios for Vietnam will be updated based on the 5th Assessment Report (AR5) by the Intergovernmental Panel on Climate Change (IPCC).

3.2 Natural and Land Use Condition

3.2.1 Natural Condition

(1) Landscape

Central Highlands lies on a series of contiguous plateaus as follows.

Table 3.2.1 Plateau in Central Highlands

Plateau	Elevation	Notes
Kon Tum Plateau	about 500 m	Covering most of Kon Tum province and spreading to Cambodia and Laos.
Kon Plong Plateau	1,100 ~ 1,300 m	Located along Kon Plong district
Kon Ha Nung Plateau	700 ~ 1,000 m	Weathering crust of brownish red feracite from on neutral magma, mainly bazan.
Pleiku Plateau	750 ~ 800 m	Domed shape relatively flat terrain in the north and northeast
Mdrak Plateau	400 to 500 m	Located at the East of Dak Lak and adjoining with Khanh Hoa province
Buon Ma Thuot Plateau	300 ~ 800 m	Located in the center of the Gia Lai province, the plateau lies about 90 km from North to South, 70 km from East to West. The north part is 800 meters high, 400 meters in the South, and 300 meters in the West
Mo Nong Plateau	800 ~ 1,000 m	Covering the Dak Nong Province and partially encroaching into Cambodia
Lam Vien Plateau	1,500 m	The area is about 1,080 km². Mountainous terrain with slopes of 8-10°.
Di Linh Plateau	about 900 ~ 1,000 m	From Bao Loc mountain pass to Prenn and D'ran mountain pass

Source: MONRE

All of these plateaus are surrounded by high mountain ranges and massifs to the east. Mountainous terrain covers the north, east and south sides of the area. The north is blocked by the Ngoc Linh mountain range, which is the largest mountain in the north of Central Highlands. It is located in the northwest-southeast

[2] RCP 4.5: Representative Concentration Pathways 4.5W/m^2
[3] RCP 8.5: Representative Concentration Pathways 8.5W/m^2

direction with nearly 200 km with a lot of high mountains.

The east side is pronounced by a series of mountains laying in the north-south direction. It is shaped like a bow, protruding eastward to form a wall separating Central Highlands with the coastal plain. They include An Khe range with the highest peak at Chu Truong (1,331 m), Chu Dju (1,230 m), Vong Phu (2,010 m), Khanh Hoa (1,978 m), Chu Yang Sin (2,400 m) and Bi Dup (2,287 m). The south is bordered by the last mountains of the Truong Son Nam range with Brai An Eak (1,864 m), Nam So and Rlung Bo.

The lowlands and plains from the north to south include the valley between Kon Tum Mountain lying along the Po Ko river about 45 km and the terrain is quite flat. An Khe valley is a valley located between the mountains. It is 5 km width and 400 m to 500 m in height. Ea Sup plain is a denuded plain with rather flat, mountainous ridges of 140 m to 300 m and gradually descending to the west.

Surface of topography in Central Highlands gradually slopes from the east to west while still preventing southeast winds blowing to the region. In addition, the complex terrain in Central Highlands is continuously dissected, with clear hierarchy, covering highland topography, mountainous terrain and valley terrain (Ref. AT 3.2.1).

(2) Soil

Soil is considered as one of the most important resources in Central Highlands where the three (3) popular types of soil are Ferric Acrisols, Rhodic Ferralsols and Humic Acrisols. These types of soil are supposed to be very suitable for agriculture and forest development. However, these soils are not equally distributed.

In Kon Tum Province, the majority of soil is Ferrlic Acrisol. Second to Ferric Acrisols is Humic Acrisols which stays along the northern border of Kon Tum Province.

In contrast with Kon Tum, there are several soil types in Gia Lai Province. There are Rhodic Ferralsols, Ferric Acrisols, Humic Ferralsols, Carisols and Umbric Gleysols. Among the soils, the Rhodic Ferralsols is the most common type located in the middle of Gia Lai. Soils like Ferric Acrisols and Carisols follow, occupying almost the same portion as the former and their distribution is intertwined in the whole area.

Dak Lak Province has the same number and type of soil with the northern provinces. The Rhodic Ferralsols is located in the center of Dak Lak. In the west and east border of Dak Lak, Ferric Acrisols occupy a large area and is the most common soil type.

The most common soil type in Dak Nong is the Rhodic Ferralsols whereas in Lam Dong it is the Ferric Acrisols. In contrast, Humic Acrisols takes the second place in Lam Dong in soil population. It is located in the northern border with Dak Lak (Ref. AT 3.2.2 and AT 3.2.3).

(3) Geology

Central Highlands is one of the most ancient belts in Southern Vietnam. It is divided into three different tectonic belts, including i) Kon Tum, ii) Srepok and iii) Da Lat belts, all of which belong to a large-scale structure called the Truong Son orogenic belt, which is part of the Indochina block. This region is composed of Archean-Proterozoic basement rocks and early to middle Paleozoic cover rocks. These basement rocks are widely exposed in Gia Lai, Kon Tum, Dak Lak and Dak Nong provinces. Meanwhile in Lam Dong area, the Mesozoic rocks are mainly exposed on the surface. Basement rocks consist of granulite, amphibolite and greenschist facies metamorphic rocks. These rocks are covered by volcanogenic sedimentary rocks, metamorphosed sedimentary rocks of greenschist facies, sandstone, siltstone and shale. The early to middle Paleozoic materials and Carboniferous to Triassic rocks were overlain by Jurassic, low-grade metamorphosed terrigenous sedi-mentary rocks. These older structures were eventually covered by Cenozoic magmatic formations.

Cenozoic magmatic formations, widely exposed in Central Highlands, belong to a basaltic series distributed in eastern and south-eastern Asia and mainly consists of basalts of Pliocence-Pleistocence and Pleistocence age rocks that developed after the end of the East Sea opening in the middle Miocene. Tectonic faults are well developed in Central Highlands, including deep-seated faults such as Poko–Ia Mo, Dak Selo–Mang

Yang, M'Drak–An Khe, Pe Ko–Ba river, Rach Gia–Buon Ma Thuot (Ref. AT 3.2.4).

(4) Groundwater

Hydrogeological zone of Central Highlands is shown below:

a) Hydrogeological Condition

Central Highlands consists two groups of aquifers, i.e. porous and fissure aquifers. The porous group consists of i) aquifers in Holocene sediments, ii) aquifers in Pleistocene sediments and iii) aquifers in Neogene sediments (Ref. AT 3.2.5).

The fissure group consists of iv) aquifers in middle Pleistocene basalt, v) aquifers in Pliocene-Pleistocene basalt, vi) aquifers in upper Cretaceous sediments, vii) aquifers in lower Middle Jurassic sediments and viii) aquifers in Neoproterozoic metamorphic formations. Among these aquifers, those in the Pleistocene and Pliocene-Pleistocene basalts are the most important and productive due to their large distribution, big thickness, good availability and quality.

b) Groundwater Reserves

Based on the report of the Nation Research Project KC 08-05, to evaluate groundwater resources in the whole Central Highlands, the study team assesses the groundwater potential of each plateau, lowland and plain by using the calculation of potential exploitation reserves by the following equation:

$$Qep = Qn + Vs$$

Where: *Qep* – potential exploitation reserves, *Qn* – natural dynamic reserves, *Vs* – natural static reserves.

The total potential exploitation reserves of Central Highlands is about 5,394 MCM/day which is distributed in each area as follows:

Table 3.2.2 Potential Exploitation Reserves of Plateau

Plateau	Potential Exploitation Reserves (MCM/day)
Kon Ha Nung plateau	163.3
Pleiku plateau	1,124.0
Buon Ma Thuot plateau	920.7
Dak Nong plateau	258.7
Di Linh plateau	492.0
Da Lat plateau	101.1
Kon Tum plateau	92.2
An Khe lowland with inselberg	10.7
Cheo Reo – Phu Tuc lowland	176.7
Krong Pach – Lak lowland:	257.8
Ea Sup denuded plain	1,780.0

Source: MONRE

Table 3.2.3 Hydrogeological Zone of Central Highlands

Type of Groundwater Flow	Aquifer	Thickness (m)	Rocks
Intergranular	Indefinitive Quaternary	2-40	Silt, Sand, Gravel
	Holocence	5-50	Sand, Gravel, clayer sand, containing gravel
	Pleistocene	5-50	Sand, Gravel, clayer sand, sandy loam, loamy sand
	Neogen	5-500	Sandstone, siltsone
Fissured	Basalt	10-500	Thoneiitic basalt, subalkaline olivine basalt
	Crertcaeous	100-500	Conglomerate, sandstone, siltstone
	Jurassic	500-2000	Sandstone, siltstone, shale, conglomerate
	Triassic	950-1800	Conglomerate, sandstone, intermingle coal
	Cacboniferous - Permain	500	Marber intercalated with quartz-sericite schist, sandstone

Source: MONRE

c) Groundwater Consumption in 2001 and 2010

In 2001, the groundwater consumption in Central Highlands was low, except for some areas of the central area of Kon Tum, Srepok River basin of Gia Lai and the south of Lam Dong. In 2010, groundwater consumption became much bigger than in 2001, especially in Kon Tum and Gia Lai Provinces (Ref. AT 3.2.6 and AT 3.2.7).

3.2.2 Land Use

General characteristics of the typical land use classifications are as follows (Ref. AT 3.2.8):

Annual Crop	:	The annual cropped area is generally located at the foot of mountains and along the downstream stretch of the River basin. Some are also identified along the rivers. The dense annual crop land is mainly used for paddy, maize, soybean, bean, sugarcane and sweet potato, etc.
Perennial Crop	:	The perennial cropped area is generally located at Central Highlands on the mountains/hills and along the upstream stretch of the river basin. Some are also identified along the rivers. The dense perennial crop land, is mainly used for coffee, cashew nuts, pepper, fruits and tea, etc.
Forest land	:	Forest land is usually covered with tall trees which are mainly identified around the mountainous area.
Residential land	:	The urbanised or residential land area.
Waters	:	Rivers and lakes
Land of defence	:	Defence area, which is used by the army.
Mineral land	:	The area that shows the mining area.
Unused area	:	The area that shows bare-soil land and unused area.

In Central Highlands, of the total geographical area of 54,735 km^2, land use statistics are available for roughly 51,174 km^2, constituting more than 93% of the total area. The most general use of land is forestry, ranging from 33% in Dak Lak to 68% in Kon Tum. The average is more than 53% of the total area. The lowest land use area for all provinces is water surface, from 0% in Kon Tum and Lam Dong, to 4% in Dak Lak. According to the available data, the residential land has a big difference depending on the province, with the estimated area from 2% in Kon Tum and Lam Dong, but increasing to more than 25% in Dak Lak.

The total area of the perennial crop is similar to the total area of the annual crop in Central Highlands which amounts to about 11.2% to 14.2% respectively. The smallest area of the annual crop is only 2% in Lam Dong and up to about 21% in Gia Lai. The area of the residential crop is about 12% in all provinces and is observed to have a slightly higher percentage in Dak Nong at 17% of the total area. The total area for other uses including unused area, land of defense, mineral land and no data area, etc. was estimated at around 13% (equal to 7,023 km^2), but varies from 108 km^2 (2%) in Dak Nong to more than 2,800 km^2 (29%) in Lam Dong. The summarized land use by province in Central Highlands is summarized as follows:

Table 3.2.4 Present Land Use in Central Highlands by Province

Area (Unit: km^2)

Classification	Kon Tum	Gia Lai	Dak Lak	Lam Dong	Dak Nong	Total
Annual Crop	1,355	3,322	2,099	198	975	7,950
Perennial Crop	789	1,874	1,066	1,314	1,112	6,155
Residential Land	148	485	3,389	235	276	4,533
Forestry Land	6,639	7,996	4,343	5,208	3,997	28,182
Water Surface	6	215	580	38	54	892
Others	760	1,658	1,682	2,815	108	7,023
Total	9,698	15,549	13,158	9,808	6,522	54,735

Source: MONRE

Land use by the river basins are evenly distributed with about 50% of the forestry land area, ranging from 46% to 55% in Srepok and Se San basin, respectively. The estimated annual cropped area is about 18% in most of river basins except in the Dong Nai River basin at 5%. In contrast, the perennial cropped area in Dong Nai River Basin is about 19% and is much higher than the other river basins (from 7% to 13%, average is 10% of the total area). Because of the population distribution of each area, the residential areas by the river basins are uneven, from 3% in Dong Nai and Se San River Basin and up to more than 15% in Srepok River Basin. The area of surface water by the river basin is very small compared to the total area and ranging about 0.5% to 3% (equal to 60 km^2 to 487 km^2). Other land use including mineral land,

land of defense, and unused area are quite similar, from 1,226 km^2 in the Se San River Basin to 1,928 km^2 in the Srepok River Basin, sharing 11% to 20%, respectively.

Table 3.2.5 Present Land Use in Central Highlands in 2011 by River Basin

Area (Unit: km^2)

Classification	Se San	Ba	Srepok	Dong Nai	Total
Annual Crop	2,075	2,319	2,664	425	7,483
Perennial Crop	1,451	750	1,799	1,767	5,766
Residential Land	322	686	2,629	282	3,919
Forestry Land	6,243	5,355	8,339	4,892	24,830
Water Surface	60	272	487	48	867
Others	1,226	1,632	1,968	1,821	6,647
Total	11,377	11,014	17,887	9,236	49,513

Source: MONRE

3.3 Social Economy

3.3.1 Administration, Population and Migration

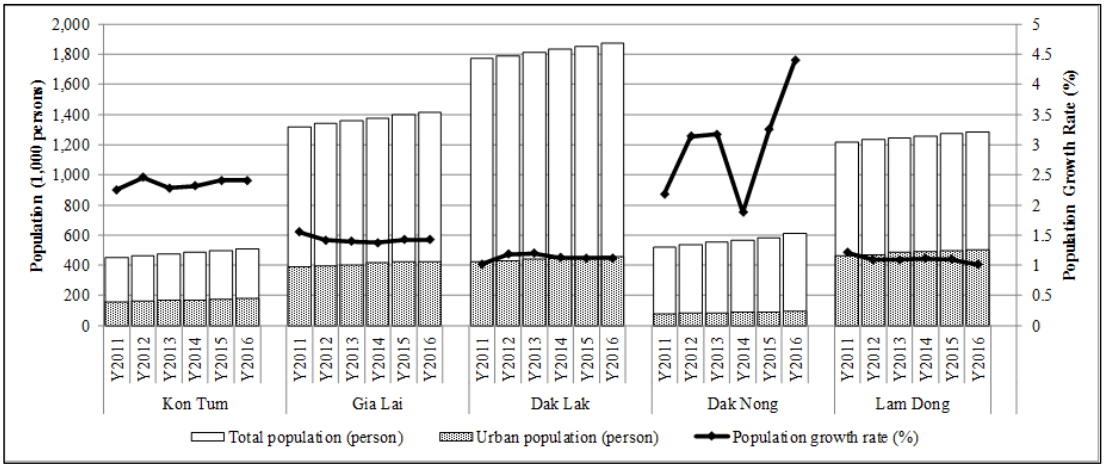
Although the geographical area of Central Highlands covers around 16.5% of the whole country, its population remains approximately 6% of the total population[4]. The population densities of the five provinces are different from each other, from the lowest in Kon Tum at 52 person/km^2 to the highest in Dak Lak at 143 person/km^2. The share of urban population is the lowest in Dak Nong at 15.2% and the highest is in Lam Dong at 39.2%. The most number of administration units and that of communes are seen in Gia Lai to accommodate 1.4 million people in the second largest provincial area as follows (Ref. AT 3.3.1).

Table 3.3.1 Administration and Population of Central Highlands in 2016

Item	Unit	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
Geographical area	km^2	9,674	15,511	13,030	6,509	9,783
Population in 2016	person	507,818	1,417,259	1,874,459	609,595	1,285,943
Share of rural population	%	64.4	70.1	75.6	84.8	60.8
Population density	person/km^2	52	91	143	94	131
Administration unit at district level and above	No.	10	17	15	8	12
City	-	1	1	1	0	2
Town	-	0	2	1	1	0
District	-	9	14	13	7	10
Communes under city, town and district (total)	No.	102	222	184	71	147

Source: Provincial Statistical Yearbook 2016

The population growth from 2011 to 2016 of the five provinces were moderate and stable except in Dak Nong, although its urban population growth did not change much in the same period. Data regarding the population and urbanization of Central Highlands is shown as follows.



Source: Provincial Statistical Yearbook 2016

Figure 3.3.1 Population and Urbanization of Central Highlands (2011-2016)

The unusual curve that has been seen in Dak Nong's population growth rate is also found in its migration rate. The migration coming from outside Dak Nong to Dak Nong far exceeded that of the migration from the province to the outside of Dak Nong. This caused a net-migration rate as much as 36.2‰ in 2012 and

[4] According to Vietnam Statistical Yearbook 2016, total geographical area of Vietnam is 330,967 km^2 and its entire population is 92,701,100 as of 2016.

35.6‰ in 2014. Similar phenomenon is observed in Kon Tum in 2012 and 2013, with values of 6.5‰ and 7.4‰, but it is insignificant.

Table 3.3.2 Migration Rate of Central Highlands (2010-2015)

(Unit: ‰)

Item	Year	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
Migration from outside the province	2011	8.8	4.9	7.7	5.7	9.2
	2012	11.8	4.9	8.4	42.3	6.8
	2013	13.3	8.0	9.7	18.4	8.0
	2014	6.7	5.2	3.7	42.7	6.0
	2015	3.9	1.7	2.5	3.8	3.9
Migration from the province to outside	2011	9.8	6.8	12.3	10.7	8.2
	2012	5.3	5.3	7.8	6.1	8.9
	2013	5.9	8.1	8.5	6.7	8.4
	2014	7.6	7.1	6.1	7.1	9.1
	2015	1.9	2.3	4.5	4.9	5.3
Net-Migration Rate	2011	-1.0	-1.9	-4.6	-5.0	1.0
	2012	6.5	-0.4	0.6	36.2	-2.1
	2013	7.4	-0.1	1.2	11.7	-0.4
	2014	-0.9	-1.9	-2.4	35.6	-3.1
	2015	2.0	-0.6	-2.0	-1.1	-1.4

Note: Figures contain only those who are registered to the Home Affair Division of each Commune People's Committee.
Source: GSO website (accessed September 2017)

Taking another look at the migration volume by type and flow observed in the mid-term census on the national population and housing conducted in 2014, both Dak Nong and Kon Tum provinces had a large number of people migrating from other provinces compared to their population (79.3% and 61.7%, respectively). On the other hand, migrations of Gia Lai, Dak Lak and Lam Dong mostly occurred within the provinces. Regardless of intra or inter provincial migration, 72.0% of the flow in Dak Nong were from rural to rural, and so was 52.5% in Kon Tum. The data is summarized as follows.

Table 3.3.3 Migration Rate and Flow in 2014

Year	Unit	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
Total number of migration	person	27,521	56,735	74,946	39,479	61,531
by type of migration						
Intra-district	person	6,904 (25.1%)	20,736 (36.5%)	27,491 (36.7%)	5,220 (13.2%)	18,818 (30.6%)
Inter-district	person	3,647 (13.3%)	12,569 (22.2%)	18,611 (24.8%)	2,947 (7.5%)	15,536 (25.2%)
Inter-province	person	16,970 (61.7%)	23,430 (41.3%)	28,844 (38.5%)	31,312 (79.3%)	27,177 (44.2%)
By migration flow						
Rural to Rural	person	14,442 (52.5%)	20,982 (37.0%)	30,896 (41.2%)	28,425 (72.0%)	22,457 (36.5%)
Rural to Urban	person	4509 (16.4%)	13759 (24.3%)	17255 (23.0%)	4257 (10.8%)	15340 (24.9%)
Urban to Rural	person	3,951 (14.4%)	6,397 (11.3%)	9,622 (12.8%)	3,629 (9.2%)	8,180 (13.3%)
Urban to Urban	person	4,619 (16.8%)	15,599 (27.5%)	17,173 (22.9%)	3,163 (8.0%)	15,554 (25.3%)
Migration trend*						
Migration from outside	%	35.2	17.1	15.8	55.5	21.6
Migration from province	%	13.2	16.5	24.8	25.9	26.3
Net Migration rate	%	22.0	0.6	-9.1	29.5	-4.7

Note: The migration trend captured in the IPS2014 is different from those from 2011 to 2015 in the previous table. It is assumed that the migration rates from 2011 to 2015 reflect the official registration of residents, whereas IPS2014 collected not only locally-registered citizens but those who did not register themselves.
Source: Inter-censal population and housing survey (IPS) 2014

The purpose of migration varies. People from the north, south and central coast who migrate into Central Highlands mostly look for job opportunities as laborers, whereas those from the Northern Midlands and Mountains seek farmland, cultivation area and places to settle down with their families. According to the People's Committee of the Dak Nong Province[5], an average 170,000 people have been migrating to the province since 1976[6]. Majority of them come from ethnic minorities from the mountainous areas of the north-western region. The migrants come to seek farmlands and similar local contexts and places to live in in the rural area of the province. This large-scale migration helped satisfy their local needs for labor, however, the negative impacts were observed as the number of people increased. Such impacts include the increased people living without basic infrastructure, the severe damages and destruction on forest resources, the illegal land use and transfer, the increase in poverty incidence, as well as poor education.

[5] The Decision No. 22U-R7/QD-UBND dated on 10 Feb 2014 on the approval of project planning on stable free migration to Dak Nong Province toward 20U-U20, and the Report No. 400/BC-UBND dated on 31 July 2017 on the present situation of stable free migration and solution for the next period.

[6] As encouraged by the GOVN. Kinh people migrated to Central Highlands from the Red River Delta from 1971 to 1985, and ethnic minorities also moved mainly from Northern area between 1986 to 1995. They were given incentives for their new lives such as farmland, food and start-up funds. However, migrants created numerous problems (local conflict, social evil, environmental problems, forest destruction, bad social security, etc.), so that the GOVN no longer assists their migration from early 2000s.

3.3.2 Provincial Products

Dak Lak's GPDP shares 30.1% of the entire region, followed by Lam Dong (28.5%) and Gia Lai (23.4%). The main sector of Dak Nong, Lam Dong and Dak Lak is agriculture. The shares are 50.1%, 46.3% and 45.0% respectively. Gia Lai has strong industry sector (20.5%), and Kon Tum owes its GDP to construction and services sectors at 13.3% and 39.6% respectively as follows:

Table 3.3.4 Gross Provincial Domestic Product (GPDP) at Current Prices by Sectors in Central Highlands in 2016

Item	Kon Tum		Gia Lai		Dak Lak		Dak Nong		Lam Dong	
	VND bil.	%	VND bil.	%	VND bil.	%	VND bil.	%	VND bil.	%
Share among five provinces in Central Highlands	-	7.3	-	23.4	-	30.1	-	10.7	-	28.5
GPDP	16,232	100.0	51,854	100.0	66,891	100.0	23,708	100.0	63,123	100.0
1. Agriculture, forestry and fishery	4,658	28.7	19,502	37.6	30,120	45.0	11,870	50.1	29,243	46.3
2. Industry	1,792	11.0	10,643	20.5	6,549	9.8	2,136	9.0	7,040	11.2
Mining	90	0.6	139	0.3	302	0.5	127	0.5	333	0.5
Processing and manufacturing	974	6.0	3,568	6.9	3,532	5.3	1,046	4.4	2,855	4.5
Electricity supply	680	4.2	6,840	13.2	2,554	3.8	853	3.6	3,599	5.7
Water supply and waste management	49	0.3	96	0.2	161	0.2	110	0.5	253	0.4
3. Construction	2,154	13.3	3,467	6.7	3,536	5.3	973	4.1	3,486	5.5
4. Service	6,426	39.6	16,509	31.8	25,214	37.7	7,513	31.7	20,853	33.0
Wholesale and retail motor vehicles	1,582	9.7	5,048	9.7	9,752	14.6	2,647	11.2	5,572	8.8
Financial, banking and insurance activities	887	5.5	1,960	3.8	2,736	4.1	674	2.8	2,855	4.5
Education and training	981	6.0	2,039	3.9	2,898	4.3	813	3.4	2,108	3.3
Others service	2,977	18.3	7,463	14.4	9,828	14.7	3,379	14.3	10,318	16.3
5. Import tax	1,202	7.4	1,732	3.3	1,472	2.2	1,216	5.1	2,501	4.0

Source: Provincial Statistical Yearbook 2016

In terms of GPDP at constant 2010 prices, Lam Dong has the second biggest figure among five provinces at VND 42,677 billion in 2016, and biggest figure in per capita GPDP at constant 2010 prices at VND 33,187 thousand. It comes from the fact that Lam Dong has stable and sound economic growth led by high valued goods and services such as vegetables, flower, aluminum, and tourism. Dak Nong and Gia Lai have similar figures of GPDP per capita at constant 2010 prices in 2016 (at VND 26,645 thousand and VND 25,586 thousand, respectively). Gia Lai owed its economy to industry sector, mainly electricity supply produced at their hydropower plants. Dak Lak, with the second highest share of agriculture, forestry and fishery, has the biggest GPDP at VND 44,421 billion in 2016 but its per capita GPDP was the second lowest at VND 23,698 thousand since agriculture land per capita in Dak Lak is at small-scale although they heavily depend on income from agriculture sector7. Kon Tum, where all kinds of GPDP figures are the lowest among all five provinces, has the least share of agriculture due to its poor quality of soil and low agricultural productivities.

Table 3.3.5 Gross Provincial Domestic Product (GPDP) of Central Highlands

Items	Unit	Year	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
GPDP at constant 2010 prices	VND Bil.	2011	7,650	26,309	34,371	11,143	29,525
		2012	8,338	27,658	35,142	12,158	32,137
		2013	8,987	29,277	37,583	13,127	34,470
		2014	9,640	31,404	39,121	14,158	36,779
		2015	10,443	33,739	41,509	15,170	39,542
		2016	11,285	36,263	44,421	16,243	42,677
Share of agriculture, forestry and fishery to GPDP	%	2011	28.8	34.7	46.2	50.4	45.6
		2012	28.6	34.9	44.3	47.8	44.7
		2013	27.8	35.1	44.6	46.8	44.1
		2014	27.1	34.9	44.3	46.2	43.8
		2015	26.4	34.5	43.2	46.1	43.0
		2016	25.4	33.9	42.0	45.6	41.9
GPDP per capita at constant 2010 prices	VND '000	2011	16,940	19,905	19,398	21,360	24,227
		2012	18,019	20,633	19,560	22,597	26,085
		2013	18,990	21,540	20,732	23,648	27,678
		2014	19,909	22,792	21,340	25,035	29,207
		2015	21,059	24,459	22,393	25,980	31,060
		2016	22,222	25,586	23,698	26,645	33,187
Per capita Growth Rate	%/year	2011/13-2014/16 /_1	5.4	5.5	4.1	4.7	6.2

Note: /_1: Weighted Average: From average of 2011/13 to average of 2014/16 (for 3 years), Source: Provincial Statistical Yearbook 2016

[7] Agriculture land per capita of five provinces are: 0.52 ha/person in Kon Tum, 0.57 ha/person in Gia Lai, 0.33 ha/person in Dak Lak, 0.59 ha/person in Dak Nong, and 0.29 ha/person in Lam Dong.

3.3.3 Investment

Non-state enterprises[8] share 97% to 98% of all enterprises in five provinces. Foreign investment enterprises are mostly found in Lam Dong for perennial crops as well as the processing of the products and distribution. Some enterprises revolve around products such as coffee, tea, flowers, dairy products, and silk products, textile, garment, aluminum and tourism, etc.

By economic activity, most of the agriculture sector enterprises are found in Dak Lak or Lam Dong (133 nos and 188 nos). The number of industry sector enterprises in Lam Dong is also large (532 nos) mainly because of the demand of mining and processing. Numerous number of construction sector enterprises are found in every province, among which Dak Nong has the least compared to other provinces. This is because the population of Dak Nong remains small, and enterprises tend to keep their offices in Dak Lak[9] even though they have construction works in Dak Nong. The data regarding the number of enterprises in the Central Highland provinces are shown as follows.

Table 3.3.6 Number of Enterprises in Central Highlands in 2015

	Kon Tum		Gia Lai		Dak Lak		Dak Nong		Lam Dong	
	No.	%	No.	%	No.	%	No.	%	No.	%
I. Enterprises by Investors	1,234	100.0	2,677	100.0	3,011	100.0	1,400	100.0	3,565	100.0
State owned enterprise	29	2.4	45	1.7	59	2.0	28	2.0	31	0.9
Non-State enterprise	1,204	97.6	2,629	98.2	2,950	98.0	1,368	97.7	3,465	97.2
Foreign investment enterprise	1	0.1	3	0.1	2	0.1	4	0.3	69	1.9
II. Enterprises by economic activity	1,234	100.0	2,677	100.0	3,011	100.0	1,400	100.0	3,565	100.0
1. Agriculture, forestry and fishery	56	4.5	84	3.1	133	4.4	50	3.6	188	5.3
2. Industry	148	12.0	315	11.8	314	10.4	221	15.8	532	14.9
Mining	25	2.0	56	2.1	40	1.3	30	2.1	72	2.0
Processing and manufacturing	111	9.0	233	8.7	243	8.1	170	12.1	439	12.3
Electricity supply	9	0.7	23	0.9	15	0.5	9	0.6	11	0.3
Water supply and waste management	3	0.2	3	0.1	16	0.5	12	0.9	10	0.3
3. Construction	318	25.8	456	17.0	488	16.2	165	11.8	504	14.1
4. Service	712	57.7	1,822	68.1	2,076	68.9	964	68.9	2,341	65.7
Wholesale and retail motor vehicles	395	32.0	1,277	47.7	1,523	50.6	802	57.3	1,439	40.4
Transportation and storage	67	5.4	175	6.5	113	3.8	30	2.1	138	3.9
Accommodation and food service activities	55	4.5	64	2.4	59	2.0	28	2.0	278	7.8
Financial, banking and insurance activities	10	0.8	20	0.7	21	0.7	13	0.9	29	0.8
Scientific and technical activities	158	12.8	5	0.2	229	7.6	72	5.1	248	7.0
Others service	27	2.2	281	10.5	131	4.4	19	1.4	209	5.9

Note 1:/"Other service" includes information & communication, real estate activities, administrative & support service activities, education & training, human health & social work activities, art, entertainment & recreation, socio-political organization activities.
2: As of 31 December 2015.
Source: Provincial Statistical Yearbook 2016

Among the three kinds of investors (state, non-state and foreign investment), the share of non-state investments in Lam Dong reached 81.3% of the total investment in the province, equivalent to VND 18,699 billion. This consists the biggest non-state investment among the five provinces. The non-state investment amounts in Kon Tum and Dak Nong (VND 5,321 billion and VND 5,972 billion, respectively) remain one third of Lam Dong's, and the state investment shares over 30 % of the total investment amount in both provinces (37.8% and 30.5%, respectively).

By economic activity, the amount and share of the investment in the agriculture sector is outstanding in Dak Lak (VND 5,507 billion that shares 32.4% of total investment in the province). The investment in the agriculture sector in Gia Lai, Dak Nong and Lam Dong are at similar scale (VND 2,809 billion, VND 2,612 billion and VND 2,581 billion, respectively). Lam Dong's economy is sustained not only by the agriculture sector but industry and service sectors represented by processing and manufacturing (VND 1,939 billion), wholesale and retail motor vehicles (VND 1,964 billion), transportation and storage (VND 2,030 billion), and accommodation and food service activities (VND 1,034 billion). The data on the preliminary investment amount by investors in Central Highlands are showing as follows).

[8] "Non-state enterprise" refers to private enterprises, cooperative name companies, private limited companies, joint stock companies without state capital, joint stock companies with 50% and less than of charter capital shared by the government.
[9] Southern part of Dak Lak was split in 2004 to create a new province, Dak Nong.

Table 3.3.7 Investment Amount by Investors in Central Highlands in 2016 (preliminary)

Item	Kon Tum		Gia Lai		Dak Lak		Dak Nong		Lam Dong	
	VND bil.	%	VND bil.	%	VND bil.	%	VND bil.	%	VND bil.	%
I. Total Investment Amount	8,613	100.0	17,051	100.0	17,009	100.0	8,658	100.0	23,000	100.0
State investment	3,244	37.7	3,500	20.5	4,924	28.9	2,638	30.5	3,776	16.4
Non-state investment	5,321	61.8	13,501	79.2	11,852	69.7	5,972	69.0	18,699	81.3
Foreign investment	49	0.6	50	0.3	234	1.4	48	0.6	525	2.3
II. Investment Amount by economic activity	8,613	100.0	17,051	100.0	17,009	100.0	8,658	100.0	23,000	100.0
1. Agriculture, forestry and fishery	1,075	12.5	2,809	16.5	5,507	32.4	2,612	30.2	2,581	11.2
2. Industry	720	8.4	8,356	49.0	3,512	20.6	1,087	12.6	2,664	11.6
Mining	51	0.6	22	0.1	301	1.8	115	1.3	105	0.5
Processing and manufacturing	152	1.8	1,435	8.4	1,455	8.6	251	2.9	1,939	8.4
Electricity supply	433	5.0	6,102	35.8	1,530	9.0	555	6.4	512	2.2
Water supply and waste management	83	1.0	796	4.7	226	1.3	165	1.9	108	0.5
3. Construction	130	1.5	2,628	15.4	1,105	6.5	2,120	24.5	965	4.2
4. Service	6,688	77.7	3,259	19.1	6,885	40.5	2,839	32.8	16,790	73.0
Wholesale and retail motor vehicles	148	1.7	344	2.0	717	4.2	650	7.5	1,964	8.5
Transportation and storage	3,776	43.8	324	1.9	2,477	14.6	529	6.1	2,030	8.8
Accommodation and food service activities	53	0.6	172	1.0	182	1.1	78	0.9	1,034	4.5
Financial, banking and insurance activities	29	0.3	119	0.7	117	0.7	2	0.0	282	1.2
Scientific and technical activities	18	0.2	23	0.1	168	1.0	38	0.4	153	0.7
Others service	2,664	30.9	2,276	13.4	3,224	19.0	1,542	17.8	11,327	49.2

Source: Provincial Statistical Yearbook 2016

3.3.4 Trade

Retail sales value within provinces is large in Dak Lak (VND 50,557 billion in total) as they have a strong need of domestic consumption in the local markets. On the contrary, the need of Dak Nong remained small, but its export value is the largest (USD 655,130,000) followed by Dak Lak (USD 489,411,000). Main export products from these two provinces are from the agriculture sector, which further explains that they heavily depend on the agriculture sector. The breakdown of the data is shown as follows.

Table 3.3.8 Trade Value at Current Price of Central Highlands in 2016 (preliminary)

Item	Unit	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
Retail Sale Value at current prices	VND Bil.	11,129	36,130	50,557	9,721	26,108
Food and foodstuff		3,970	12,790	16,169	2,992	11,964
Garment		787	2,190	1,721	537	1,466
Household equipment		1,248	2,787	6,721	787	2,839
Wood and construction materials		1,440	1,848	5,228	788	1,810
Other goods		3,684	16,515	20,718	4,617	8,029
Export Value	USD '000	114,447	211,662	489,411	655,130	449,689
Mineral and heavy industry products		0	3,489	0	0	160,389
Handicrafts and light industry products		8,292	26,308	16,575	0	34,529
Agriculture products		106,115	165,207	472,686	631,470	254,686
Forestry products		0	2,724	0	840	0
Others		40	13,934	150	22,820	85
Import Value	USD '000	3,156	91,423	17,017	112,010	137,132
Machinery, instrument, accessory		1,135	436	1,127	580	13,851
Fuels, raw materials		2,021	50,297	0	111,430	113,110
Foodstuff		0	349	0	0	10,171
Others		0	40,341	15,890	0	0

Source: Provincial Statistical Yearbook 2016

Taking a look at goods they export and import shown as follows, Kon Tum, Gia Lai and Dak Lak export cassava and rubber although those from Kon Tum are relatively small compared to the former provinces. All provinces export coffee, out of which Dak Lak shares quite large amount (209,578 ton). It is noteworthy that Kon Tum export processed wood (65,681m^3), and Lam Dong export flowers (265,401 thousand branches) and aluminum (657,222 tons).

Table 3.3.9 Main Goods for Exportation and Importation

Item	Unit	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
Main goods for exportation						
Cassava	Ton	30,183	78,550	97,380	-	-
Coffee	Ton	1,266	115,580	209,578	133,908	63,320
Pepper	Ton	-	3,514	5,329	14,503	
Tea	Ton	-	-	-	8	14,862

Item	Unit	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
Cashew nuts	Ton	-	-	471	38,669	1,480
Rubber	Ton	1,777	8,175	6,463	-	-
Honey	Ton	-	-	8,092	-	-
Vegetable	Ton	-	-	-	-	8,988
Flower	1000 branches	-	-	-	-	265,401
Textile yarn	1000 m^2	-	-	-	-	1,467
Processed wood	m^3	65,681		150	-	-
Articles of wood	1000 pieces	140	6,209	-	1,290	-
Garment products	1000 pieces	-	-	-	-	20,338
Aluminum	Ton	-	-	-	-	657,222
Main goods for importation						
Fertilizers	Ton	-	-	16,426	-	-
Wood materials	m^3	7,107	-	-	-	-
Wooden products	USD '000	-	21,513	-	-	-
Cashew nuts	Ton	-	18,440	-	30,196	-
Pepper	Ton	-	-	-	3,372	-
Material for garment	USD '000	-	-	-	-	10,919
Machinery	USD '000	-	436	-	-	13,851

Note 1: "-" not available, 2: In Dak Nong, they import raw cashew nuts to process at factories in the province together with those they produce domestically.
Source: Provincial Statistical Yearbook 2016

3.3.5 Social Status

(1) Literacy

Literacy rates from 2011 to 2016 have been at a standstill without a tangible sign of improvement. Average literacy rate in Central Highlands is the second worst in the country. Literacy rates of Dak Lak, Dak Nong and Lam Dong are almost above the regional average and close to the national, while Kon Tum and Gia Lai are below the regional average. These are shown as follows.

Table 3.3.10 Ratio of Literate Population 15 Years Old and Above in Central Highlands (2011-2016)

(Unit: ‰)

Year	Whole country	Central Highlands	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
2011	94.2	90.8	88.2	83.9	93.2	93.9	94.1
2012	94.7	92.1	87.6	87.9	94.6	94.2	93.6
2013	94.8	91.2	88.2	83.9	94.2	94.0	94.3
2014	94.7	90.3	86.8	85.6	91.4	92.3	94.0
2015	94.9	90.4	87.9	84.0	92.9	93.7	92.6
2016	-	-	-	-	-	-	-

Note: "-" not available, Source: Vietnam Statistical Yearbook 2014 and 2015

(2) Health

The rate of infant mortality is high in Central Highlands compared to the national average infant mortality rate. As shown in Table 3.3.11, except Lam Dong, the infant mortality rate of each of the provinces are far above the national level. Infant mortality rate is a basic health indicator that describes health conditions, and at the same time, relates to the surrounding hygienic conditions, nutritious statuses, and parents' knowledge on child rearing. It gives an implication that local population in Kon Tum, Gia Lai Dak Nong and Dak Lak are lacking in the either one of the facets mentioned above.

Table 3.3.11 Infant Mortality Rate of Central Highlands (2011-2015)

(Unit: Infant deaths per 1,000 live births)

Year	Whole country	Central Highlands	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
2011	15.5	24.3	40.7	27.0	22.0	26.1	14.2
2012	15.4	26.4	40.0	30.8	24.6	28.5	16.5
2013	15.3	26.1	40.0	30.6	24.7	28.5	16.5
2014	14.9	25.9	38.7	28.9	24.2	27.1	16.6
2015	14.7	24.8	38.1	26.3	24.0	25.7	16.3

Note: Infant mortality rate shows the probability of infants' dying between their births and exactly one year of age expressed per 1,000 live births.
Source: GSO Homepage

(3) Income

The monthly average income per capita of 2014 indicates that the provinces in Central Highlands except Lam Dong (VND 2,498,000/month) are far below the national average (VND 2,640,000/month). Kon Tum has the lowest average income per capita among the five provinces (VND 1,587,000/month), while the gap between the lowest and highest income groups is at a minimum (7.0). The disparity in Dak Nong is as much as the national average (9.7).

Table 3.3.12 Monthly Average Income per Capita in 2014 at Current Prices

(Unit: thousand VND/month)

	Whole country	Central Highlands	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
Total Monthly Average Income	2,640	2,008	1,587	1,759	1,988	1,823	2,498
The lowest income group (A)	660	510	496	434	550	392	711
The highest income group (B)	6,413	4,574	3,449	3,705	4,658	3,792	5,921
('C) = (B)/(A)	9.7	9.0	7.0	8.5	8.5	9.7	8.3
Income Source							
Salary & wage	1,238 (46.9%)	674 (33.6%)	736 (46.4%)	642 (36.5%)	599 (30.1%)	444 (24.4%)	875 (35.0%)
Agriculture, forestry & fishery	484 (18.3%)	863 (43.0%)	389 (24.5%)	699 (39.7%)	937 (47.1%)	1,078 (59.1%)	998 (40.0%)
Non-agriculture, forestry & fishery	591 (22.4%)	356 (17.7%)	326 (20.5%)	341 (19.4%)	332 (16.7%)	218 (12.0%)	470 (18.8%)
Others	327 (12.4%)	115 (5.7%)	136 (8.6%)	77 (4.4%)	120 (6.0%)	83 (4.6%)	155 (6.2%)

Source: Vietnam Statistical Yearbook 2015

Unlike the national tendency, income from agriculture, forestry and fishery means are important to the local people of the region. Dak Nong people owe on an average of 59.1% of their monthly income to the agriculture sector. The Dak Lak people earn around VND 1,988,000 monthly per person, nearly half of which is from agriculture. It is only the Kon Tum Province where people rely more on salary and wages.

(4) Poverty Incidence

Poverty incidence in Central Highlands is at a high of 15.3% (except Lam Dong which is at 5.2%) and is more severe than the national average of 8.2%. Kon Tum has the worst poverty rate at 23.0% among all the five provinces followed by Dak Nong at 19.2%. The poor populations are mostly found in the rural area. As seen in Gia Lai and Lam Dong, approximately 90% of poor households live in the rural area, and so are the households in Dak Lak (85.2%) and Kon Tum (77.0%). The data from the provinces are shown as follows.

Table 3.3.13 Poverty in Central Highlands in 2016

Item	Unit	Whole country	Central Highlands	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
Number of poor households	No	1,986,697	204,996	28,990	54,925	76,434	28,739	15,908
Rate to the total number of households	%	8.2	15.3	23.0	16.6	17.8	19.2	5.2
Number of poor households living in rural area	No	1,801,510	168,346	22,326	49,738	65,133	16,942	14,207
Rate of to all poor households in rural area	%	90.7	82.1	77.0	90.6	85.2	59.0	89.3

Note 1: Total number of household, rural and urban households, total number of ethnic minority households of 2016 are not available. According to the information from GSO, total number of ethnic minority households as of 2015 was 3,040,956.
2: the GOVN introduced norms for multidimensional poverty measuring (income norm and indicators measuring the level of deprivation of access to basic social services) by the Prime Minister's Decision 59/2015/QD-TTg (dated 19 Nov 2015) to apply during 2016 and 2020.

Source: Decision No. 945/QD-BLDTBXH dated June 22nd, 2017 by Ministry of Labor, Invalids and Social Affairs on Approved the results of poverty and near poor households survey in 2016

(5) Ethnic Minorities

Compared to the national average at 14.6%, Central Highlands is home to various of ethnic minorities with a population share of 36.4%. Among the five provinces, the rate of ethnic minority population is the largest in Kon Tum at 54.9%. The second largest rate of ethnic minority population is found in Gia Lai at 45.9% (Refer. AT 3.3.2).

Among them, the shares of poor ethnic minority households are considerably high in Kon Tum (92.8%). Even if the ratio of ethnic minority households to the total number of households is rather low in Lam Dong, Dak Nong and Dak Lak (25.0%, 29.2% and 34.3% respectively), the shares of the poor ethnic minority households are 63.9%, 60.0% and 62.2% of the total poor households, respectively. The data is shown as follows.

Table 3.3.14 Ethnic Composition of Central Highlands in 2015

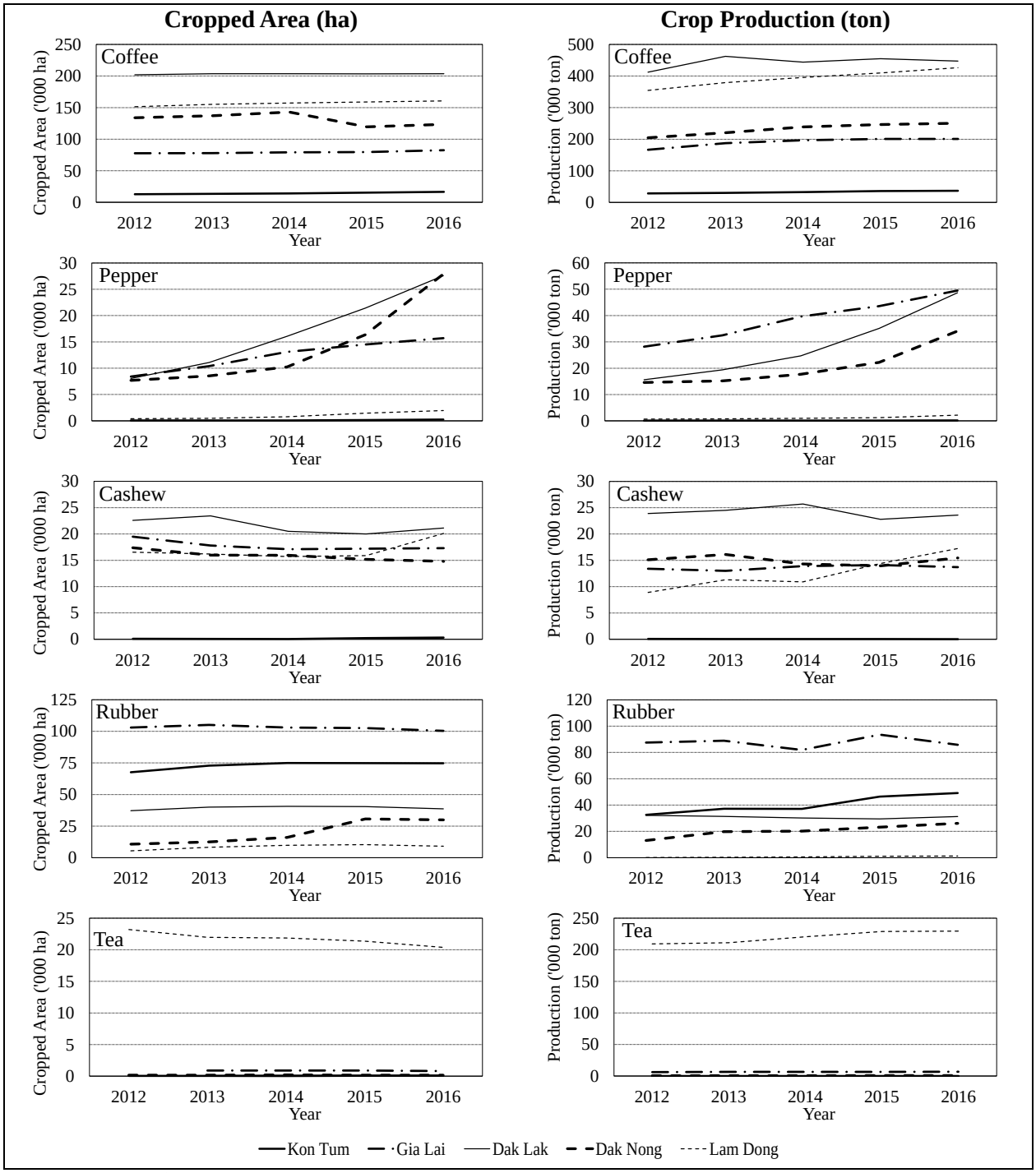
Item	Unit	Whole country	Central Highlands	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
Total population (A)	person	91,713,350	5,623,831	495,876	1,417,259	1,853,698	583,910	1,273,088
Total ethnic minority population (B)	person	13,386,330	2,047,907	272,152	650,816	636,491	170,363	318,085
(C') = (B)/(A)	%	14.6	36.4	54.9	45.9	34.3	29.2	25.0
Total poor households (D)	person	1,986,697	204,996	28,990	54,925	76,434	28,739	15,908
Total poor ethnic minority households ('E)	person	956,820	123,169	26,908	21,336	47,524	17,242	10,159
(F) = ('E)/(D)	%	48.2	60.1	92.8	38.8	62.2	60.0	63.9

Source: Total population: Provincial Statistical Yearbook 2016. Total ethnic minority population: Results of the survey on the socio-economic status of 53 ethnic minorities, Committee for Ethnic Minorities Affairs, 2015. Poor households and poor ethnic minority households: Decision No. 945/QD-BLDTBXH dated June 22nd, 2017 by Ministry of Labor, Invalids and Social Affairs on Approved the results of poverty and near poor households survey in 2016

3.4 Agricultural Status

3.4.1 Crop Production

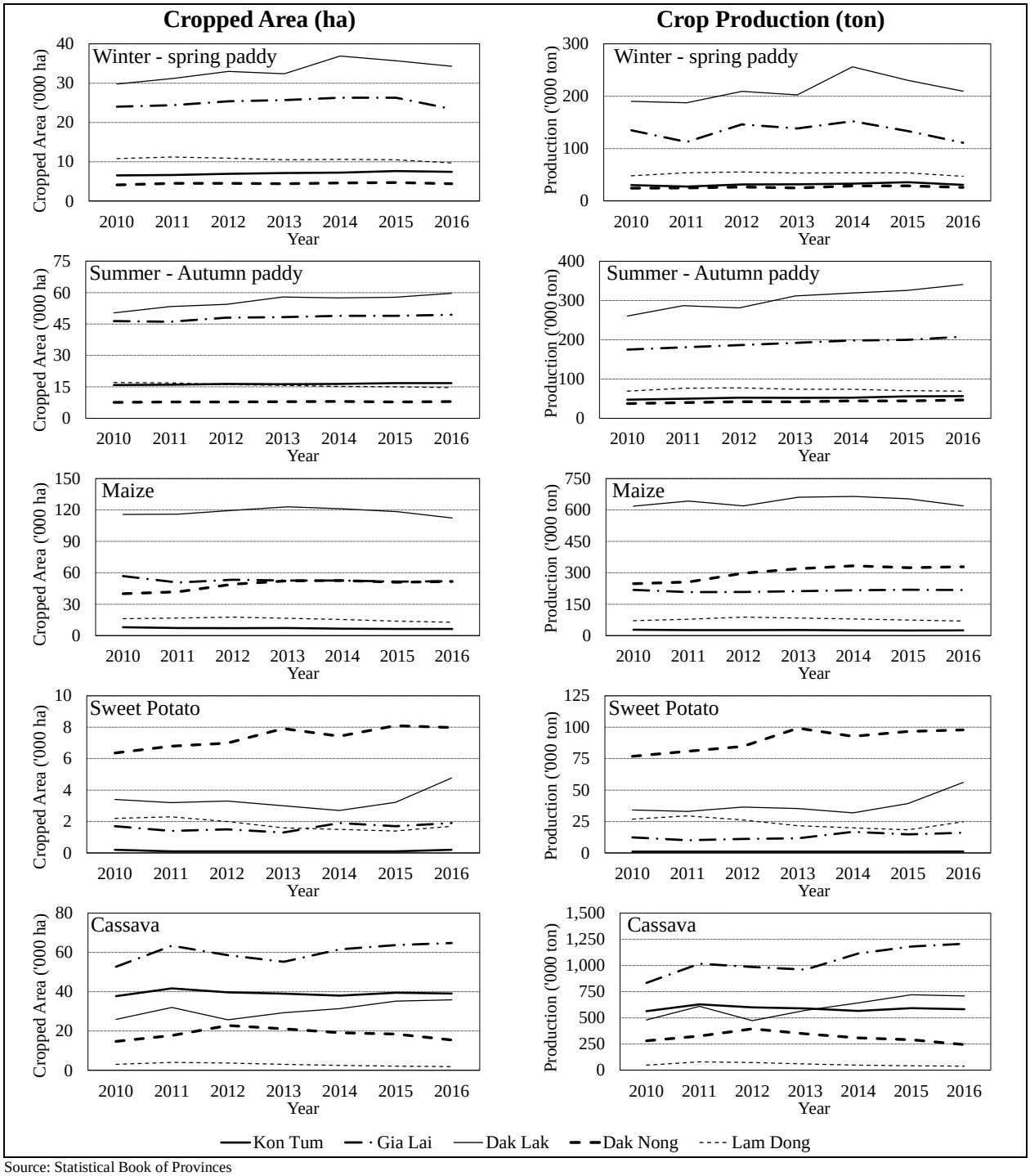
In Central Highlands, there are various type of crops cultivated under its diverse topography and climate. More than 60% of the lands are used for agricultural purposes, a major industry, contributing to the livelihood of the rural population in Central Highlands. The cropped areas of coffee are almost constant or slightly increased except in Dak Nong Province. However, the production of coffee has increased in the three provinces mainly Gia Lai, Dak Nong, and Lam Dong. In Dak Nong Province, despite the decreased cropped area in 2015, the production continuously increased. The most significant expansion is observed in pepper cultivation in the three provinces of Gia Lai, Dak Lak, and Dak Nong as follows:



Source: Statistical Book of Provinces

Figure 3.4.1 Cropped Area (left) and Production (right) of Perennial Crops in Central Highlands

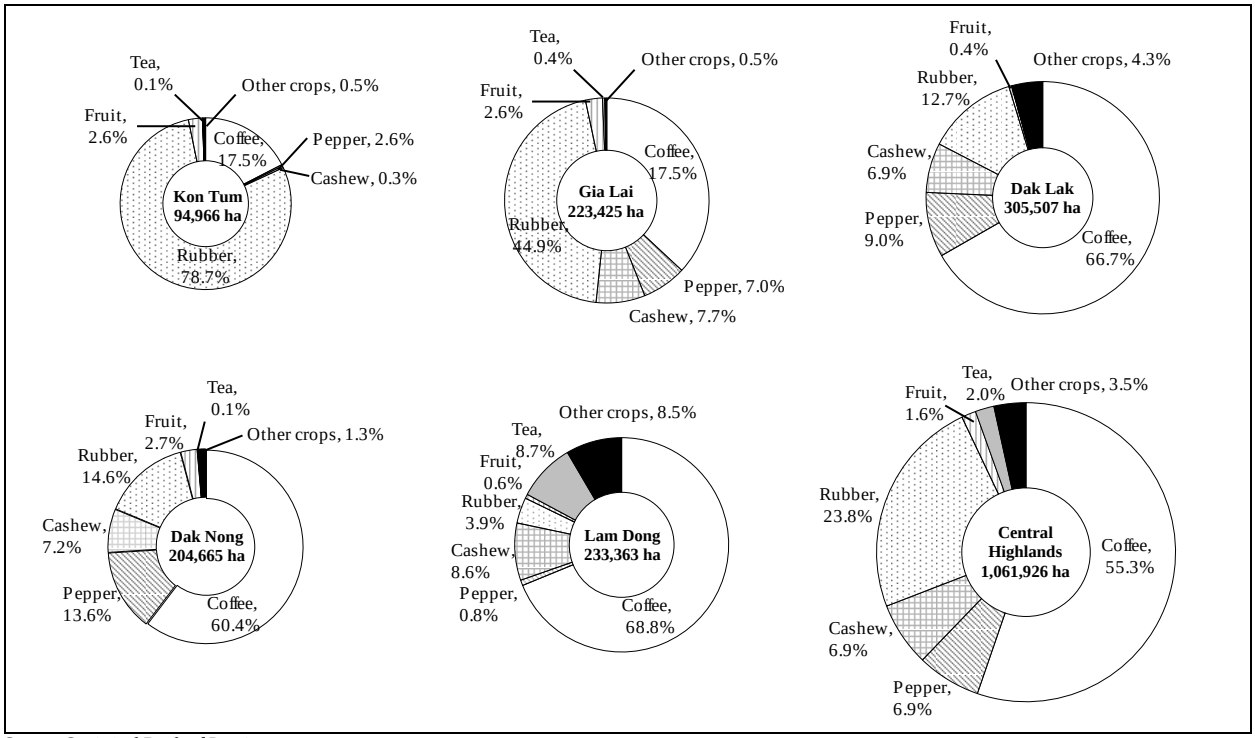
The cropped area and production of winter-spring paddies and summer-autumn paddies in the three provinces of Kon Tum, Dak Nong and Lam Dong are almost constant. On the other hand, in Gia Lai and Dak Lak provinces, the cropped area and production of winter-spring paddies decreased in the last two years. In contrast, summer-autumn paddies increased continuously. The cropped area and production of sweet potato in Dak Lak and Dak Nong increased in recent years. Regarding cassava, Gia Lai and Dak Lak provinces expanded the cropped area and production. The detail information of cropped area and crop production are illustrated as follows:



Source: Statistical Book of Provinces

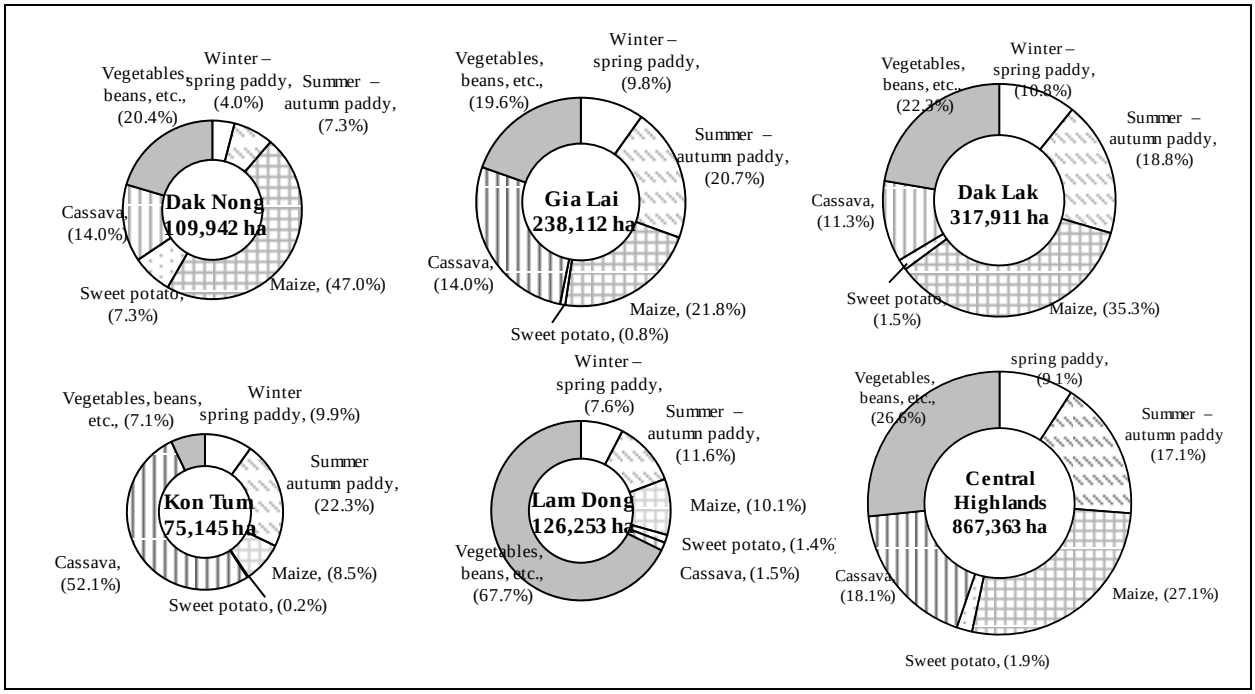
Figure 3.4.2 Cropped Area (left) and Production (right) of Annual Crops in Central Highlands

The following figures show the current cropped area for perennial and annual crops of the five provinces in Central Highlands. Generally, Coffee and rubber are the major perennial crops while paddy, maize and cassava are the main annual crops. The Lam Dong Province is an exception where the cultivation of rubber and cassava is limited while tea and vegetable cultivation are much more popular compared to the other four provinces.



Source: Statistical Book of Provinces

Figure 3.4.3 Share of Cropped Area of Perennial Crops in Central Highlands in 2016



Source: Statistical Book of Provinces

Figure 3.4.4 Share of Cropped Area of Annual Crops in Central Highlands in 2016

The yield of tea ranges from 1.58 ton/ha in Kon Tum to 10.72 ton/ha in Lam Dong. The yield of coffee is average around 2.3 ton/ha. Among the five provinces, it can be deemed in general that the yields in Kon Tum are lower among other provinces. Likewise, those in Dak Lak are higher than the other provinces. Production and yield of major crops in Central Highlands are as follows:

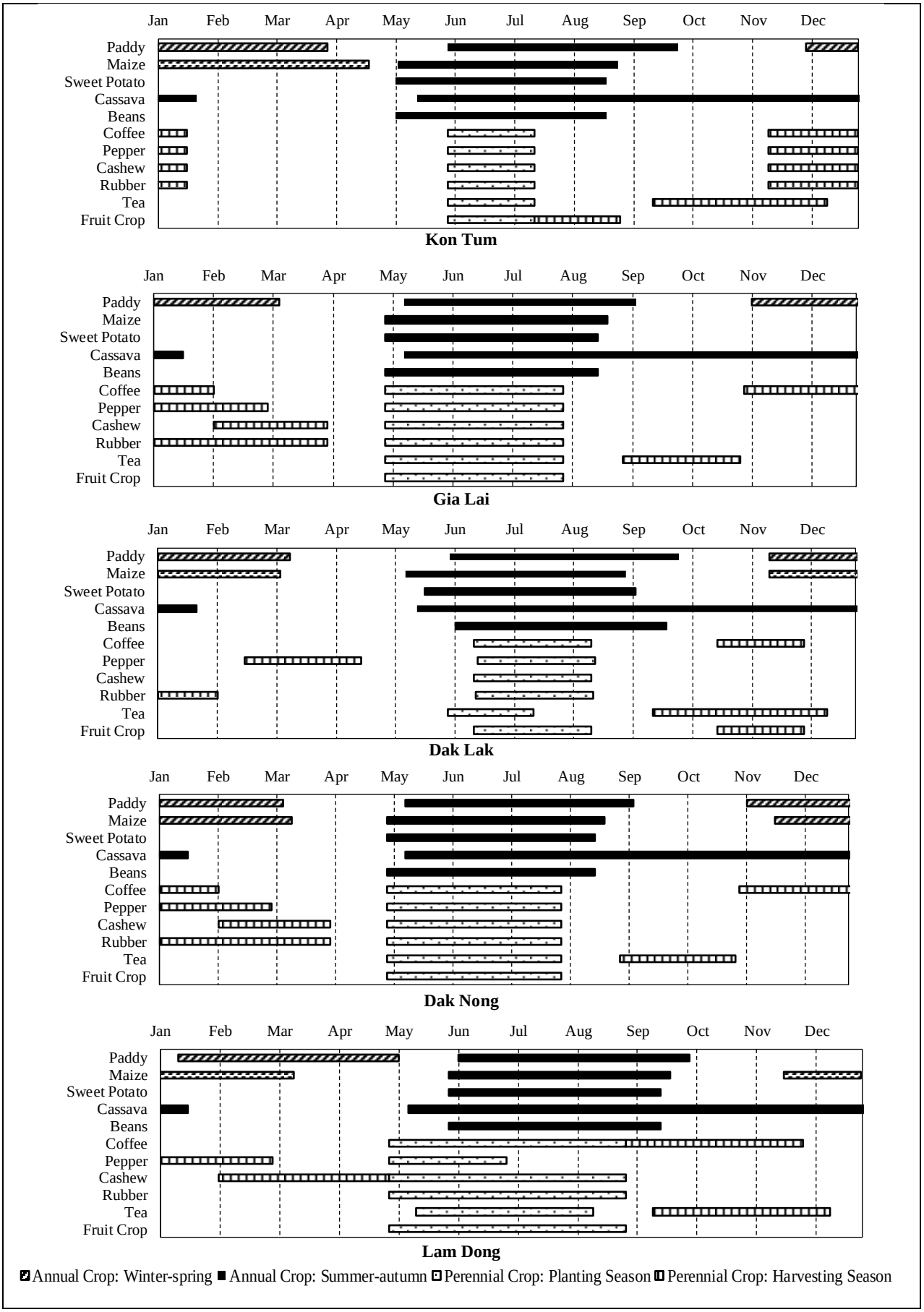
Table 3.4.1 Main Crop Production in Central Highlands in 2015/16

Item		Central Highlands	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
Perennial Crop							
Coffee	Production (ton)	1,347,925	35,941	201,012	454,810	246,549	409,613
	Yield (ton/ha)	2.34	2.35	2.52	2.24	2.06	2.58
Pepper	Production (ton)	102,318	127	43,601	35,141	22,207	1,242
	Yield (ton/ha)	1.90	0.87	3.01	1.64	1.36	0.86
Cashew	Production (ton)	65,230	37	14,057	22,787	13,957	14,392
	Yield (ton/ha)	0.95	0.17	0.82	1.14	0.92	0.91
Rubber	Production (ton)	193,776	46,432	93,564	29,454	23,221	1,105
	Yield (ton/ha)	0.75	0.62	0.91	0.73	0.76	0.11
Tea	Production (ton)	236,448	114	6,700	-	779	228,855
	Yield (ton/ha)	10.54	1.58	7.87	-	4.87	10.72
Annual Crop							
Winter - spring paddy	Production (ton)	481,960	35,751	133,427	230,229	28,940	53,613
	Yield (ton/ha)	5.68	4.71	5.07	6.45	6.17	5.11
Summer - autumn paddy	Production (ton)	699,033	55,765	199,697	325,596	44,170	73,805
	Yield (ton/ha)	4.57	3.32	4.08	5.64	5.60	3.44
Maize	Production (ton)	1,295,620	24,243	219,337	653,392	324,350	74,298
	Yield (ton/ha)	5.37	3.81	4.25	5.52	6.36	5.35
Sweet Potato	Production (ton)	170,120	1,045	14,777	39,326	96,580	18,392
	Yield (ton/ha)	11.69	7.92	8.85	12.21	11.92	12.91
Cassava	Production (ton)	2,826,388	591,952	1,180,911	720,741	291,160	41,624
	Yield (ton/ha)	17.80	14.99	18.58	20.48	15.81	19.65

Source: Statistical Book of Provinces

3.4.2 Cropping Pattern

In all provinces of Central Highlands, paddy and maize are cultivated twice a year, i.e. during the winter-spring cropping season, generally from December to April, and during the summer-autumn cropping season, generally from June to October. This happens in other provinces, except Gia Lai province where maize is only cultivated once in the summer-autumn season. The two seasons for paddy cultivation in Lam Dong Province is one month later than the other four provinces. The beginning and ending of cassava cultivation is similar among the five provinces. As for the perennial crops, the planting and harvesting seasons are different among the five provinces. Of which, the planting is usually conducted during the rainy season (from May to August) while the harvesting varies in the dry season. To be more specific, the planting coffee trees are done from the beginning of May to the end of August while the harvesting coffee is made from the beginning of November to the end of January. The coffee production in Lam Dong Province is different that the planting and harvesting are continuously conducted. The cropping pattern in the five provinces are described as follows. The detailed information can be referred to AP 3.4.1.



Source: Statistical Book of Provinces

Figure 3.4.5 Cropping Pattern in Central Highlands

3.4.3 Crop Varieties and Farming Practices in Dry and Wet Years

(1) Crop Varieties and Farming Practices Introduced by Provinces

For annual crops, the short-growing varieties and drought tolerance varieties have been recommended by the provinces during the dry season. The provinces also recommend avoiding planting in dry areas to reduce crop damage caused by drought.

For perennial crops, application of water saving irrigation, inter-cropping fruit trees and cover vegetation to save water and reduce evaporation are recommended. In dry areas, the provinces also recommended to avoid planting coffee or pepper, and instead convert to drought tolerant crops. The detailed varieties and farming practices for annual and perennial crops in the dry and wet years by provinces are shown as follows.

Table 3.4.2 Crop Varieties and Farming Practices in Dry and Wet Years

Crops/Dry & Wet Years		Crop varieties/ Cropping Pattern/ Farming Practices introduced by Provinces								
Annual crops	Dry year	Requirement: • Short growing period • Drought tolerant varieties								
		(1) Earlier planting of dry season crops/ autumn-spring for utilization of available water for planting								
		Farming Practices				**KT**	**GL**	**DL**	**DN**	**LD**
		Early planting in dry season (day)				10-15	10-15	10-15	-	-
		No planting in dry season				do	do	do	do	do
		(2) Planting short growing paddy varieties								
		Paddy short growing varieties	**Season**	**Growing Period (day)**	**Yield (ton/ha)**	**KT**	**GL**	**DL**	**DN**	**LD**
		Che Bien 3988	Wet	90-95	5.0-5.8	-	do	do	-	-
			Dry	105-110	6.0-6.5	-	do	do	-	-
		Hoa Uu 109	Wet	95-100	5.4-6.0	-	do	-	-	-
			Dry	105-110	6.3-6.8	-	do	-	-	-
		Prevailing paddy varieties	Wet	100-110	3.5-5.8	do	do	do	do	do
			Dry	110-125	4.3-6.5	do	do	do	do	do
		(3) Drought tolerant maize varieties								
		Maize tolerant varieties	**Season**	**Growing Period (day)**	**Yield (ton/ha)**	**KT**	**GL**	**DL**	**DN**	**LD**
		LVN10, CP888, V98-2, DK171, C919, BioseedB21	Wet	90-95	5.5-6.5	do	-	-	-	-
			Dry	95-100		do	-	-	-	-
		AIQ1268	Wet	94-98	5.5-7.0	-	do	-	-	-
			Dry	100-118		-	do	-	-	-
		P4181	Wet	89-94	5.3-6.5	-	do	-	-	-
			Dry	95-99		-	do	-	-	-
		Prevailing maize varieties	Wet	95-125	4.0-6.5	do	do	do	do	do
			Dry	100-135		do	do	do	do	do
	Wet year	Requirement: • Short growing period								
		(1) Earlier harvesting of wet season crops to initiate dry season cropping earlier								
Perennial crops	Dry and Wet year	Requirement: • Drought tolerant varieties								
		Farming Practices		**Effect**		**KT**	**GL**	**DL**	**DN**	**LD**
		Decrease or minimal increase of production area		Reduce water demand in dry season		do	do	do	do	do
		Replacing crops in wet season		Minimize water use in dry season		do	do	do	do	do
		Water saving in wet season		Preservation of water resources for dry season		do	do	do	do	do
		Inter-cropping fruit trees (durian and avocado) in the coffee garden		Reduce evaporation, keep soil humidity, and increased water use efficiency at 15-20%		-	-	do	-	-
		Inter-cropping fruit trees (durian and avocado) in the coffee garden		Reduce evaporation, keeping soil humidity, and increased water use efficiency at 15-20%		-	-	do	do	-
		Inter-cropping pepper with the live trees in the coffee garden		Reduce evaporation		-	-	15-20%	10-15%	-
		Planting shade trees in the coffee and pepper gardens		Reduce evaporation, prolonging the interval between the previous irrigation time and the next irrigation time		-	-	-	do	-
		Planting pepper with the live trees and planting cover vegetation in the pepper garden		Reduce evaporation and saving water by 10-20% compared with normal planting		-	-	15%	20%	-
		Apply water saving irrigation for coffee and pepper		Saving water compared with common practice		-	-	do	do	-
		Use net cover to protect from direct sun light for pepper		Reduce evapotranspiration		-	do	do	do	-

Note: KT: Kon Tum, GL: Gia Lai, DL: Dak Lak, DN: Dak Nong, LD: Lam Dong
"-" No responses
Source: Central Highlands Provinces (DARD)

(2) Farming Practices Plans and Activities by Provinces

Converting drought paddy field to crops with high profit and high marketability is recommended by provinces. Examples are sweet potato, tobacco, ginger, turmeric, water melon and vegetables.

Applying farming practices to save water such as System of Rice Improvement (SRI), Climate Smart Agriculture (CSA) for annual crops, and sprinkler, drip irrigation, etc., for perennial crops.

Investing in dredging canal construction, as well as ponds, and reservoirs are applied to store water for irrigation and prevent the floods in the provinces.

Table 3.4.3 Plans and Activities on Farming Practices in Dry and Wet Years

Crops/Dry & Wet Years		Plans and activities by Provinces					
Annual crops	Dry year	(1) Convert drought paddy field to crops with high profit and high marketability					
		Province	**KT**	**GL**	**DL**	**DN**	**LD**
		Converted crops	maize, soybean	maize, soybean, sweet potato, vegetable	sweet potato, tobacco, ginger, turmeric, water melon	-	-
		(2) Dry season:					
		Farming Practices by Provinces	**KT**	**GL**	**DL**	**DN**	**LD**
		Planting vegetable, flowers in net house, plastic house and installing drip and tube irrigation systems	-	-	-	-	do
		Identifying drought areas and guiding people to change their growing crops as well as introduction of crop rotation to suit water saving	do	do	do	do	do
		Applying advanced methods for rice, such as System of Rice Improvement (SRI), Climate Smart Agriculture (CSA)	-	do	-	-	-
		Applying water-saving irrigation methods such as sprinkler, drip irrigation, etc.	-	do	-	do	-
		Usage of short-term varieties to avoid drought at the end of the crop season	do	do	do	do	do
Perennial crops	Dry and Wet year	**Crops/ Farming Practices**	**KT**	**GL**	**DL**	**DN**	**LD**
		Crops with less water requirement (cashew, nuts, etc.)	do	do	do	do	do
		Intercropping fruit trees (durian and avocado) in the coffee garden	-	-	do	-	-
		Investing in main irrigation works to store water for irrigation and to prevent the floods	do	do	-	do	-
		Dredging canals construct, ponds, and reservoirs	do	do	do	do	-
		Preparing groundwater sources map in drought-prone areas, and preparing water resources utilization plan	-	do	do	do	-
		Investing in water resources monitoring systems for surface and groundwater	-	do	do	-	do

Note: KT: Kon Tum, GL: Gia Lai, DL: Dak Lak, DN: Dak Nong, LD: Lam Dong, "-" No responses
Source: DARD of 5 provinces in Central Highlands

3.4.4 Crop Budget

For the purpose of analyzing profitability of agriculture in Central Highlands, data on the crop budget were collected. The four provinces of Kon Tum, Gia Lai, Dak Nong, and Lam Dong were able to provide data but Dak Lak Province was not able to collect any information on crop budget due to the fact that investigation of the agricultural manufacturing cost has not been made yet.

Based on the survey results on crop budget seen in Table 3.4.4, there are significant differences of net income among annual and perennial crops in the four provinces. Due to the lower net income of annual crops, the farmers are shifting gradually from annual crops such as maize and cassava to perennial crops in the slope field to obtain more income. However, according to the survey results, there are two barriers preventing farmers to change their crop patterns, i) initial investment cost and ii) irrigation water supply.

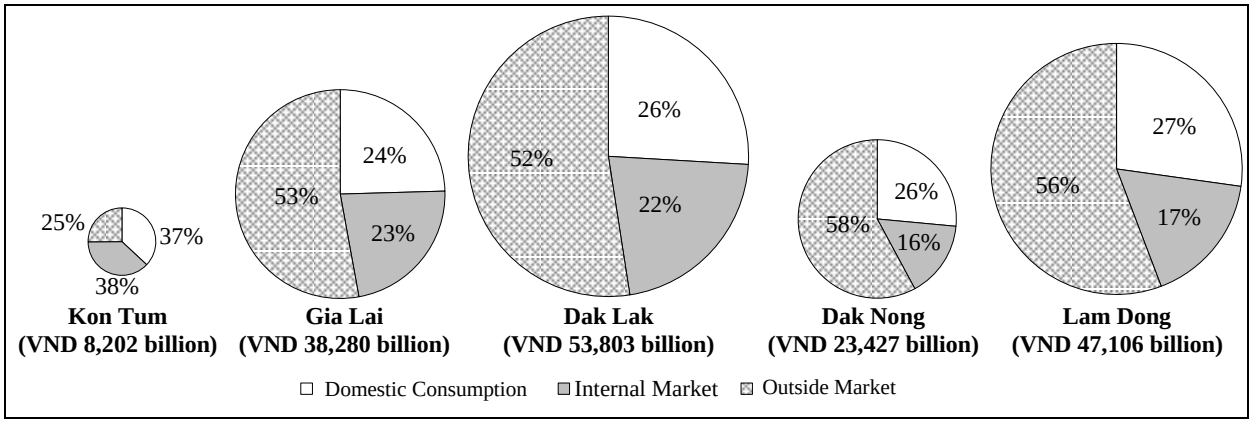
Table 3.4.4 Crop Budget of Major Crops in Four Provinces

Item		Kon Tum	Gia Lai	Dak Nong	Lam Dong	Item		Kon Tum	Gia Lai	Dak Nong	Lam Dong
Perennial Crop						**Annual Crop**					
Coffee						Winter-spring Paddy					
(a)	Production cost	69,825	63,371	71,764	71,259	(a)	Production cost	23,580	22,286	27,512	24,085
(b)	Gross income	109,876	135,240	93,500	161,318	(b)	Gross income	27,132	32,434	32,729	30,954
(c)	Net income (c/a%)	40,050 (57)	71,869 (113)	21,736 (30)	90,059 (126)	(c)	Net income (c/a%)	3,552 (15)	10,149 (92)	5,217 (19)	6,869 (29)
Pepper						Summer-autumn Paddy					
(a)	Production cost	158,496	145,778	207,191	149,322	(a)	Production cost	23,580	21,909	-	24,085
(b)	Gross income	284,606	304,905	476,850	185,457	(b)	Gross income	27,489	30,791	-	30,771
(c)	Net income (c/a%)	126,110 (80)	159,172 (109)	269,659 (130)	36,135 (24)	(c)	Net income (c/a%)	3,909 (17)	8,882 (40)	-	6,686 (28)
Cashew						Maize					
(a)	Production cost	25,387	18,793	30,426	22,707	(a)	Production cost	15,090	16,003	25,269	24,314
(b)	Gross income	50,610	50,820	43,313	52,713	(b)	Gross income	18,390	26,618	28,787	29,897
(c)	Net income (c/a%)	25,223 (99)	32,027 (170)	12,886 (42)	30,006 (132)	(c)	Net income (c/a%)	3,301 (22)	10,615 (66)	3,518 (14)	5,583 (23)
Tea						Cassava					
(a)	Production cost	71,570	45,140	15,733	97,184	(a)	Production cost	28,274	24,303	10,788	22,480
(b)	Gross income	77,625	76,000	145,594	140,000	(b)	Gross income	44,673	36,325	25,479	29,736
(c)	Net income (c/a%)	6,055 (8)	30,860 (68)	129,862 (825)	42,816 (44)	(c)	Net income (c/a%)	16,399 (60)	12,022 (49)	14,691 (136)	7,256 (32)

Note: "-" no data available, Source: Statistical Book of Provinces

3.4.5 Marketing

The market trends of agricultural products are assessed by domestic consumption, trade at local markets and outside markets. In Central Highlands, the total of domestic consumption and trade at local markets shares about half the consumption and the remaining half is traded to outside markets in general. Kon Tum Province shows a different trend from the other provinces in which about 75% of agricultural products are consumed inside the province and only 25% are traded to outside markets (Ref. AT 3.4.5). The agricultural products traded at local markets and outside markets in Central Highlands is shown as follows.



Sources: Statistic Books 2014, DOITs in Central Highlands and Result of the Vietnam household living standards survey 2014

Figure 3.4.6 Agricultural Products traded at Local and Outside Markets in Central Highlands

In Central Highlands, there are 374 markets selling more than VND 40 trillion annually. The numbers of markets range from 26 in Kon Tum Province to 147 in Dak Lak Province. The difference of the annual sales amount between Dak Lak Province at the highest and Dak Nong Province at the lowest is more than three times. The outline of the local markets in Central Highlands are summarized as follows:

Table 3.4.5 Outline of Local Markets in Central Highlands

Province	Nos of Markets	Nos of Shops	Annual Sales Amount (VND mil./year)
Kon Tum	26	2,691	4,266,517
Gia Lai	91	9,130	9,792,979
Dak Lak	147	15,348	12,990,716
Dak Nong	33	3,712	4,092,055
Lam Dong	77	8,122	8,939,881
Central Highlands	374	39,003	40,082,149

Sources: 1) Statistic Books 2014, 2) DOITs in Central Highlands, and 3) Result of the Vietnam household living standards survey 2014

3.5 Infrastructure

3.5.1 Irrigation and Flood Protection

(1) Irrigation area and cropping intensity

In the five provinces, there are 788 existing provincial irrigation systems covering around 144,669 ha and 1,305 district-managed systems covering around 62,839 ha. The average irrigation area is 184 ha/system in the provincial systems and 48 ha/system in the district systems. The provincial systems in Gia Lai Province are the largest compared to the other provinces, with 1016 ha/system on the average followed by Lam Dong Province with an average of 283 ha/system and Dak Nong Province with 164 ha/system.

The cropping intensity (cultivated area per irrigation service area per year) in the four provinces are 191% in the provincial systems and 189% in the district systems. These values are lower than the national average of 174% both the provincial and district systems. The irrigation development of the potential irrigable area in the four provinces in an average is 86%, ranging from 70% in Dak Nong to 94% in Lam Dong. In comparison with the nation at 69% of the potential area, irrigation development in the five provinces is well advance. Existing irrigation systems in Central Highlands in 2016 are shown as follows.

Table 3.5.1 Existing Irrigation Systems in Central Highlands in 2016

Item	Kon Tum		Gia Lai		Dak Lak		Dak Nong	
	Province	District	Province	District	Province	District	Province	District
No of System (No.)	175	317	31	309	308	322	196	34
Service Area (ha)	13,834	2,820	31,497	25,069	30,644	16,488	32,052	1,374
Average Service Area (ha/system)	79	9	1016	81	99	51	164	40
Cropping Intensity of Irrigation System (%)	194	168	154	188	198	200	179	183
Potential Irrigable Area (ha)	18,234		63,795		80,765		41,880	
Irrigated Area (ha)	16,654		56,566		47,132		33,426	
% to the Potential*	91		89		58		80	

Item	Lam Dong		Five Provinces		Whole Nation	
	Province	District	Province	District	Province	District
No of System (No.)	74	322	788	1305	14,830	31,550
Service Area (ha)	20,907	19,016	144,669	62,839	4,125,391	1,375,130
Average Service Area (ha/system)	283	59	184	48	278	44
Cropping Intensity of Irrigation Service Area (%)	181	181	191	189	174	
Potential Irrigable Area (ha)	45,293		227,214		5,610,892	
Irrigated Area (ha)	39,923		207,508		3,860,294	
% to the Potential*	77		83		69	

"*": Irrigated area/potential irrigable area, Source: MARD, DARD, IMC

The cropping intensity varies by systems and provinces. In the dry season (winter-spring), the cropping intensity is 84% in the provincial systems and 93% in the district systems. The annual cropping intensity of the district systems is higher than the provincial systems, i.e. 189 and 179 on average of the provinces, except in Kon Tum Province. This is shown as follows.

Table 3.5.2 Cropping Intensity of Irrigation Systems in Central Highlands in 2016

Province	Provincial System				District System			
	Total Service Area (ha)	Cropping Intensity*			Total Service Area (ha)	Cropping Intensity*		
		Winter-Spring (ha)	Summer-Autumn (ha)	Annual (%)		Winter-Spring (ha)	Summer-Autumn (ha)	Annual (%)
Kon Tum	3,772	3,772	3,553	194	3,019	2,392	2,680	168
Gia Lai	22,144	12,029	22,144	154	17,949	15,795	17,949	188
Dak Lak	24,361	23,886	24,361	198	10,324	10,324	10,321	200
Dak Nong	6,347	6,347	5,041	179	209	209	174	183
Lam Dong	10,560	10,560	8,546	181	5,946	5,946	4,818	181
Central Highlands	67,184	56,595	63,645	179	37,446	34,666	35,942	189

Note: '*' (irrigated area in Winter-spring + Summer-autumn seasons)/total service area, Source: DARD, IMC

(2) Flood Protection Facilities

According to the mid-term plans and the disaster management committees, nine projects for flood protection were planed and partially implemented in Central Highlands. Construction of dykes does not prevail in Central Highlands. Four out of five provinces applied reservoirs as their respective flood control structures. According to statistics, total flood control volume in Central Highlands is 386.92 MCM with a total number of dams that have flood control is 13. There is no existing dams having flood control in Lam Dong Province. In contrast, Gia Lai has the largest flood control volume among the 5 provinces.

Table 3.5.3 Flood Protection Facilities in Central Highlands

Item	Unit	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong	Central Highlands
1.Project for Flood Protection [1]							
No. of Project	No.	2	2	4	1	0	9
Length of Slope Protection							
Completed	km	9.68	1.05	5.87	2.49	0	19.09
Under Construction	km	0	12.33	0	0	0	12.33
Length of boundary dyke							
Completed	km	0	0	44.90	0	0	44.9
Under Construction	km	0	0	0	0	0	0
Total Cost	VND billion	482.17	689.07	518.71	13.54	0	1,703.48
2.Existing Dams for Flood Control [2]							
No. of Dam	No.	2	5	4	2	0	13
Flood Control Volume	MCM	51.61	256.76	105.02	70.43	0	386.92

Sources: [1]; Mid-term Plans (2016-2020) and Disaster Management Committees, [2]; MARD and MOIT

3.5.2 Other Infrastructure

(1) Road

In the five provinces, 1,159 registered roads with a total length of around 12,050 km are constructed. The road density per 1,000 population is 2.12 km that is almost the same as the national average of 2.10 km. The road density to the economically used land, i.e. used and forestry area in the six provinces is 0.23 km/km^2. This is lower than the national average of 0.67 km/km^2. The road density per km^2 shown in Table 3.5.4 varies from 0.19 km/km^2 in Kon Tum as the lowest to 0.25 km/km^2 in Dak Nong.

Table 3.5.4 Existing Road of Central Highlands in 2016

Type of Road	Kon Tum		Gia Lai		Dak Lak		Dak Nong	
	No.	Length (km)	No.	Length (km)	No.	Length (km)	No.	Length (km)
1. Existing Road								
National	5	444	5	594	7	741	4	413
Provincial	11	446	12	430	11	353	6	227
District	45	643	44	1,719	109	1,445	61	799
Urban	88	204	243	837	174	460	71	198
Total	149	1,737	302	3,580	301	2,999	142	1,637
2. Road Density (km/person or km^2)								
Per 1,000 persons		3.42		2.53		1.60		2.68
Per km^2 of used and forestry area		0.19		0.24		0.24		0.25

Type of Road	Lam Dong		5 Provinces		Viet Nam	
	No.	Length (km)	No.	Length (km)	No.	Length (km)
1. Existing Road						
National	8	422	29	2,614	109	16,831
Provincial		339	48	1,795	n.a	36,225
District	74	919	333	5,524	n.a	129,259
Urban	175	417	751	2,117	n.a	8,500
Total	265	2,098	1,159	12,050	109	190,815
2. Road Density (km/person or km^2)						
Per 1,000 persons		1.63		2.12		2.10
Per km^2 of used and forestry area		0.22		0.23		0.67

Note: n.a: not available

Item	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong	5 Provinces	Viet Nam
Used area and forestry land in 2015 (km^2)	9,262	14,894	12,396	6,430	9,647	52,629	286,838
Population in 2015 (1,000 person)	507.8	1,417.3	1,874.5	609.6	1,285.9	5,695.1	90,728.9

Source: DOTs in Central Highlands, Provincial Statistics

The traffic volumes of the national and provincial roads ranges from 95 pcu/day to 23,024 pcu/day and from 16 pcu/day to 13,747 pcu/day, respectively. The traffic volume of district roads is between 20 pcu/day and 1,000 pcu/day. This is shown as follows.

Table 3.5.5 Traffic Volume of Roads of Central Highlands in 2016

Province	National Road (pcu/day)		Provincial Road (pcu/day)		District Road (pcu/day)	
	Lowest	Highest	Lowest	Highest	Lowest	Highest
Kon Tum	1,092	3,253	16	3,757	20	1,000
Gia Lai	121	6,061	198	2,481	40	900
Dak Lak	1,331	11,638	922	11,793	50	1,000
Dak Nong	95	4,502	1,507	2,498	20	432
Lam Dong	8,164	23,024	5,204	13,474	20	750

Source: DOTs in Central Highlands

The roads in Central Highlands are poorly maintained. As shown in Table 3.5.6, 32% of the national roads, 35% of the provincial roads, 38% of the district roads and 13% of urban roads in the five provinces are in poor condition and require improvement. As the management level of the road goes down to the district level, the conditions of the district roads worsen.

Table 3.5.6 Road Condition of Central Highlands in 2016

Province	National Road (km)		Provincial Road (km)		District Road (km)		Urban Road (km)	
	Total Length	Bad Condition	Total Length	Bad Condition	Total Length	Bad Condition	Total Length	Bad Condition
Kon Tum (%)	444 (100)	128 (29)	446 (100)	234 (52)	643 (100)	364 (57)	204 (100)	105 (51)
Gia Lai (%)	594 (100)	157 (27)	430 (100)	125 (29)	1,461 (100)	593 (41)	561 (100)	172 (31)
Dak Lak (%)	741 (100)	235 (32)	353 (100)	112 (32)	1,445 (100)	321 (22)	460 (100)	139 (30)
Dak Nong (%)	413 (100)	267 (65)	227 (100)	108 (48)	799 (100)	422 (53)	198 (100)	117 (59)
Lam Dong (%)	422 (100)	47 (11)	339 (100)	45 (13)	919 (100)	314 (34)	417 (100)	134 (32)
Total (%)	2,614 (100)	834 (32)	1,795 (100)	624 (35)	5,266 (100)	2,015 (38)	1,841 (35)	667 (13)

Source: DOTs in Central Highlands

(2) Water Supply

About 60 urban water supply systems were established in the five provinces covering a population of around 1.2 million. The average design capacities are 2,757 m^3/day/system. The beneficiary population ratios are 74% which is lower than the national average. The existing urban water supply systems are tabulated as follows.

Table 3.5.7 Existing Urban Water Supply Systems of Central Highlands in 2016

Item	Unit	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong	5 Provinces	Viet Nam
Number of System	No.	9	18	11	6	16	60	500
Beneficiary	person	124,328	193,334	420,635	67,950	397,027	1,203,274	29,524,405
Total Urban Population	Person	174,680	422,473	450,585	89,838	496,157	1,633,733	30,035,000
% of beneficiary to the total urban population	%	71	46	93	76	80	74	98
Utilized Capacity	m^3/day	17,974	36,330	54,968	9,500	46,650	165,422	7,000,000
Beneficiary per system	person/system	13,814	10,741	38,240	11,325	24,814	20,055	59,049
Capacity per system	m^3/day/system	1,997	2,018	4,997	1,583	2,916	2,757	14,000

Note: Urban population includes the surrounding rural population under water supply
Source: Water supply companies and provincial DOCs in Central Highlands

The utilization of the design capacity of the urban water supply systems is around 68% as seen in following table. The design capacity of the system needs to be installed considering the future and realistic demand of the target area, however the capacity utilized seems to be under the installed capacity. This can be due to the fact that the systems were used several years after their construction.

Table 3.5.8 Utilization of Urban Water Supply Systems of Central Highlands in 2016

Province	Installed Capacity (m^3/day)	Utilized Capacity	
		(m^3/day)	%
Kon Tum	32,690	17,974	55
Gia Lai	46,477	36,330	78
Dak Lak	73,901	54,968	74
Dak Nong	18,700	9,500	51
Lam Dong	72,020	46,650	65
Total	243,788	165,422	68

Source: Urban water supply companies and provincial DOCs in Central Highlands

(3) Electrification

The electrification rate in the five provinces is 97%, ranging from 95% in Dak Lak Province to 99% in Kon Tum and Lam Dong. That is almost the same as the national average electrification rate of 98%. Comparing the data by districts in the following table, the five provinces still have a lower electrification rate. Of the 60 districts, 28 districts (47% of the total) are lower than the average electrification rate in their respective provinces. Electrification development becomes slow and costly mainly due to the mountainous topography, poor accessibility, and scattered population of the five provinces. The data regarding the present electrification of Central Highlands are tabulated as follows.

Table 3.5.9 Present Electrification of Central Highlands in 2016

Item	Kon Tum	Gia Lai	Dak Lak	Dak Nong
No. of Total Household	109,089	319,992	477,046	139,233
No. of Electrified H.H	108,450	315,835	452,387	133,642
Provincial Electrification (%)				
Average	99	99	95	96
Range by District (Lowest - Highest)	84 - 100	97 - 100	85.7 - 99.6	81.4 - 98.8
No. of districts less than provincial electrification rate (%)	2 (20%)	11 (73%)	6 (40%)	3 (38%)
Total No. of District	10	15	15	8

Item	Lam Dong	5 Provinces	Viet Nam
No. of Total Household	331,700	1,377,060	24,760,000
No. of Electrified H.H	329,569	1,339,883	24,373,000
Provincial Electrification (%)			
Average	99	97	98
Range by District (Lowest - Highest)	97.4 - 100	81.4 - 100	54 - 100
No. of district less than provincial electrification rate (%)	6 (50%)	28 (47%)	-
Total No. of District	12	60	-

Note: "-" Not Available
Source: provincial DOITs in Central Highlands

3.5.3 Operation and Maintenance of Infrastructure

(1) Irrigation

The Irrigation Management Company (IMC) is the organization managing the provincial irrigation systems in Central Highlands. On the other hand, the district irrigation systems are managed by the District Peoples Committee (DPC) except in Gia Lai Province where the systems are managed not only by the DPC but also by enterprises and cooperatives. The data is summarized as follows. In Gia Lai province, there are 239 systems managed by cooperatives and 86 systems managed by state enterprises respectively. The JICA Study team classified the enterprises financed by PPC is similar as IMC.

Table 3.5.10 PPC Decisions on O&M of Irrigation Systems in Central Highlands

Item	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
PPC decision No					
	1008/QĐ-UBND (Decentralization) Dated 06/09/2016	60/2007/QĐ-UBND (Decentralization) Dated 13/12/2013	21/2016/QĐ-UBND (Decentralization) (Revision of decision 38/2014/QĐ-UBND) Dated 18/05/2016	2090/ QĐ-UBND (Decentralization) Dated 28/12/2011	618/QĐ-UBND (Decentralization) Dated 30/03/2017
O&M Organizations and Targets					
IMC	• Height of Dam: H_d ≥10 m • Capacity of the reservoir: W≥1x10^6 m^3 • Spillways height: H≥4 m	• Height of Dam: H_d ≥10 m • Capacity of the reservoir: W≥1x10^6 m^3 • Spillways height: H≥4 m • Service area ≥100ha	• Height of Dam: H_d ≥12 m • Capacity of the reservoir: W≥0.5x10^6 m^3 • Spillways height: H≥4 m • Service area ≥100 ha	Systems are assigned	• Height of Dam: H_d ≥15 m • Capacity of the reservoir: W≥3x10^6 m^3 • Spillways height: H≥10 m • Service area ≥200 ha • Major canal and structures
DPC	• Capacity of the reservoir: W<1x10^6 m^3 • Spillways height: H<4 m	• Capacity of the reservoir: W<1x10^6 m^3 • Service area <100 ha	• Capacity of the reservoir: W<0.5x10^6 m^3 • Service area <100 ha	Systems are assigned	• Height of Dam: H_d ≥15 m • Capacity of the reservoir: W<3x10^6 m^3 • Spillways height: H<10 m • Service area <200 ha
Others	Systems built by private, state companies	1. Cooperatives & local enterprises 2. State enterprises	1. Coffee and rubber companies 2. Government Administration Units 3. Cooperatives	Systems built by private, state companies	Systems built by private, state companies

Note: Numbers for Kon Tum, Gia Lai and Dak Nong are updated and slightly different from the figures in decisions
Source: Prepared by JICA Survey Team based on the Decisions mentioned in the table and data provided by DARDs.

The provincial systems are operated by IMC with 0.5 to 7.7 persons on average per system as shown in the table below. The O&M coverage area is 110 ha to 242 ha per person. The annual O&M cost varies per province, VND 60 million/system in Lam Dong to VND 854 million/system in Gia Lai. The annual rehabilitation expenditure of the provincial system ranges from none to VND 183 million. The total of O&M and rehabilitation cost per hectare ranges from VND 1.0 to VND 1.9 million.

The data on district irrigation systems were collected in Gia Lai, Dak Nong and Lam Dong, but Kon Tum and Dak Lak was not able to provide. The district irrigation systems are maintained by 0.4 person to 1.0 person on average per system in the three provinces, or 63 ha to 154 ha is managed by one person. The annual O&M cost varies from VND 35 million/system in Dak Nong to VND 65 million/system in Gia Lai. The annual rehabilitation expenditure of district irrigation systems is from none in Dak Nong to VND 135 million/system in Lam Dong. The total of O&M and rehabilitation cost per hectare including staff salary ranges from VND 0.5/ha to 2.0 million/ha as follows:

Table 3.5.11 O&M Activities of Irrigation in Central Highlands in 2016

Item	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
Provincial System					
Number of Staff Assigned (person/system/year)	0.5	7.7	1.3	0.9	3.1
Number of Staff Assigned (ha/person/year)	165	110.4	119.5	241.9	143.6
O&M Cost (VND million/system/year)	111.0	854.2	86.7	121.3	59.6
Rehabilitation Cost (VND million/system/year)	0.0	168.4	63.0	232.4	134.7
O&M + Rehabilitation Cost (VND million/ha/year)	1.3	1.2	1.0	1.6	1.9
District System					
Number of Staff Assigned (person/system/year)	-	1.0	-	0.6	0.4
Number of Staff Assigned (ha/person/year)	-	98.3	-	63.0	154.5
O&M Cost (VND million/system/year)	38.1	64.5	-	35.3	59.6

Item	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
Rehabilitation Cost (VND million/system/year)	-	20.1	-	0.0	134.7
O&M + Rehabilitation Cost (VND million/ha/year)	-	0.8	-	0.6	1.9

Note: '-' Not Provided, Sources: Provincial IMCs, CMCs, DARDs

In the five provinces, 105 water user groups (WUGs) were organized with a coverage of 5,452 ha as shown in the table below. The percentage of the service area covered by the WUGs of the total service area of both provincial and district irrigation systems are rather small, having a percentage of less than 10%. Among of the provinces, Kon Tum has the highest at 5.7% and Dak Lak has the smallest at 0.1%. The average of the five provinces are 2.8%.

The figures in the table below mainly shows the number of WUGs covering the district irrigation systems. Only in Dak Nong province, 12 WUGs are organized covering the turnout's area. Data on WUGs organized in the systems managed by the IMC in other provinces are not provided due to no monitoring by DARD.

Since the irrigation facilities are scattered in the rural area, it is difficult to be managed by the IMCs and the government agencies because of the limited number of staff in the five provinces. Therefore, the participatory irrigation management (PIM) will be indispensable for effective O&M of irrigation systems in Central Highlands.

Table 3.5.12 Status of WUGs of Irrigation Systems in Central Highlands

Item	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong	5 provinces
1. Provincial Systems						
No. of Systems	175	31	308	196	74	784
Service Area (ha)	13,834	31,497	30,644	32,052	20,907	128,934
2. District Systems						
No. of Systems	317	70	322	34	322	1,065
Service Area (ha)	2,820	25,069	16,488	1,374	19,016	64,767
3. WUGs						
No. of WUGs						
- Provincial	-	-	-	12	-	12
- District	60	26	1	1	5	93
- Total No. of WUGs	60	26	1	13	5	105
Area covered (ha)	955	1,813	56	1,718	910	5,452
Ratio of Service Area covered by WUGs (%)	5.7	3.2	0.1	5.1	2.3	2.8

Note: '-' Not Provided

Source: Survey result of Center for Participatory Irrigation Management

(2) Road

Based on the data collected from the Department of Transportation (DOTs) in the five provinces, the road O&M cost for national roads ranges from VND 25 million/km/year in Dak Nong to VND 50 million/km/year in Gia Lai. On the other hand, the O&M cost for provincial roads are VND 4-35 million/km/year. The frequency of maintenance for national roads is monthly except for Dak Lak where other roads are maintained less frequently than the other four provinces.

The O&M cost for district roads is limited to VND 2-6 million/km/year, by about once to four times of O&M activities annually. In comparison of the minimum requirement of the BPM pavement applied for most of the district roads at VND 15–20 million/year, the present O&M expenditure at around VND 4 million/km/year is limited to less than 30% of the requirement. The O&M status of roads in the five provinces in 2016 is as follows:

Table 3.5.13 O&M Status of Roads of Central Highlands in 2016

Province	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong	Viet Nam
1. O&M Cost (VND million/km/year)						
National	27.4	50.0	37.3	25.0	43.0	25.0
Provincial	31.1	25.0	3.5	15.0	34.7	40.0
District	4.0	6.4	2.0	5.0	5.0	5.0
2. Frequency (times/year)						
National	12	12	4	12	12	12
Provincial	4	12	4	12	6	12
District	4	4	1	4	2	4

Source: DOTs in Central Highlands

(3) Water Supply

The 120 urban water supply systems with necessary treatment functions in the five provinces are maintained by provincial water supply companies, water supply centers under the DARD, or the O&M organizations under the DPCs. The urban water supply systems are maintained by 6 to 15 staffs per system. Most of the urban systems generate net income from the water fee collected and are utilized for rehabilitation expenditure and extension of the distribution lines. The provincial water supply companies are the most capable O&M organizations in their respective provinces, with skilled technical and O&M staff on hand. The O&M status of urban water supply in the five provinces in 2016 are summarized as followings.

Table 3.5.14 O&M Status of Urban Water Supply of Central Highlands in 2016

Item	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong	Total
1. Total Urban System	9	18	11	6	16	60
No. of staff assigned (person)	63	107	163	45	91	469
Annual revenue (VND millions/year)	29,917	60,467	88,279	24,411	85,817	288,891
O&M cost (VND millions/year)	8,943	30,899	20,415	14,765	48,686	123,708
2. Per System						
Number of staff assigned (person/system)	7	6	15	8	6	
Annual revenue (VND millions/system/year)	3,324	3,359	8,025	4,069	5,364	
O&M cost (VND millions/system/year)	994	1,717	1,856	2,461	3,043	

Source: Urban Water supply companies and provincial DOCs in Central Highlands

3.6 Natural Disaster

3.6.1 Trend of Natural Disaster

In Central Highlands, drought is the most severe natural disaster alongside with the damage caused by flooding. The cropped area damaged by drought and other natural disaster is as follows:

Table 3.6.1 Cropped area damaged by Disaster in Central Highlands (2010-2016)

(Unit: ha)

Province	2010	2011	2012	2013	2014	2015	2016
Drought							
Kon Tum	3,157	2,501	-	-	-	253	4,194
Gia Lai	-	17,409	-	-	-	-	30,556
Dak Lak	22,317	13,672	35,864	37,142	23,363	81,654	95,757
Dak Nong	-	-	-	-	-	-	18,525
Lam Dong	541	998	1,399	1,810	1,889	1,614	32,174
Central Highland	26,015	34,580	37,263	38,952	25,252	83,521	181,206
Flood and other natural disaster							
Kon Tum	146	1,168	233	2,240	198	236	225
Gia Lai	1,081	1,254	-	-	-	-	11,139
Dak Lak	30,869	4,371	15,033	8,298	6,773	26	11,771
Dak Nong	716	44	99	19	537	-	-
Lam Dong	820	-	-	-	-	-	2,272
Central Highland	33,632	6,837	15,365	10,557	7,507	262	25,407

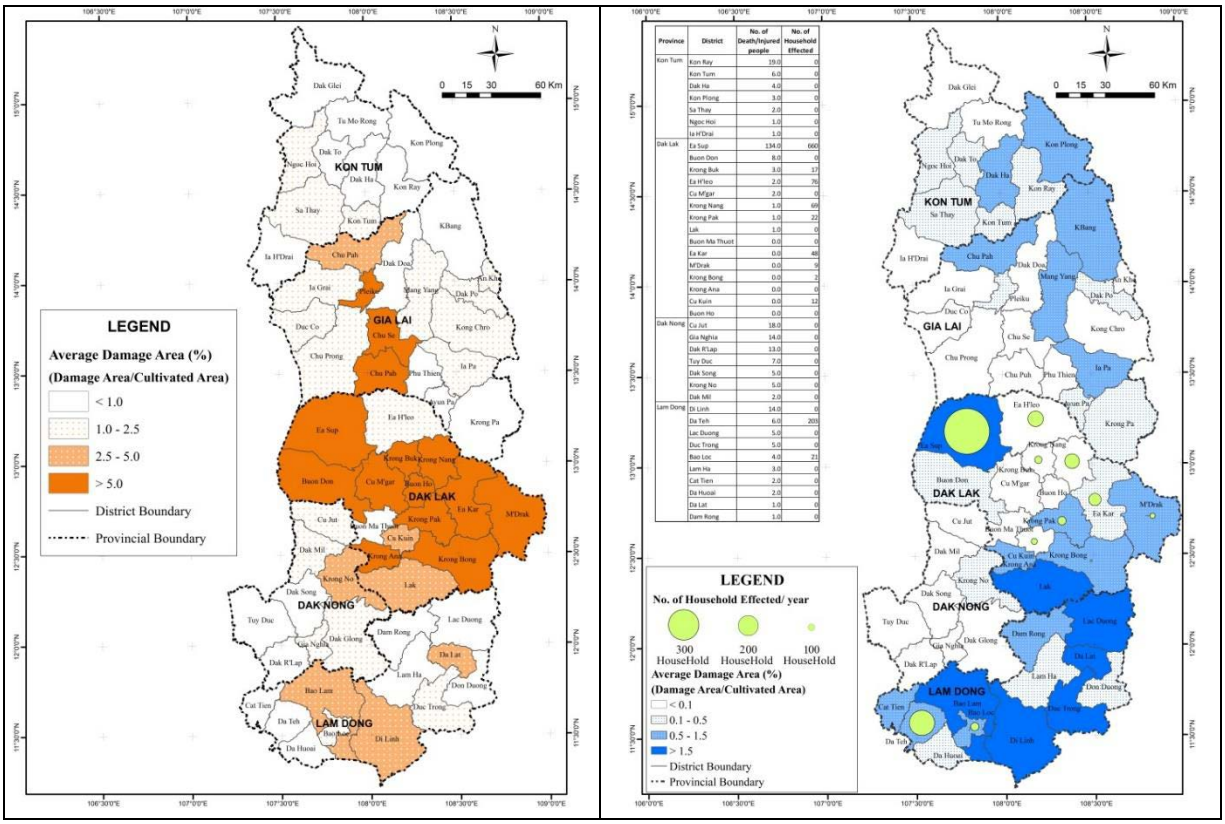
Note: "-" no data available, Source: Statistical Book of Provinces

The drought affected areas have become larger year after year in Central Highlands. On the other hand, the affected area by other disasters shows an insignificant trend. Among the five provinces in the region, Dak Lak is the most vulnerable province affected by drought as well as other natural disasters, where the damaged area by drought was around 13,000 ha to 95,000 ha. More than half of the total damaged area was made in the last seven years. Although Lam Dong Province suffered droughts every year since 2010, the damaged areas were less than 2,000 ha except in 2016. Kon Tum Province was affected correspondingly by flood and other disasters for seven years, but the damaged areas were not enlarged. On the other hand, drought infrequently occurs in Gia Lai and Dak Nong provinces and their damaged areas in one drought event only reached to around 17,000 ha.

In Dak Lak Province, floods affected more than 1,600 ha of the cropped area, of which 920 ha were completely damaged. In addition, landslides occurred at several places due to heavy rain during rainy season in the 2016 to 2017. The total losses by the disasters in the province were estimated at VND 75 billion[10].

[10] http://en.nhandan.com.vn/society/item/5240602-flooding-causes-damage-in-central-region-and-central-highlands.html

The annual average of drought and flood damages during 2010 to 2016 are mapped in Figure 3.6.1 and tabulated in Table 3.6.2:



Province	District	No. of Death/Injured people	No. of Household Effected
Kon Tum	Kon Ray	19.0	0
	Kon Tum	6.0	0
	Dak Ha	4.0	0
	Kon Plong	3.0	0
	Sa Thay	2.0	0
	Ngoc Hoi	1.0	0
	Ia H'Drai	1.0	0
Dak Lak	Ea Sup	134.0	660
	Buon Don	8.0	0
	Krong Buk	3.0	17
	Ea H'leo	2.0	76
	Cu M'gar	2.0	0
	Krong Nang	1.0	69
	Krong Pak	1.0	22
	Lak	1.0	0
	Buon Ma Thuot	0.0	0
	Ea Kar	0.0	46
	M'Drak	0.0	9
	Krong Bong	0.0	2
	Krong Ana	0.0	0
	Cu Kuin	0.0	12
	Buon Ho	0.0	0
Dak Nong	Cu Jut	18.0	0
	Gia Nghia	14.0	0
	Dak R'Lap	13.0	0
	Tuy Duc	7.0	0
	Dak Song	5.0	0
	Krong No	5.0	0
	Dak Mil	2.0	0
Lam Dong	Di Linh	14.0	0
	Da Teh	6.0	203
	Lac Duong	5.0	0
	Duc Trong	5.0	0
	Bao Loc	4.0	23
	Lam Ha	3.0	0
	Cat Tien	2.0	0
	Da Huoai	2.0	0
	Da Lat	1.0	0
	Dam Rong	1.0	0

Source: JICA Study Team

Figure 3.6.1 Disaster Map in Central Highlands (Average of 2010-2016) (Left: Drought; Right: Flood)

3.6.2 Impact by Drought in 2015/16

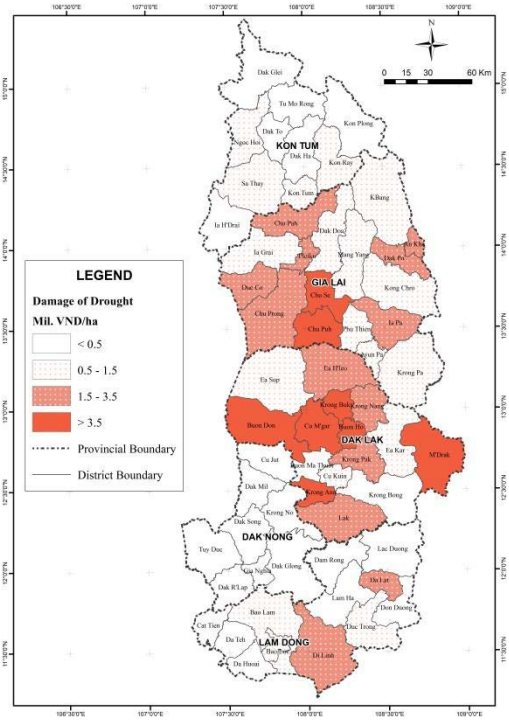
Table 3.6.2 Cropped area damaged by Drought 2015/16 in Central Highlands

Crop Type	Unit	Central Highlands	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
Perennial Crop	ha	140,630	2,533	12,748	76,755	18,126	30,469
	%/1	13.7	2.7	5.8	25.8	9.6	13.4
Annual Crop	ha	38,575	1,661	17,808	17,867	399	840
	%	4.4	2.2	7.4	5.6	0.4	0.7
Total	ha	179,206	4,194	30,556	94,622	18,525	31,309
	%	9.4	2.5	6.7	15.3	6.2	8.8

/1: Percentage of cropped area damaged of the total Cropped area.
Note: Since the total areas include seedling and nursery areas, the values of Dak Lak and Lam Dong provinces are different from Table 3.6.1.
Source: Statistical Book of Provinces

The drought damage map of Central Highlands in 2015/2016 was prepared by showing the damaged value per hectare. The prolonged drought started from the summer of 2014 to spring 2016 and damaged thousands of hectares of the cropped areas in Central Highlands. The impact on the perennial crops was more serious than that on annual crops except in Gia Lai Province. The damaged area in the region was 179,206 ha (9.4%) of the total cropped area. Dak Lak Province had the most damaged area comprising 76,755 ha of perennial crops and 17,867 ha of annual crops. In Dak Nong and Lam Dong provinces, while the damaged area of perennial crops reached to more than 18,000 ha and 30,000 ha, respectively, those of annual crops were less than 1,000 ha in both provinces. In Kon Tum Province, the limited area of less than 3% of the total cropped area was affected. The damaged areas of perennial and annual crops are summarized in Table 3.6.2.

The damaged value of the drought evaluated at VND per hectare is shown in the map shown in Figure 3.6.2.



Source: JICA Study Team

Figure 3.6.2 Disaster Map of Drought in Central Highlands in 2015/16

3.6.3 Disaster Organization and Activities

The steering committees for natural disaster prevention and control were organized at provincial and district levels in Central Highlands. Under the PPC chairpersons, the members are appointed from DARD, DONRE, DOT DOC, DOH, DOLISA, DPI, DOF, chairpersons of mass organizations, etc. Similarly, at the district level, under the district chairpersons, the heads of divisions and chairpersons of mass organizations are appointed. They are responsible for preparation and implementation of disaster prevention and recovery works at the provincial and district level.

The regular and specific activities of the committees vary between the five provinces depending on available provincial budget (VND 4.0 to 14.2 billion/year). After the 2015/2016 drought damages, the central government allocated budgets from VND 17.6 billion in Kon Tum to VND 57.0 billion in Dak Lak in 2016 depending on the damage brought about by drought. The provincial organizations pointed out a shortage of budget, degraded irrigation facilities, lack of equipment for early warning systems for disasters, etc. Limited awareness raising activities for the local people, water saving works, strengthening monitoring and assessment of meteorological and hydrological data and groundwater are recognized activities in the provincial level. These activities will not require a large budget in comparison to the budget needed for improvement and construction of irrigation facilities. The data on organizations and recent activities of steering committees for natural disaster prevention and control highlands are shown in Table 3.6.3.

Table 3.6.3 Organization and Recent Activities of Steering Committees for Natural Disaster Prevention and Control at Central Highlands (as of 2017)

	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
Provincial members	• PPC Chairperson • PPC Vice Chairperson • DARD Director • Vice Director of relevant departments (DONRE, DPI, DOF, DOT, DOC, DOH, DOLISA, etc.) • Chairperson of mass organization (Women Union, Red Cross Association, Youth Union, etc.)				
District members	• DPC Chairperson • DPC Vice Chairperson • Head of relevant divisions (Agricultural, Natural resources and environment, etc.) • Chairperson of mass organizations (Women Union, Red Cross Association, Youth Union, etc.)				
Activities in General	• Plan and implement the disaster prevention and recovery programs (drought, floods, etc.). • Raise community and staff awareness for disaster management and prevention. • Formulate evacuation and stable livelihood plan for people in flood-prone area.				
Specific Activities	• Distribute rescue equipment to flood area. • Organize emergency drill.	• Provide water and tanks in the drought season. • Encourage farmers for crop diversification	• Canal dredging, pond construction, provide fee for pumping water, repair irrigation and water supply works. • Inform the flood discharge plan to local people	• Canal dredging, pond construction, provide fee for pumping water. • Introduce water-saving facility. • Give warnings in dry season to store water.	• Reservoir and canal dredging, provide fee for pumping water, repair irrigation and water supply systems. • Distribute rescue equipment to flood area. • Construction ponds and small reservoirs.
Provincial budget (Regular budget)	• VND 4.0 billion	• VND 4.5 billion	• VND 5.0 billion	• VND 4.0 billion	• VND 5.0 billion • 2016: VND 9.2 billion (contingency budget).
Central budget (recover drought damages 2015-16)	• Year 2016, VND 17.6 billion • Year 2017, VND 19.8 billion	• Year 2016, VND 17.9 billion	• Year 2016, VND 57.0 billion	• Year 2016, VND 18.6 billion	• 2016, VND 53.2 billion • 2017, VND 18.1 billion • VND 0.138 billion by private enterprises.
Issues	• Limited budget for preparation of rescue activities. • Irrigation systems degraded. • Lack of equipment for early warning system.	• Irrigation systems degraded. • Lack of drought prevention works.	• Limited budget for upgrading and repairing irrigation systems.	• Shortage of reservoirs capacity for irrigation demand. • Limited budget for construction of irrigation systems.	• Limited budget for construction and rehabilitation of irrigation systems.

Source: Steering Committees for Natural Disaster Prevention and Control of Five Provinces

3.7 Plans and Programs on Agriculture Development and Water Resources Management

3.7.1 Accomplishments during 2011-2015

(1) SEDP 2011-2015

The following table shows the targets and accomplishments of the Social Economic Development Plan (SEDP) between 2011 and 2015. Although Dak Lak has the biggest GPDP among the five provinces in the region (VND 66,981 billion as of 2015), its GPDP growth (8.0%) is far below the target (14.0% – 15.0%) during the said period. A similar situation is also observed in the achievements of Dak Nong. Both provinces have low growth in the industrial and service sectors which holds them back from achieving the target set in the SEDP. This in turn, keeps them heavily dependent on the agriculture sector. The rest of the three provinces, on the other hand, show stable economic growth in all three sectors. Provincial revenues, however, did not match with their growth. Achievements in forest cover were far below their targets in all five provinces, among which Dak Lak and Dak Nong experienced huge losses. Targets and achievements are summarized in Table 3.7.1.

Table 3.7.1 Targets and Achievement in SEDP 2011-2015 of Central Highlands

Indicator	Unit	Kon Tum		Gia Lai		Dak Lak		Dak Nong		Lam Dong	
		Target	Achievement in 2011-2015	Target	Achievement in 2011-2015	Target	Achievement in 2011-2015	Target	Achievement in 2011-2015	Target	Achievement in 2011-2015
1. Economic Target											
1) GPDP Growth	%/year	15.0	13.2	12.8	12.8	14.0-15.0	8.0	15.5	7.5	15.0	14.1
- Agriculture	%/year	8.0	7.4	6.2	7.2	5.0-6.0	4.2	5.4	4.8	7.8	8.4
- Industry and construction	%/year	20.0	16.5	16.9	15.8	23.0-24.0	10.2	25.8	17.9	22.5	20.5
- Service	%/year	16.0	16.9	14.9	15.5	20.0-21.0	11.6	18.0	7.2	19.0	17.5
2) Per capita GRDP	VND mil/year	28.0	32.7	34.2	35.0	34.0-34.5	32.7	27.4	36.7	44.5	45.5
3) Economic structure by sector in 2015											
- Agriculture	%	35.0-36.0	30.2	33.0	36.2	32.0-33.0	45.4	33.6	49.6	36.8	36.0
- Industry and construction	%	27.0-28.0	23.1	36.7	33.6	25.0-26.0	15.6	40.1	26.7	26.8	28.0
- Service	%	35.0-36.0	39.1	30.3	30.2	41.0-42.0	35.3	26.3	23.7	35.2	36.0
4) Provincial revenue in 2015	VND bil.	7,778	2,050	4,900	3,050	24,274	18,057	1,883	6,690	29,800	25,170
5) Provincial expenditure in 2015	VND bil.	28,728	24,810	8,950	8,172	33,147	43,442	NA	25,195	NA	46,184
2. Social Target											
Average poor household rate	%/year	4-5 /_4	4.6	3.4	3.2	3.0	2.7	3.0	3.0 /_1	<2 /_2	<2 /_3
3. Environmental Target											
1) Forest cover	%	68.0	62.4	53.1	46.1	52.0	39.2	57.0	39.0	60.4	52.5
2) Rate of clean and sanitary water usage											
- In urban area	%	NA	NA	100	>99	90	72	90	90	90	65
- In rural area	%	90	85	90	85	85	86	90	85	85	86
3) Treated waste rate from hospital	%	-	57	-	-	75	75	-	-	-	80
4) Rate of gathered & selected solid waste	%	90	90	90	93	90	78	80	95	85-90	75

Note 1: /_1: 5.08% for ethnic minority /_2: <8% for ethnic minority /_3: <6% for ethnic minority
/_4: Average number of target households that escape from poverty was estimated as 5,012 households per year. Rate of poor household by 2010: 11.67%, NA: Not available
2: The poverty rate was calculated based on previous poverty measure: the ratio of the number of people or households whose income per capita fall below the poverty line among total surveyed population and households. It takes into consideration both food and minimum expense for non-food.
Source: Report on SEDP 2011 - 2015 of Central Highlands

(2) Infrastructure Development Plan 2011-2015

In accordance with the SEDP 2011-2015, each province has developed its own infrastructure development plan sector by sector, in which priority projects are nominated. All five provinces regarded their infrastructure development as tractions for economic growth. Kon Tum Province had an overall idea to exploit and utilize resources for further industrialization and modernization for high, stable and rapid economic growth. Gia Lai on the other hand, planned to develop their socio-economy rapidly and sustainably to improve growth quality and competitiveness in the economy, to construct modern and synchronous infrastructure, to improve physical living condition, and to become the center of the northern part of Central Highlands. Dak Lak intended to promote the provincial potential for better economic and labor structure, as well as to stay as the centre of economy, culture, and society of the region. Dak Nong aimed to concentrate on human resource development, construction of main infrastructure serving for socio-economic development, mineral industry, creation of economic space in mining and processing industry and high technology agriculture, and improvement living standards. Lam Dong tried to increase the share of the service sector in their economy, as well as developing infrastructure systems towards modernization, developing educational systems to meet requirements on human resources and improving physical living conditions.

The plans and achievements in the infrastructure development of the provinces are summarized in Table 3.7.1 and Table 3.7.2. (Ref. AT 3.7.1). Accomplishments of Gia Lai, Dak Nong and Lam Dong in their irrigation infrastructure are far less than their plans, both in system and area. In contrast, Kon Tum almost achieved their targets. Dak Lak has achieved (or almost achieved) their targets in all sectors, whereas their GPDP did not grow as expected. This gives an implication that the infrastructure development in the province did not contribute to the economic activities in an efficient and effective manner.

Table 3.7.2 Infrastructure Development Plans and Achievements in 2011-2015 of Central Highlands (Summary)

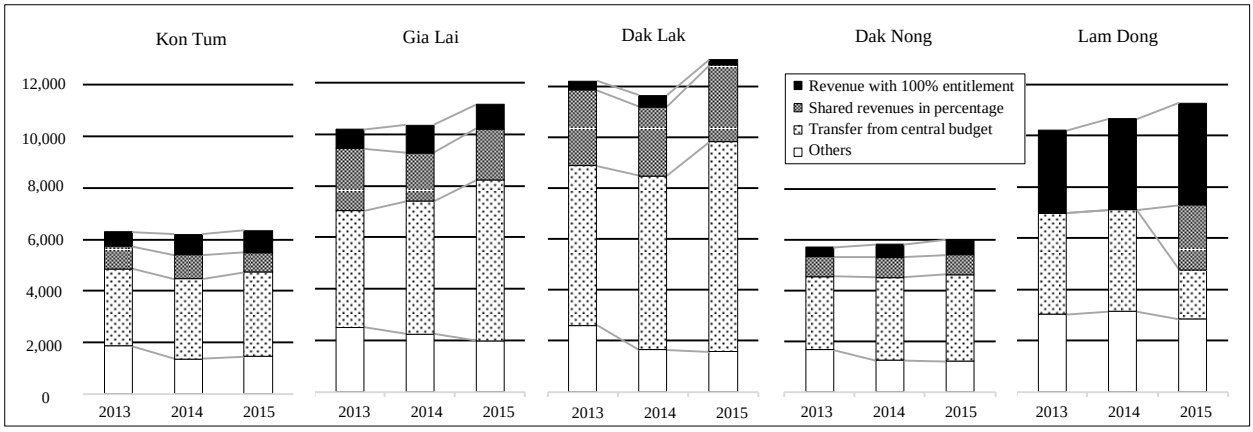
Item		Kon Tum		Gia Lai		Dak Lak	
		Plan in 2011-2015	**Achievements in 2011-2015**	**Plan in 2011-2016**	**Achievements in 2011-2016**	**Plan in 2011-2017**	**Achievements in 2011-2017**
Road	PR	Upgrade: 4 roads	Upgrade: 10 roads	N/A	Upgrade: 108.3 km	Upgrade concreted surface: 100%	Upgrade concreted surface: 96% (364km)
	DR	N/A	N/A	Upgrade & construct: 1,523 km, asphalt and cement concrete: 60%, pavement surface: 30%	Upgrade 230.3 km Construct: 313km	Upgrade concreted surface: 80%	Upgrade concreted surface: 81% (1,137km)
	Others	N/A	Communal road: 100%; villages with road accessing to center communes: 568/671	Rural roads with asphalt and cement concrete pavement: 40%	Upgrade 200km commune road, Upgrade & repair: 1,843 km rural road Construct 34 bridges (1.475,6m), 1.510 culverts	Concreted surface of commune road: 50%, 100% communes have bituminous road accessing to the center.	Concreted surface of commune road: 42% (1,352km), 99% communes have road accessing to the center.
Irrigation	System	Upgrade and construct: 69 reservoirs, 460 weirs, 8 pumping stations	Upgrade 523 irrigation works	Upgrade and construct: 242 reservoirs, 82 weirs, 15 pumping stations, 16 canals	Construct 19 irrigation works	Construct: 81 reservoirs, 6 dams, 19 pumping stations	Upgrade: 91 works New construct: 128 works, 554km
	Area	Total: 18,315 ha	Total: 16,742 ha	Total: 52,000 ha	Increase 8,000 ha	Total: 235,280 ha (75%)	Total: 224,169 ha (76%)
Water Supply		90% rural population	85% rural population	100% urban and 90% rural population	99% urban and 85% rural population	90% urban and 85% rural population	72% urban and 86% rural population
Electrification		N/A	98% village; 98% rural households	100% household	N/A	100% village; 99% ethnic household	95% (315) village; 97% (39,755) ethnic households
Industry		Invest 3 industrial zones (360 ha)	Upgrade 3 industrial zones; new invest 10 industrial clusters	N/A	Invest and upgrade 12 industrial zones	N/A	N/A

Item		Dak Nong		Lam Dong	
		Plan in 2011-2015	Achievements in 2011-2015	Plan in 2011-2016	Achievements in 2011-2016
Road	PR	100% asphalt-concreted	99% asphalt-concreted	Upgrade 3 PR. 721 to meet class IV	Upgrade 3 provincial road
	DR	100% asphalt concreted	80% asphalt-concreted	N/A	Newly construct 72 bridges on district and rural roads (1,200m)
	Others	100% commune road is asphalt concreted 100% village has 1-2km asphalt concreted road	Upgrade 245km road to village 100% village has 1-2km asphalt concreted road	30% surface of rural road is bituminous and cement concrete;	Newly construct: 705 km of rural road; upgrading and repairing: 1,065km rural road;
Irrigation	System	Upgrade and construct 181 reservoirs, 44 weirs, 5 pumping stations	Upgrade 91 works, construct 219 irrigation works	Upgrade & construct: 503 reservoirs, 76 weirs, 30 pumping stations; 18 flood prevention works	Upgrade & construct: 217 reservoirs, 86 weirs, 19 pumping stations
	Area	Irrigated area: 49.180 ha	Rate of irrigated area: 68%	Irrigated area: 133,942 ha	Irrigated area: 56,779 ha
Water Supply		90% population, 100% district center	90% urban, 99% rural population	90% urban, 85% rural population	65% urban, 86% rural population
Electrification		100% hamlet; 95% ethnic household	99% hamlet; 95% household	N/A	N/A
Industry		Construct 7 industrial zones	Completion 7 industrial zones (484.6 ha)	Construct 2 industrial zones	N/A

Note: "PR" stands for provincial road, and "DR" for district road., Source: SEDPs of Central Highlands

(3) Local Revenues and Expenditures 2013-2015

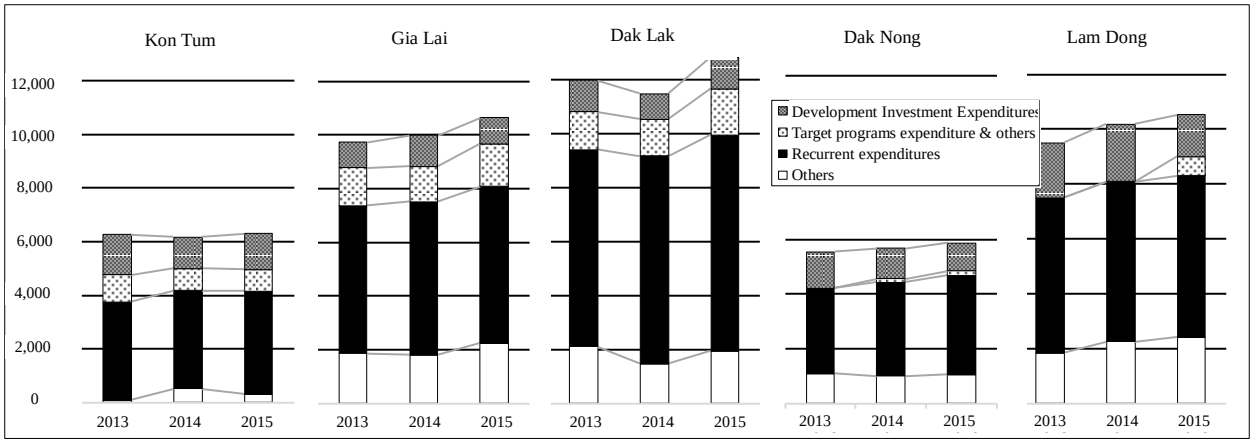
Figure 3.7.1 shows the total local revenues in the last three years from 2013 to 2015. Local revenues of each province from 2013 to 2015 shows that they heavily depended on transfers from the central budget, particularly Gia Lai and Dak Lak, in which they count on the shared revenues in percentage as well. Among them, Lam Dong Province has more revenues of its own, which implies Lam Dong has more stable collection (Ref. AT 3.7.2).



Note:1/ "Revenues with 100% entitlement" includes land & house tax, natural resource tax (except those from oil and gas), license tax, land use right transfer tax, agricultural land use tax, the land use levy, land rent. 2/ "Share revenues in percentage" refers those shared between central budget and local budget under the provisions in Clause 2, Article 30 of the State Budget Law. It includes VAT and enterprise income tax. 3/ "Transfers from central budget" is comprised of "balancing transfers" and "target transfers".
Source: Department of Finance of the five provinces

Figure 3.7.1 Local Revenues in the Five Provinces (2013-2015)

Looking at the development expenditure, Kon Tum had the biggest share of development investment and target programs in their total local expenditures. (40.0% in 2013, 32.2% in 2014 and 34.1% in 2015). Gia Lai and Lam Dong did not achieve the targets in their infrastructure development plan but showed steady growth in their GPDP as they spent 55% to 60% of their local expenditures for recurrent expenditures. Dak Lak, where most of their targets of infrastructure development plan from 2011 to 2015 were attained, had the lowest amount and ratio of development investment expenditures in the region. This can be one of the causes for their low economic growth in five years (Ref. AT 3.7.3).



Note:1/ "Development investment expenditure" includes investment in construction of socioeconomic infrastructure projects managed by the localities, investment in & support for enterprises, and other expenditures. 2/ "Target programs expenditure" is covered by the transferred budget from the central government for specific purposes such as supporting new policies, implementing national programs/projects in the local areas, socioeconomic programs/projects, and dealing with emergency difficulties.

Figure 3.7.2 Local Expenditure in the Five Provinces (2013-2015)

3.7.2 Plans and Programs for 2016-2020

(1) SEDP 2016 - 2020 and Accomplishments in 2016

The implementation of the SEDP from 2016 to 2020 shows positive signs in 2016 except for a few issues. Average GPDP growth has shown favourable results overall in all five provinces, whereas the industry and construction sector of Kon Tum (10.8% in 2016 against the target up to 2020: 16.3%) and Dak Nong (9.7% against 21.2%) require boosting tractions to tackle the gap. For Dak Lak and Dak Nong, growth in the industry and construction sector will play a key role to reduce their present dependency in the agriculture sector in their economic structures (Dak Lak: 44.8% in 2016 against the target up to 2020: 38.6%, Dak Nong: 50.6% against the target: 43.6%). The target rate of clean and sanitary water usage in rural area in Kon Tum is 100% and still is a big gap from their current level (85.3%).

Table 3.7.3 Targets of SEDP 2016-2020 and Status in 2016 of Central Highlands

Indicator	Unit	Kon Tum		Gia Lai		Dak Lak		Dak Nong		Lam Dong	
		Target	Status 2016	Target	Status 2016	Target	Status 2016	Target	Status 2016	Target	Status 2016
1. Economic Target											
1) Average GPDP Growth	%	9.0	8.1	7.5	7.5	8.7	7.0	>9.0	7.5	8.0-9.0	7.9
- Agriculture	%	6.0	4.2	5.6	5.6	4.5	4.3	5.3	5.8	6.0-6.5	5.2
- Industry and construction	%	16.3	10.8	8.5	8.5	10.8	11.0	21.2	9.7	10.0-10.5	7.1
- Service	%	6.5	8.5	8.8	8.8	11.4	9.0	7.2	7.7	8.5-9.0	11.1
2) GPDP per capita by constant price 2010	VND mil.	52.5	32.2	32.3	36.6	60.4	35.6	>54.0	38.9	70.0-73.0	49.1
3) Economic structure by sector in 2020											
- Agriculture	%	26.0-27.0	29.2	37.3	39.4	38.6	44.8	43.6	50.6	46.0-46.5	48.2
- Industry and construction	%	31.0-32.0	24.0	28.9	27.4	18.0	14.5	22.1	13.7	19.5-20.0	17.4
- Service	%	35.0-36.0	39.3	33.9	33.2	39.3	38.7	28.7	30.5	33.4-34.0	34.4
4) Provincial revenue	VND bil.	3,500.0	1,953.7	4,650.0	3,541.8	5,000.0	4,146.0	10,101.0	1,610.0	10-12% / year	10,942.5
5) Provincial expenditure	VND bil.	NA	5,060.2	18,389.0	8,930.0	48,585.0	18,157.0	31,289.0	5,433.0	NA	14,839.4
2. Social Target											
Average poor household rate	%	3.0-4.0	3.5	1.8	2.8	2.5-3.0	2.9	2.0 /_1	2.0 /_2	1.5-2.0 /_3	1.5
3. Environmental Target											
1) Forest cover	%	63.8	62.7	46.6	46.2	40.1	39.4	42.0	39.1	55.0	53.5
2) Rate of clean and sanitary water usage											
In urban area	%	NA	NA	>99.0	99.0	90.0	75.0	100.0	92.0	70.0	67.0
In rural area	%	100.0	85.3	95.0	89.0	95.0	87.0	90.0	84.0	90.0	NA
3) Rate of gathered and selected solid waste	%	95.0	91.0	95.0	93.0	90.3	79.5	100.0	98.0	95.0	85.0

Note 1: /_1: 5% for ethnic minority /_2: 5% for ethnic minority /_3: 2-3% for ethnic minority NA: Not available

2: the GOVN introduced norms for multidimensional poverty measuring by the Prime Minister's Decision 59/2015/QD-TTg (dated 19 Nov 2015) to apply during 2016 and 2020. However, the average poor household rate in 2016 seems to be still calculated based on the previous poverty measuring.

Source: Report on SEDP 2016 - 2020 of Central Highlands

(2) Infrastructure Development Plans 2016-2020

As per infrastructure development, Kon Tum is pushing industrialization, modernization, and ensuring a rapid, high and stable economic growth to enhance environmental protection, and lastly adaptation to climate change actively. In Gia Lai, they formulated strategies on economic development for border gate regions, implementing growth model renovation, and economic structure shifts to focus more on industry-trade-service sectors, as well as giving priority to industrial development serving for agricultural production. Dak Lak tries to develop an economy towards green growth up to 2020, and regard Buon Ma Thuot City as the urban center of the entire region. Dak Nong tries to develop the agricultural sector towards high quality merchandise, by applying advanced techniques for high and stable effectiveness. They improve living standards for people in combination with poverty reduction. In Lam Dong, they maintain growth speed and movement of reasonable economic structure and continue stable and rapid development (Ref. AT 3.7.4). The summarized plans are show as follows.

Table 3.7.4 Infrastructure Development Plans 2016-2020 of Central Highlands (Summary)

Item		Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
Road	PR	• Upgrade and develop new PRs for 312 km	• Upgrade two (2) PRs (No. 12, No. 7) for 930km	• Develop 100% of PRs by bituminous/concrete • Upgrade: five (5) PRs (159km). • Expand the existing PRs for 359 km	• Increase the rate of PRs with two (2) lanes up to 59%	• Upgrade nine (9) PRs (five (5) new roads)
	DR	• New construction of DR for 148 km	• Construction of DR for 1,670km	• Develop DRs with bituminous/concrete surface for 2,020 km	• Develop DRs with asphalt concrete surface for 100%	• Develop DRs with bituminous/ concrete surface (100%)
	Others	• Maintain and upgrade rural road with surface structure: over 60%	• Upgrade 6,732 km. • Rural roads with asphalt and concrete pavement: 60%	• Bituminous surface commune road: 900 km	• Improve/New commune roads:100%	• Improve/New commune roads:100%
Irrigation	System	• Improve/New: - Reservoirs: 69 - Weirs: 460 - Pumping stations: 8	• Improve/New: - Reservoirs: 242 - Wiers:82 - Pumping stations: 15 - Canals: 16	• Improve/New: - Reservoirs: 165 - Dams: 7 - Pumping stations: 27 - Canal: 23	• Improve/New: - Reservoirs: 150 - Weirs: 10 - Pumping stations: 4	• Improve/New: - Reservoirs: 503 - Weirs: 76 - Pumping stations: 30
	Area	• 54,433 ha	• 81,560 ha	• 235.280 ha	• 101,082 ha	• 131,785 ha
	Others	• Focus district: Ia H'Drai /_1	• Combine water supply for aquaculture and environmental protection	-	• Priority reservoirs: Gia Nghia Town, Kien Duc Town, Dak Rlap	• Priority irrigation works: Dạ Si, Dong Thanh, Ka Zam
Water Supply		• Coverage: 100% rural population	• Coverage: 100% urban and 95% rural population	• Coverage: 90% urban and 95% rural population	• Coverage: 100% urban and 90% rural population	• Coverage: 99% rural, 90% urban population

Item	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
Electrification	• Distribute: 100% hamlet	• Distribute: 100% hamlet	• Distribute: 100% hamlet	• Distribute: 100% hamlet	• Distribute: 100% hamlet
	• Distribute: 99% household	• Distribute: 100% household	• Distribute: 100% household	• Distribute: 99% household	• Distribute: 99% household
Industry	• Industrial parks and Bo Y border-gate economic zone	• Improve Tra Da Industrial Zone and new invest to industrial cluster	• Widen existing industrial park • New investment: 7 industrial parks (551.4 ha)	• New investment: Tam Thang, Nhan Co, Dak Ha, Thuan An, Quang Tam, Krong No, Dak Song industry parks	• Expand industrial parks: Loc Son and Phu Hoi
Environment/ Disaster prevention	• Drainage canal network at Dak Ha commune • Banks' protect: Dak To Kan river	• Banks' protect: Hoi Phu stream and Ayun river	• Banks;' protect: right side of Krong Kmar Stream, Krong mar town • Improve efficiency of water use for the drought affected provinces	• Banks' protect: Buon Knha village, Dak Wil commune • Upgrading irrigation works for drought prevention	• Protect watershed forest, dredging internal streams

Note: /_1: Ia H'Drai district was established in 2015 (Resolution No. 890/NQ-UBTVQH13 dated March 11th, 2015), Source: Provincial SEDPs in 2016-2020

(3) Mid-term Investment Projects 2016-2020

Table 3.7.5 shows the mid-term investment projects during 2016 and 2020, focusing on irrigation, water supply, flood prevention and other infrastructures. The road sector has the most number of projects and investment amount throughout all five provinces. The number Kon Tum's projects for industry sector accounts for the second biggest share to its road sector. Other provinces concentrate the of their resources to either irrigation, water supply or flood prevention. Kon Tum, Gia Lai and Dak Lak all have a high average investment amount per project (VND 158.6 billion, VND 104.8 billion and VND 116.6 billion, respectively). Number of projects per district and average investment amount per district are, however, more in Dak Nong and Lam Dong (20.4 projects and 34.4 projects per district, VND 1,459.8 billion and VND 1,317.1 billion, respectively) (Ref. AT 3.7.5).

Table 3.7.5 Mid-term Investment Projects (2016-2020) in Central Highlands

Items	Kon Tum			Gia Lai			Dak Lak		
	No.	Amount (VND billi.)	(%)	No.	Amount (VND billi.)	%	No.	Amount (VND billi.)	(%)
1. Amount of Project per Sector									
Irrigation	3	222.2	3.0	3	370.2	4.8	15	1,054.6	7.6
Water Supply	3	423.1	5.8	6	473.2	6.2	5	406.3	2.9
Flood	3	1,197.7	16.4	2	689.1	9.0	3	175.0	1.3
Road	16	1,903.2	26.1	24	1849.9	24.2	37	3,255.9	23.5
Industry	6	1,718.3	23.6	4	245.1	3.2	2	140.0	1.0
Electricity	0	0.0	0.0	0	0.0	0.0	4	925.0	6.7
Other sectors	15	1,831.0	25.1	34	4026.0	52.6	53	7,923.0	57.1
Total	46	7,295.5	100	73	7,653.5	100	119	13,879.8	100
2. Investment Scale									
No. of target/total districts (No.)	10/10			17/17			15/15		
No. of Projects per district (No.)	4.6			4.3			7.9		
Average per project (VND bill.)	158.6			104.8			116.6		
Average per district (VND bill)	729.6			450.2			925.3		
Items	**Dak Nong**			**Lam Dong**			**Total**		
	No.	**Amount (VND billi.)**	**(%)**	**No.**	**Amount (VND billi.)**	**%**	**No.**	**Amount (VND billi.)**	**(%)**
1. Amount of Project per Sector									
Irrigation	17	1,516.6	13.0	38	1,372.5	8.7	76	4,536.1	8.1
Water Supply	7	261.8	2.2	5	647.9	4.1	26	2,212.3	3.9
Flood	4	565.9	4.8	0	0.0	0.0	12	2,627.7	4.7
Road	62	4,063.2	34.8	126	6,180.2	39.1	265	17,252.4	30.6
Industry	2	1,693.3	14.5	0	0.0	0.0	14	3,796.7	6.7
Electricity	1	36.7	0.3	0	0.0	0.0	5	961.7	1.7
Other sectors	70	3,541.0	30.3	244	7,604.0	48.1	416	24,925.0	44.3
Total	163	11,678.5	100	413	15,804.6	100	814	56,311.9	100
2. Investment Scale									
No. of target/total districts (No.)	8/8			12/12			62/62		
No. of Projects per district (No.)	20.4			34.4			13.1		
Average per project (VND bill.)	71.6			38.3			69.2		
Average per district (VND bill)	1459.8			1317.1			908.3		

Source: Mid-term Plans (2016-2020) in Central Highlands

(4) Current Priority Projects in Central Highland Provinces

The five provinces have their priority project plans to improve living standard of people through implementation of development projects relating irrigation, water supply, flood protection, road, industry,

electricity, etc. Reviewing the project plans prepared by the respective provinces, the number of irrigation project are more than the other sectors in each province except Dak Lak. The project cost of road projects is the most among the sectors. In Lam Dong province, of the total 176 projects prepared, the number of irrigation project reaches to 120 projects (68%) with VND 1,969 billion that is only 2.2% of the total project cost. The similar trend is observed in all provinces in Central Highlands.

According to their project plans, although all of the districts in each province are targeted, the number and project cost per district differs by provinces. Dak Nong prepares more than 17 projects and Lam Dong plans to invest VND 7,293 billion per district on average. Gia Lai plans less than 4 projects with VND 673 billion. In terms of flood protection, the number and budget is less than one percent of the total investment in Central Highlands, even in the seriously damaged provinces such as Dak Lak and Lam Dong. The outlines of their priority projects are as follows:

Table 3.7.6 Priority Projects by Sectors in Central Highlands

Items	Kon Tum			Gia Lai			Dak Lak		
	No.	Amount (VND billion)	(%)	No.	Amount (VND billion)	(%)	No.	Amount (VND billion)	(%)
1. Amount of Project per Sector									
Irrigation	39	956	(2.3)	36	3,090	(27.0)	6	489	(2.8)
Water Supply	3	226	(0.5)	14	208	(1.8)	9	466	(2.7)
Flood	6	858	(2.1)	0	-	(0)	4	580	(3.4)
Road	32	31,009	(74.8)	9	7,172	(62.7)	61	14,012	(81.4)
Industry	3	976	(2.4)	0	-	(0)	0	-	(0)
Electricity	2	7,139	(17.2)	1	971	(8.5)	2	1,657	(9.6)
Others	1	273	(0.7)	0	-	(0)	0	-	(0)
Total	86	41,438	(100)	60	11,441	(100)	80	17,204	(100)
2. Investment Scale									
No. of target/ total districts (No.)		10/10			17/17			15/15	
No. of Projects per district (No.)		8.6			3.5			5.3	
Average per project (VND billion)		482			191			215	
Average per district (VND billion)		4,144			673			1,147	
Items	**Dak Nong**			**Lam Dong**			**Total**		
	No.	**Amount (VND billion)**	**(%)**	**No.**	**Amount (VND billion)**	**(%)**	**No.**	**Amount (VND billion)**	**(%)**
1. Amount of Project per Sector									
Irrigation	97	4,108	(9.8)	120	1,969	(2.2)	298	10,611	(5.3)
Water Supply	8	212	(0.5)	6	1,188	(1.4)	40	2,300	(1.2)
Flood	4	82	(0.2)	9	187	(0.2)	23	1,707	(0.9)
Road	23	35,367	(84.1)	29	83,687	(95.6)	154	171,247	(85.8)
Industry	0	-	(0)	0	-	(0)	3	976	(0.5)
Electricity	5	2,250	(5.3)	12	489	(0.6)	22	12,507	(6.3)
Others	2	45	(0.1)	0	-	(0)	3	318	(0.2)
Total	139	42,064	(100)	176	87,520	(100)	543	199,667	(100)
2. Investment Scale									
No. of target/ total districts (No.)		8/8			12/12			62/62	
No. of Projects per district (No.)		17.4			14.7			8.8	
Average per project (VND billion)		303			497			368	
Average per district (VND billion)		5,258			7,293			3,220	

Note: The Priority Projects of development Plans, excluding Mid-term Plan (2016-2020) Projects

Source: Transportation, Irrigation, Electricity Development Plans in Central Highlands

Infrastructure in Central Highlands is not developed enough, especially in the irrigation sector. Although Dak Lak has the highest potential to implement irrigation development among the five provinces, the province does not plan to develop them by 2020. Among the 298 priority irrigation projects planned in the five provinces, 239 projects are planned to construct new facilities and 59 projects are planned to improve and rehabilitate the existing facilities. Lam Dong prepared the most ambitious plan for irrigation development with 120 projects consisting of 114 construction projects and 6 improvement and rehabilitation projects. The total service area and capacity of the reservoir planned to be developed in Lam Dong are also larger than those in the other provinces. The similar trend is observed in other sectors. Lam Dong Province prepared the plan to develop a water supply system targeting 107,000m3 of design capacity covering 471,667 beneficiaries, which is also the highest in the region. Regarding the road sector, the total length of national, provincial and district roads planned by the Lam Dong Province are longer than other provinces. As for the scale of project, it is not practical to target more than 50 km on average to be implemented by one project. It means that those priority projects are not matured sufficiently and need due consideration to be carried out.

Table 3.7.7 Feature of Priority Project in Central Highlands

Sector/Feature	Unit	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong	Total
Irrigation							
No. of project	No.	39	36	6	97	120	298
Construction	No.	20	18	2	85	114	239
Improvement/ Rehabilitation	No.	19	18	4	12	6	59
Total service area	ha	6,617	23,813	3,145	27,928	43,995	105,498
Reservoir intake/weir	mil.m^3	66.0	164.8	27.2	256.5	305.5	820.0
Water Supply							
No. of project	No.	3	14	9	8	6	40
Total design capacity	m^3	18,800	25,160	20,500	21,700	107,000	193,160
Total beneficiaries	person	86,333	73,600	90,500	103,000	471,667	825,100
Road							
No. of project	No.	23	9	61	23	29	145
Length of national highway	km	374	224	0	374	722	1,693
Length of provincial road	km	604	469	1058	604	371	3,106
Length of district road	km	125	0	56	125	181	487
Total length	km	1,103	693	1,114	1,103	1,274	5,285
Electricity							
No. of project	No.	2	1	2	5	12	22
Length of line	km	5,774	1,633	287	2,925	1,781	12,399
Total capacity	kVA	189,862	51,750	685,000	256,100	41,791	1,224,503
Flood							
No. of project	No.	6	0	4	4	9	23
No. of strengthened dam	No.	1	0	0	0	0	1
Length of protected embankment	km	12.0	0	18.9	0.9	6.8	38.6

Note: The Priority Projects of development Plans, excluding Mid-term Plan (2016-2020) Projects
Source: DARDs, DOCs, DOTs of the five provinces

The priority projects were planned to improve the rural livelihood and water resources management. For the purpose of livelihood improvement, their manner of project prioritization is reasonable. On the other hand, the scopes of the above priority projects are not completely matched with the current situation relating water resources management and disasters prevention.

(5) ODA Projects 2006-2016

The following table shows the ODA projects during 2006-2016 focusing road, irrigation, water supply, flood prevention and other infrastructures. The main donors are JICA, WB, and ADB.

Table 3.7.8 ODA Projects in Central Highlands

Project's name	Kon Tum					Gia Lai				
	No. of projects	Project cost		Disbursement		No. of projects	Project cost		Disbursement	
		Total	ODA	Total	ODA		Total	ODA	Total	ODA
Road projects	2	101,919	72,520	101,919	72,520	6	203,428	68,453	204,048	40,453
Electricity projects	2	31,663	19,874	31,663	19,874	2	36,897	0	36,897	0
Water supply projects	3	131,887	79,720	131,887	79,720	4	73,582	9,750	73,582	9,750
Irrigation projects	1	25,323	17,531	25,323	17,531	3	551,636	121,103	424,005	0
Multi-components projects	4	1,371,536	1,170,295	519,223	391,823	10	2,055,281	1,543,879	674,942	319,286
Total	12	1,662,328	1,359,940	810,015	581,468	25	2,920,824	1,743,185	1,413,474	369,489
Project's name	**Dak Lak**					**Dak Nong**				
	No. of projects	Project cost		Disbursement		No. of projects	Project cost		Disbursement	
		Total	ODA	Total	ODA		Total	ODA	Total	ODA
Road projects	8	331,515	98,591	331,515	98,591	5	287,263	152,823	287,263	152,823
Electricity projects	2	25,539	11,829	25,539	11,829	1	20,638	13,381	20,638	13,381
Water supply projects	3	1,272,075	248,181	1,272,075	248,181	1	166,942	73,809	49,018	42,465
Irrigation projects	4	856,241	356,008	856,241	356,008	0				
Multi-components projects	14	3,114,609	615,520	1,273,407	287,889	5	1,875,902	1,349,301	813,307	726,046
Total	31	5,599,979	1,330,130	3,758,777	1,002,499	12	2,350,745	1,589,314	1,170,226	934,715
Project's name	**Lam Dong**					**Central Highlands**				
	No. of projects	Project cost		Disbursement		No. of projects	Project cost		Disbursement	
		Total	ODA	Total	ODA		Total	ODA	Total	ODA
Road projects	5	163,548	105,016	163,548	105,016	26	1,087,673	497,403	1,088,293	469,403
Electricity projects	2	2,350	1,324	2,350	1,324	9	117,087	46,408	117,087	46,408
Water supply projects	4	954,973	708,042	156,708	130,289	15	2,599,459	1,119,502	1,683,270	510,405
Irrigation projects	2	53,600	18,942	53,600	18,942	10	1,486,800	513,584	1,359,169	392,481
Multi-components projects	6	1,385,911	1,131,599	634,814	452,695	39	9,803,239	5,810,595	3,915,693	2,177,739
Total	19	2,560,382	1,964,923	1,011,020	708,266	99	15,094,258	7,987,492	8,163,511	3,596,436
Source: DPI of Central Highlands Provinces										

Source: DPI of Central Highlands Provinces

CHAPTER 4 ASSESSMENT ON WATER RESOURCE AND UTILIZATION IN THE FIVE PROVINCES

4.1 Methodology of Water Balance Study

4.1.1 Outline of Assessment

The main objective of the Study is to assess water resources availability and demand in the five provinces in Central Highlands which are vulnerable and prone to the shortage of water. The methodology applied to conduct the project is summarized in the following framework. In order to carry out the Study, available data for evaluating water demand and water supply site were collected. This include not only hydro - meteorological data, topographic map, reservoir information, but also soil, land use maps, and water demand of major uses.

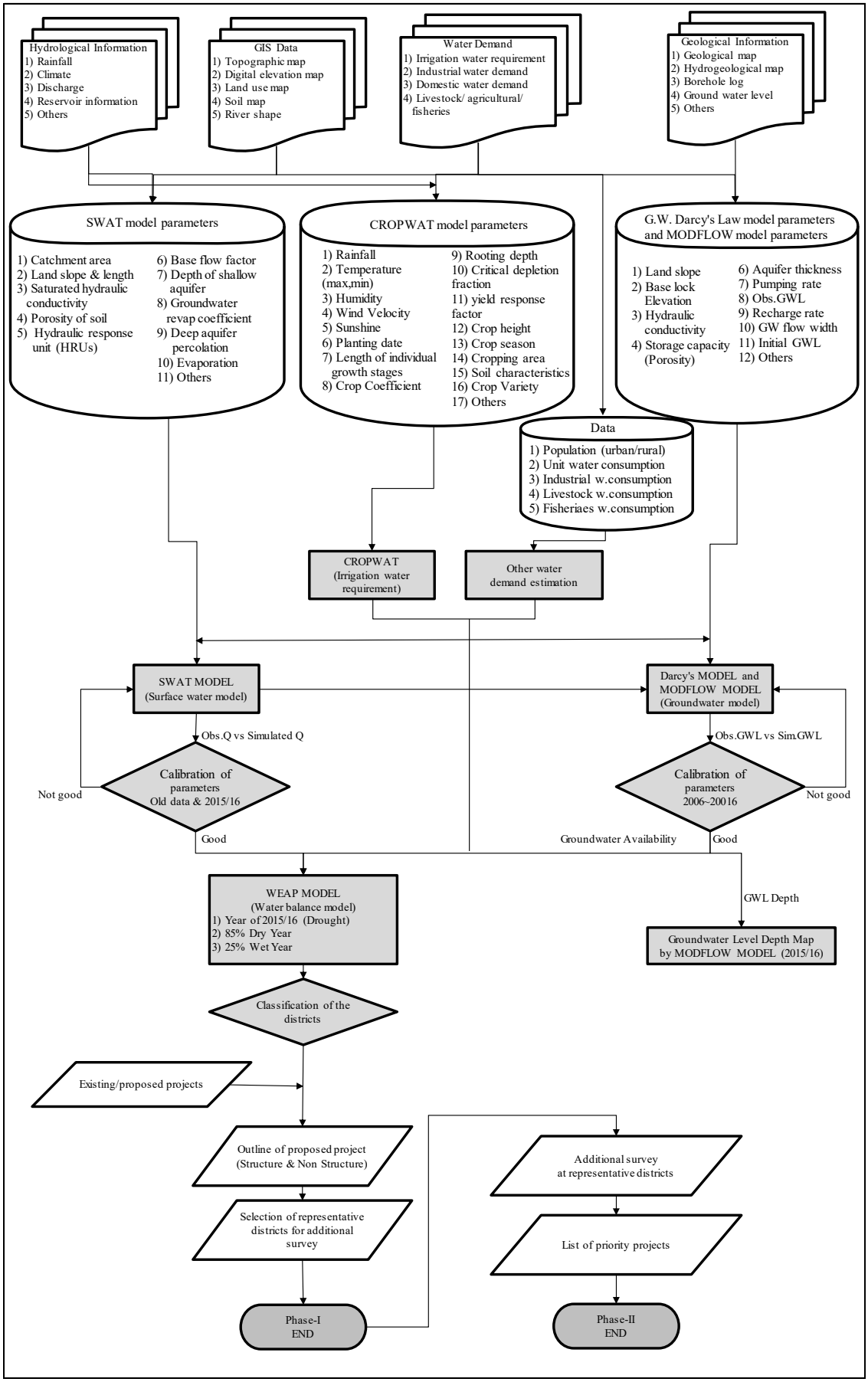
Water available in Central Highlands are classified into three classes, i.e., rainfall, surface, and groundwater resources. Each type of resources is defined with different approaches. Rainfall data from hydro - meteorological stations are used to define rainfall resources. Surface water resources are computed by the Soil and Water Assessment Tool (SWAT) and "Darcy's Law GW Model[1]" is used to estimate the groundwater resources. Both the simulation models of the surface and groundwater were used for the assessment of the water balance study by 92 sub- basins in the four river basins and by 62 districts of the five provinces in Central Highlands. In this Study, "Darcy's Law GW Model" by 92 sub-basins was used for the water balance study due to lack of hydro - meteorological data and groundwater level observation data. Therefore, when looking at sub-basins, there are places where the distribution of groundwater availability does not match the actual situation. Considering the accuracy of assessment, MODFLOW (USGS) model with a 5 km x 5 km grid was applied to estimate a more detailed spatial groundwater level depth distribution of Central Highlands area in this Study.

The water demand in the Study are a combination of the five main water requirements, i.e., irrigation, domestic, livestock, fishery, and industry. The CROPWAT 8.0 model is used to estimate the crop water requirement. Other requirements are based on the collected data and indicators on unit water demand applied in Vietnam to evaluate the water demand. In the Study, environment flow of river is also accounted by referring to the information of the reservoir operation rules applied in Se San, Ba, Srepok, and Dong Nai river basins.

The water balance assessment is made by the Water Evaluation and Planning (WEAP) model, the inputs are the results of all the previous assessment. There were three scenarios that were assessed, i.e., i) drought event from 2015 to 2016, ii) dry year, and iii) wet year. The assessment result is presented by districts (62 administrative units in number) and showed the critical area. These assessments will be a milestone for further study to prepare appropriate countermeasures for drought and flood mitigation in the area. The purposes of the water balance study for 2015/16, dry and wet years are to: i) clarify water shortage in 2015/16, ii) assess water shortage situations under dry and wet conditions with the current water demand, and iii) assess flood damages under the wet condition.

After the outline of the proposed project and identifying districts representing drought and flood prone areas, further in-depth field survey and data collection shall be made and these assessments will be the basis for formulating structural and non-structural priority projects. The final result of the Study is the priority project list for the five provinces. The Study's work flow of surface and groundwater assessment is shown as follows.

[1] The GW model is made by the JICA Study Team for the estimated groundwater level and the potential by using Darcy's Law and output from SWAT model in Excel.



Source: JICA Study Team

Figure 4.1.1 Flowchart of Water Balance Study

(1) CROPWAT

Crop water requirement is a component of agricultural water demand, which occupies the largest share of water demand among the whole water demands. In the Study, crop water requirement is assessed using CROPWAT 8.0 model (CROPWAT) in three scenarios: i) dry year, ii) wet year, and iii) under drought 2015/16. The procedure for calculating crop water requirement is summarized as follows (Ref. AT 4.1.1):

i) Collection of data and information

ii) Cropping pattern set-up

iii) Study on the reference evapotranspiration (ETo)

iv) Estimation of the crop coefficient (Kc)

v) Estimation of the crop water requirement

CROPWAT is a program developed by the Land and Water Development Division of FAO for the calculation of crop water requirements based on soil, climate, and crop data (Ref. AT 4.1.2 to AT 4.1.6). The model can consider a daily soil-water balance using various types of water supply, irrigation management conditions, and cropping patterns in each target area.

Before starting the calculation with CROPWAT, it is necessary to set up a cropping pattern. In the Study, the district cropping patterns in the five provinces are determined on the basis of collected data from Departments of Agriculture and Rural Development (DARDs) in each province. The reference ETo is defined and calculated using the FAO Penman-Monteith Equation. Considering the wideness of the target area of the Study, the time step of ETo is set at ten days.

The crop coefficient (Kc) is basically the ratio of the crop evapotranspiration (ETc) to the reference ETo, and it represents an integration of the effects of four primary characteristics, i.e., i) crop height, ii) albedo of soil surface, iii) canopy resistance, and iv) evaporation from soil[2]. Kc shall be set up in each growth stage for each crop. The crop water requirement is calculated as ETc, that is obtained by multiplying ETo by Kc. In this survey, perennial crops have three specific Kc in the first year and one specific Kc from the second year. On the other hand, each annual crop has three specific Kc as follows:

Table 4.1.1 Crop Coefficient for Perennial Crop and Annual Crop

Crop Type	Period	Stage
Perennial Crop	1st year	- Initial season - Later season
	From 2nd year	Whole season
Annual Crop	Every year	- Initial season - Middle season - Later season

Source: Prepared by JICA Study Team based on FAO, 1998

(2) Surface Water Analysis Model (SWAT Model)

1) General

The purpose of the surface water analysis is to provide an account of the overall hydrological condition in Central Highlands which are the divided catchments of the Sa San, Ba, Srepok, and Dong Nai River basins according to the available climatic and hydrological records. The surface water analysis was carried out to estimate the surface water conditions at specified locations in the river systems.

The naturalized flow is defined as the river runoff that is not affected by any water uses in their catchment area. A series of naturalized flow are usually necessary for assessment of the water demand and supply balance. The continuous naturalized flow is necessary in a time sequence of more than 20 years. The naturalized flow is principally obtained based on the observed discharges with some adjustment to eliminate the influences due to water uses. However, the available runoff records could be interrupted due to a lack of observation (Ref. AT

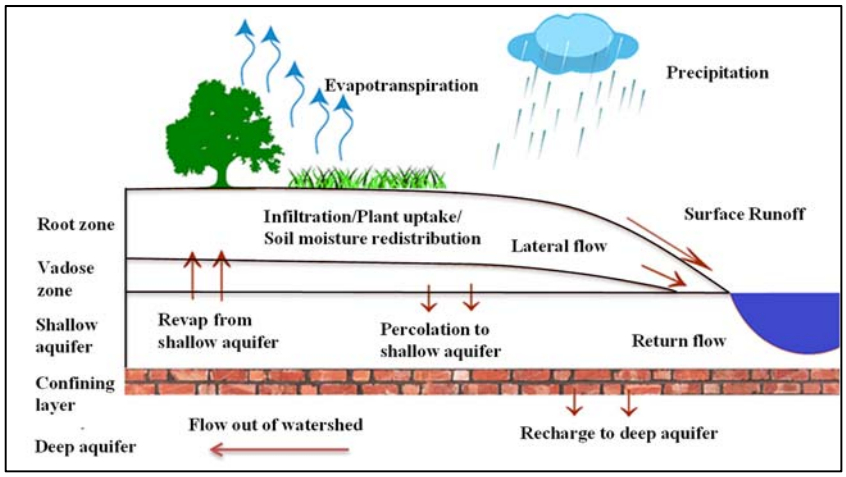
[2] FAO, 1998, Irrigation and Drainage Paper No. 56, Crop Evapotranspiration

4.1.8) and need to be estimated by sub-basin wise, where there are no observation records in the sub-basin. Applying necessary observation period of major daily discharge and daily rainfall data in the four river basins, the long-term sub-basin wise discharges were estimated by using SWAT model.

In the Study, the parameters of the SWAT model[3] were calibrated using observed discharges which were not affected by artificial water usage periods and locations such as dams, reservoirs, and intake weirs. After the interpolation of missing hydrological data, the calibration of parameters of the hydrological model was carried out. The naturalized flow was then simulated for the period of 1986 to 2016 (31 years) using the calibrated parameters.

2) Surface Water Analysis Model

SWAT is a watershed to river basin-scale model to simulate the quality and quantity of surface and groundwater and predict the environmental impact of land use, land management practices, and climate change. SWAT is widely used in assessing soil erosion prevention and control, non-point source pollution control, and regional management in watersheds. The conceptual diagram of the SWAT Model is shown as follows..



Source: JICA Study Team based on the SWAT model output

Figure 4.1.2 Overview of SWAT Model

The hydrological cycle is conceptually organized into surface flow, sub-surface flow, and unconfined groundwater flow. There is no recharge to the river flow from the confined aquifer when the aquifer water level (unconfined groundwater level) is lower than the riverbed elevation. The hydrological cycle in a catchment is schematically simplified for modeling covering upper soil layer of soil moisture storage and the underlying aquifer on groundwater. The upper soil moisture storage mainly contributes to the hydrological changes when the moisture content of the upper soil layer is transferred to the underlying aquifer where groundwater level is sufficiently low. With this assumption, a catchment is represented by a number of interacting layers in a vertical direction for the purpose of hydrological simulation. These layers represent the surface layer, the sub-surface layer, the unconfined groundwater, and the confined groundwater. A catchment is divided into a number of sub-basin blocks based on the hydrological properties of soil, topography, and geological properties. The lumped hydrological responses are modeled for each sub-basin based on various hydrological equations.

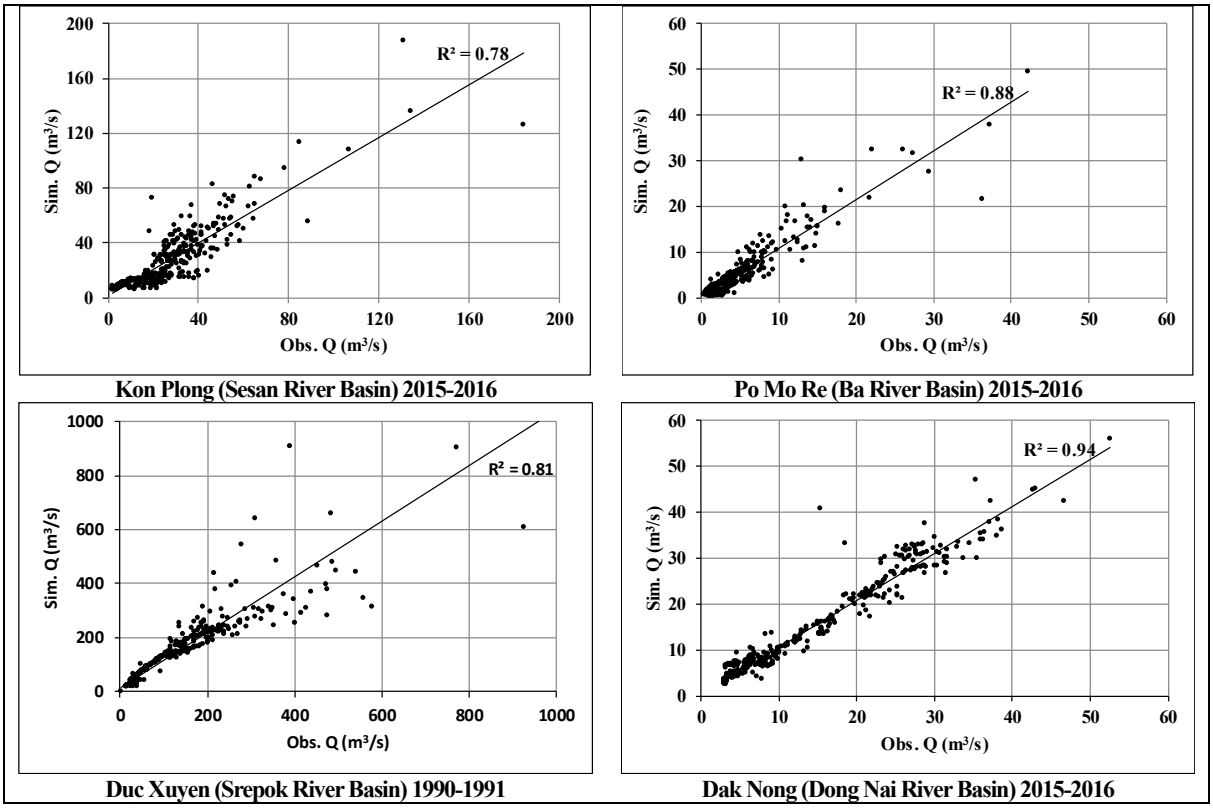
3) Modeling of the Four River Basins

The flow diagram of the four river basins together with the location of the existing dams or reservoirs were prepared (Ref. AT 4.1.11). One of the SWAT Model parameters is soil condition (Ref. AT 3.2.1) and others are topographical conditions such as catchment area, river length, slope and width, that were applied for the assessment (Ref. AT 4.1.12).

[3] SWAT is one of the physical based simulation models; the "Soil and Water Assessment Tool (SWAT)". The model was developed by USDA Agricultural Research Service (USDA-ARS) and Texas A&M AgriLife Research, part of the Texas A&M University System.

4) Calibration of Parameters

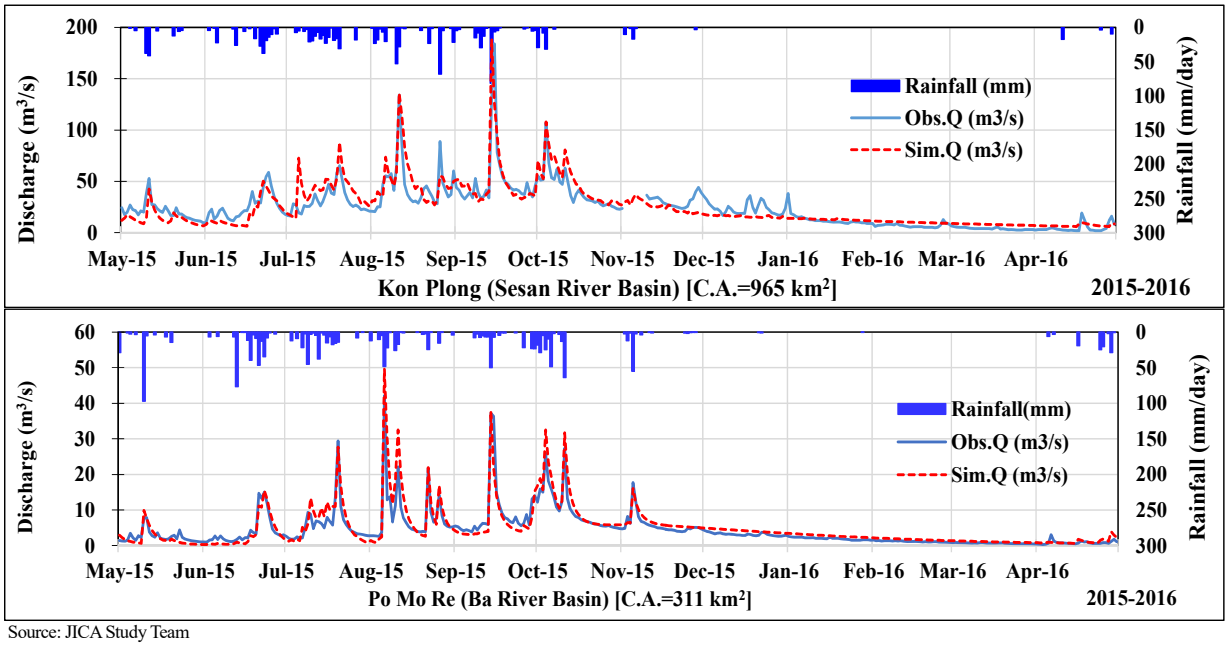
The hydrographs of the simulated discharge by the SWAT model and observed discharges for the period of 1986 to 2016 (31 years) at selected observed hydrological stations are as follows:



Source: JICA Study Team

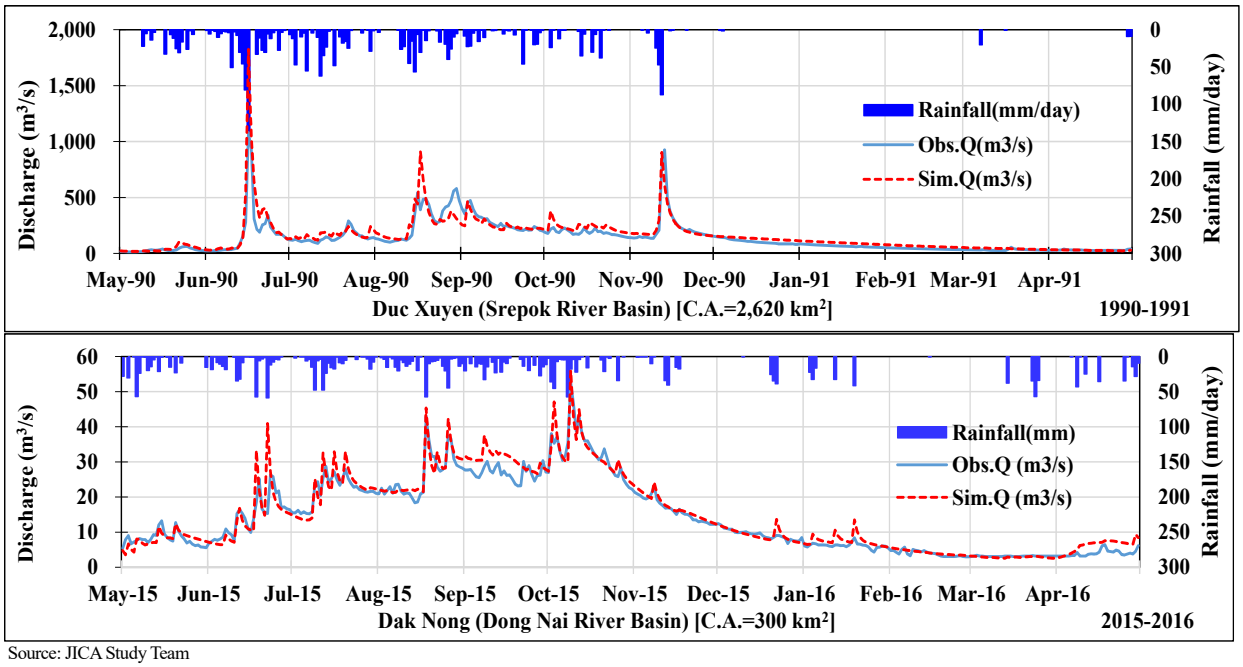
Figure 4.1.3 Scatter Plot of Observed VS Calculated Discharge

The hydrograph of the simulated discharge and observed discharge were well fitted as follows:



Source: JICA Study Team

Figure 4.1.4 Results of the Simulated and Observed Hydrograph by the SWAT Model (1/2)



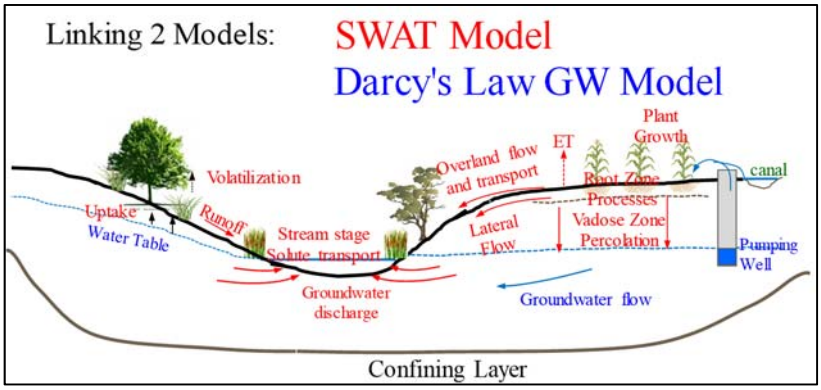
Source: JICA Study Team

Figure 4.1.4 Results of the Simulated and Observed Hydrograph by the SWAT Model (2/2)

(3) Groundwater Analysis Model

1) General

Using output data of Surface Water Analysis Model (SWAT Model) covering percolation (infiltration) to shallow aquifer, return flow to river from groundwater, evapotranspiration from shallow aquifer and recharge to deep aquifer, the groundwater flow model, i.e., GW Model by Darcy's Law prepared by sub-basin, was built up by the JICA Study Team. Conceptual diagram linking the two models is as follows (Ref. AT 4.1.9):



Source: JICA Study Team based on Department of Civil and Environmental Engineering, Colorado State University

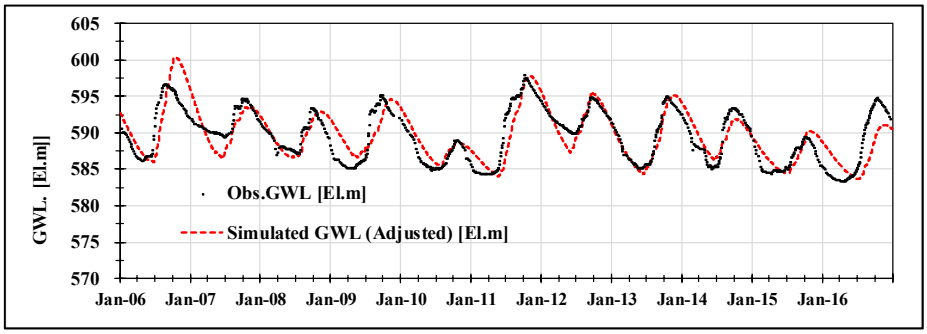
Figure 4.1.5 Overview of SWAT and GW Model

2) Groundwater Analysis Model (GW Model)

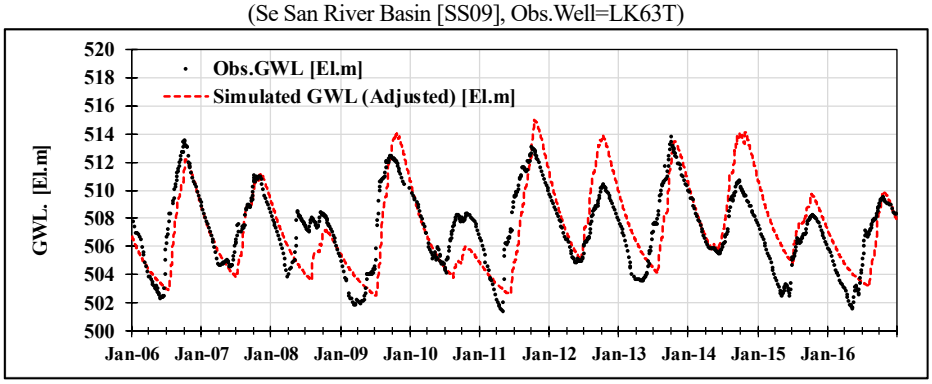
The parameters of the GW Model were decided with reference to the topographic map, geological map, hydrogeological map, (Ref. AT 3.2.1, AT 3.2.4, and AT 3.2.5), borehole log data, and observed groundwater level data. In this Study, the MODFLOW Model (USGS) was also applied to simulate the groundwater level depth by a scale of 5 km x 5 km grid (Ref. AT 4.2.10). Based on the results of the groundwater level depth map by MODFLOW, it shows that the wells, both shallow and deep wells, dries up easily in the place where the groundwater depth is deep from the ground surface during dry season. However, for the detailed analysis and improvement of accuracy, it is essential to conduct further hydrological and meteorological observations, additional installation of groundwater level observation and detailed geological survey. Due to the limitation of available data and period, this is the maximum assessment covering the five provinces in Central Highlands for this analysis.

3) Calibration of Parameters

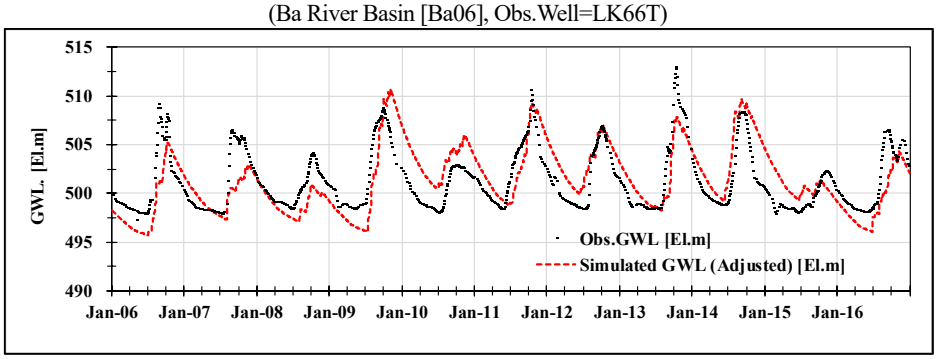
Observed groundwater from 2006 to 2016 (11 years) was simulated by the GW Model. The simulated groundwater level and observed groundwater level at observation wells are well fitted as shown as follows.



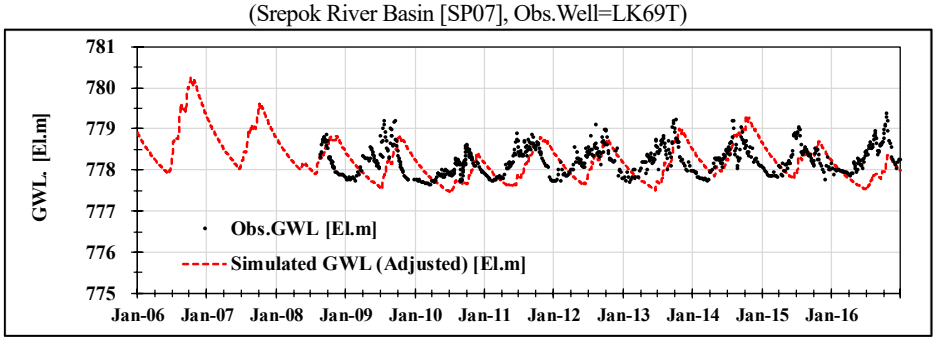
(Se San River Basin [SS09], Obs.Well=LK63T)



(Ba River Basin [Ba06], Obs.Well=LK66T)



(Srepok River Basin [SP07], Obs.Well=LK69T)



(Dong Nai River Basin [DN12], Obs.Well=LK95Tm1)

Source: JICA Study Team based on National Center for Water Resources Planning and Investigation (NAWAPI)

Figure 4.1.6 Results of Simulated and Observed Groundwater Level by GW Model

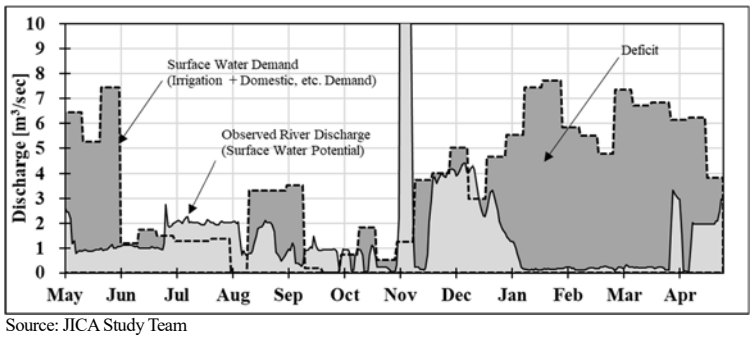
(4) Water Balance Model (WEAP Model)

The water balance simulation model of each river basin is developed and assessed by the Water Evaluation and Planning Model (WEAP Model). The WEAP Model is a generalized water balance simulation software program developed by the Stockholm Environment Institute and the software is widely applied for water resource management projects.

In the WEAP Model, water demand for irrigation, domestic, industry, livestock, and fishery by surface water and groundwater, water availability of surface water, groundwater, and reservoirs are considered daily. The water balance simulation models of each river basin are developed (Ref. AT 4.1.18).

4.1.2 Water Availability

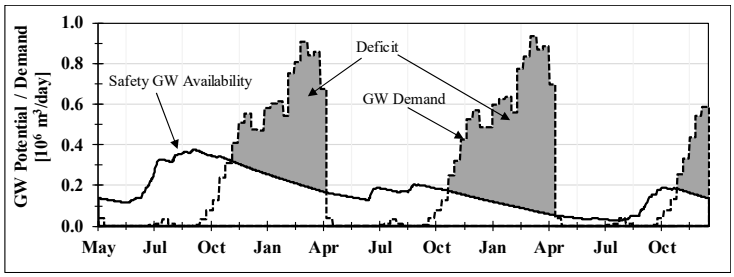
In this Study, hydrological year from May to the end of April was applied for water balance study. The following is a schematic image of the surface water availability. If the water demand comprising irrigation, domestic, industrial, livestock, and fisheries water demand is bigger than the stream flow, the deficit in water demands will occur.



Source: JICA Study Team

Figure 4.1.7 Definition of Surface Water Availability and Demand Shortage

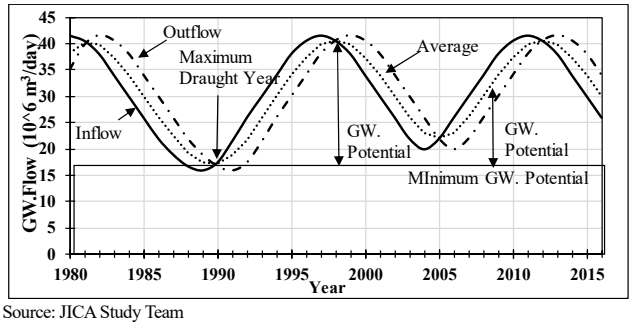
The following is a schematic image of the groundwater availability. If the groundwater demand is bigger than the groundwater availability, the deficit in water demand will occur.



Source: JICA Study Team

Figure 4.1.8 Definition of Groundwater Availability and Demand Shortage

In this Study, the safety of the groundwater availability was defined in the following figure. The safety factor[4] of 0.5 was decided based on the consideration of the aquifer characteristics, status of groundwater exploitation, and requirement of groundwater management in the area. After the calibration of the GW Model's parameters, naturalized safety groundwater availability was estimated by not considering artificial groundwater intake.



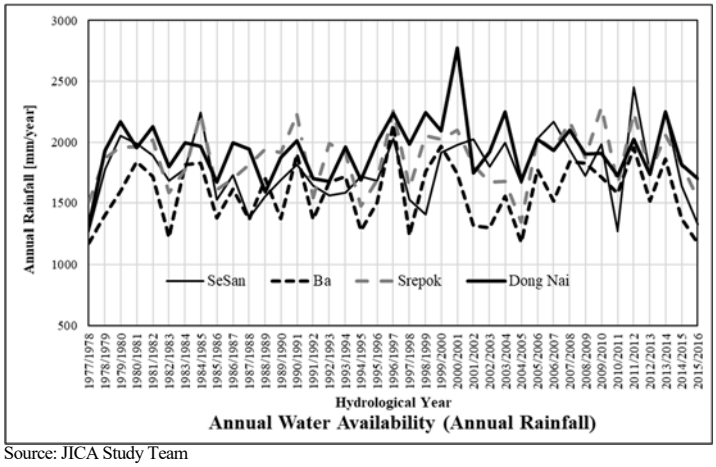
Source: JICA Study Team

Figure 4.1.9 Conceptual Diagram of Groundwater Availability in the Project

Water availability in Central Highlands for long-term period was estimated based on the rainfall data for all stations in this area. In the four river basins, the Thiessen Polygon Method was applied for computing the annual

[4] "Define groundwater exploitation registration, document sample for water resources license demand, extend, refine or renew", Ministry of Natural Resources and Environment (MONRE), Code: 27/2014/TT-BTNMT

mean areal precipitation for each catchment from rain gauge observations. The basic concept of Thiessen Polygon is to divide each watershed into several polygons, each one around a measurement point, and then take a weighted average of the measurements based on the size of each polygon, i.e., measurements within large polygons are given more weight than measurements within small polygons. According to the result, the water availability is high in Central Highlands. The average water availability from 1977 to 2016 in Central Highlands is from 1,584 mm/year in the Ba River to 1,934 mm/year in the Dong Nai River. The observed basin annual rainfall data shows that there is repetitive occurrence of flood and drought at an interval of four to five years. In general, annual rainfall tends to increase in the four basins since 1977. However, there are significant temporal fluctuations in all basins. The coefficients of variation[5] in all four basins are greater than or equal to 13%, of which highest index is seen in the Ba River basin at 16%. (Ref. AT 4.1.18 and Figure 4.1.10). This phenomenon causes the difficulty in water management in Central Highlands. Based on this rainfall data, the surface water and groundwater availability were calculated using the SWAT Model for surface water and GW Model for groundwater.



Source: JICA Study Team

Figure 4.1.10 Annual Water Availability (Annual Rainfall)

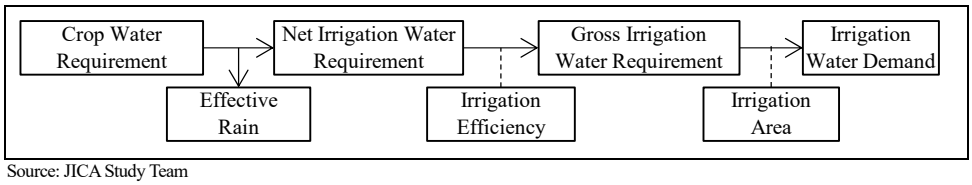
4.1.3 Water Demand

(1) Irrigation Water Demand

After the calculation of the crop water requirement, the following assessments were taken to estimate the irrigation water demand:

i) Estimate of the Effective Rainfall (Peff)
ii) Calculation of the Net Irrigation Water Requirement (NIR)
iii) Estimate of the Irrigation Efficiency (Ep)
iv) Estimate of the Gross Irrigation Water Requirement (GIR)
v) Estimate of the Irrigation Water Demand (IWD)

The relationship between each item is as follows:



Source: JICA Study Team

Figure 4.1.11 Diagram of Calculation of Irrigation Water Demand

(2) Domestic Water Demand

The domestic water demand is estimated with the population and unit water requirement, that is a volume of water consumption per unit of water requirement. The domestic water demand in each district is calculated by multiplying

[5] The coefficient of variation (CV) is a measure of relative variability. It is the ratio of the standard deviation to the average value.

the unit water requirement by district population.

Table 4.1.2 Unit Water Requirement for Domestic Use

(Unit: lit/person/day)

Category	Unit Water Requirement	Values Adopted with Water Balance Study
Special Level Urban /1	120 - 130	-
1st Level Urban /1	120 - 130	130
2nd Level Urban /1	110 - 125	125
3rd Level Urban /1	110 - 125	125
4th Level Urban /1	100 - 120	120
5th Level Urban /1	80 - 100	100
Rural /2	40 - 60	50

Note: No cities are categorized as a special level urban in the Region
Sources: /1: Resolution No. 1210/2016/UBTVQH13 dated May 25, 2016 on Urban Classification by National Assembly Standing Committee 13th
/2: TCXDVN 33:2006 (Vietnam Construction Standard No. 33:2006 by Ministry of Construction on Water Supply - Distribution System and Facilities Design Standard)

(3) Industrial Water Demand

The industrial water demand is estimated by districts based on the provincial statistics and the result of the interview survey with Department of Industry and Trade (DOITs) and industrial parks in the five provinces. The industrial water requirement per one million of production value is estimated as follows:

Table 4.1.3 Unit Water Requirement for Industrial Use

(Unit: m^3 for VND one million of product/1)

Province	Unit Water Requirement
Kon Tum	1.13
Gia Lai	0.88
Dak Lak	0.79
Dak Nong	0.76
Lam Dong	0.78

Note: /1: Volume of water requirement for one million of industrial producted value
Sources: DOITs, Statistic Books in the five provinces and JICA Study Team

(4) Livestock and Aquaculture Water Demand

Available data on unit water requirements in Vietnam is compiled from two sources: i) Study on Nationwide Water Resources Development and Management in Vietnam by JICA (2003) and ii) National Standard for Planning of Rural Design Standard. The unit water requirements of each kind of livestock and aquaculture are estimated as follows:

Table 4.1.4 Unit Water Requirement for Livestock

(Unit: lit/head/day)

Kind of Livestock	Unit Water Requirement
Buffalo	35
Cow	35
Pig	15
Goat	10/1
Poultry	0.25

Note: /1: JICA Study Team modified
Sources: National Standard for planning of Rural-design Standard (www.ViecXayDung.com)

The water demand of aquaculture depends on fish species, stocking single species (monoculture) or multiple species (polyculture). The major groups of fishes are carps, namely; common carps, grass carp, big head carps, and tilapia in Central Highlands. To maintain their cultured area, i.e., water body such as ponds and small reservoirs, the following water supply is required:

- Carps: 1.0 – 2.0 m/year
- Tilapia: 1.5 m/year
- Water losses due to seepage, evaporation, and percolation: 1.5 m/year

Considering these water demands, the JICA Study Team sets the unit water requirement for aquaculture purpose as follows:

Table 4.1.5 Unit Water Requirement for Aquaculture

Purpose	Unit	Unit Water Requirement
Aquaculture	m/ha/year	3.5

Sources: JICA Study Team

With reference to the provincial statistic book, the head numbers of livestock and areas used for aquaculture were estimated by the respective districts. Then, the water demand of livestock and aquaculture was calculated by multiplying the unit water requirement by heads or areas. Summing up each water demand, the livestock and aquaculture water demands were estimated by their respective districts.

(5) Rate of Water Sources Exploited

The water sources that are used to satisfy the water demand are from both the surface and groundwater in Central Highlands. The JICA Study Team assumed the rate of water sources exploited by each purpose in accordance with the results of the field survey, interview survey, and statistical data, are as follows:

Table 4.1.6 Rate of Irrigation Water Demand from Surface Water and Groundwater

(Unit: %)

Crop	Kon Tum		Gia Lai		Dak Lak		Dak Nong		Lam Dong	
	SW	GW	SW	GW	SW	GW	SW	GW	SW	GW
Coffee	60.5	39.5	60.5	39.5	56.0	44.0	56.0	44.0	100.0	0
Pepper	60.5	39.5	60.5	39.5	56.0	44.0	56.0	44.0	60.5	39.5
Other Perennial Crops	100.0	0	100.0	0	100.0	0	100.0	0	100.0	0
Annual Crops	100.0	0	100.0	0	100.0	0	100.0	0	100.0	0

Note: Rubber and cassava is not included that is not irrigated in Central Highlands
Source: JICA Study Team based on the report of Geology Institute

Table 4.1.7 Rate of Non-irrigation Water Demand from Surface Water and Groundwater

(Unit: %)

Water Demand	Domestic	Industry	Livestock	Aquaculture
% of Surface Water Demand	23 - 92	80	23 - 92	100
% of Groundwater Demand	8 - 77	20	8 - 77	0

Source: JICA Study Team based on the report of Geology Institute

4.2 Water Balance Study in 2015/16

4.2.1 Water Availability

Surface water availability including river discharge and reservoir storage and safety groundwater availability in 2015/16, dry and wet years (Ref. Section 4.3.1) were assessed by using SWAT, GW, and WEAP models by the sub-basins.

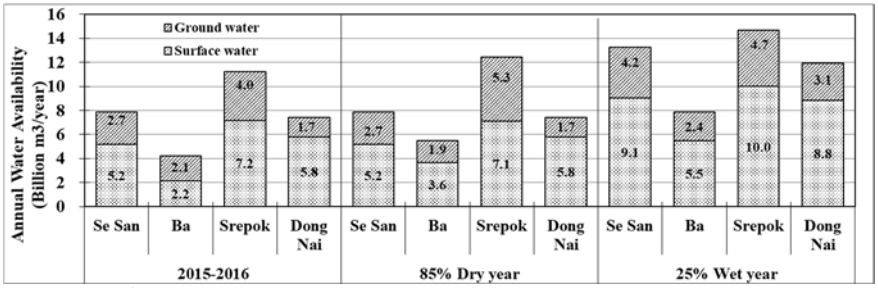
Total surface water availability of wet year for each river basin is estimated as higher than dry year or 2015/16. Total groundwater availability of wet year in the Sa San and Ba River basins is estimated as higher than those in the dry year 2015/16, but the groundwater availability of wet year in the Srepok and Dong Nai River basins is smaller compared those in the dry year. This is because these basins have large area and groundwater availability of sub-basins is influenced by rainfall distribution. In fact, some sub-basins in dry year have much rainfall than wet year and changes in groundwater level may be delayed.

Surface and groundwater availability in Central Highlands was estimated at 20,280 MCM/year and 10,483 MCM/year in 2015/16, respectively. Moreover, most of the groundwater is discharged to the rivers and flows out the region, especially during the dry season. High availability sites of surface water and groundwater are as follows (Ref. AT 4.2.1 and AT 4.2.2):

Table 4.2.1 Estimated Water Availability in Central Highlands in 2015/16

River Basin	Catchment Area (km^2)	Water Availability (MCM/year)					
		Surface Water		Groundwater		Total	
		MCM/year	%	MCM/year	%	MCM/year	%
Se San	11,377	5,162	23	2,733	26	7,895	24
Ba	10,779	2,162	10	2,075	20	4,238	13
Srepok	17,887	9,561	42	4,020	38	13,581	41
Dong Nai	9,236	5,774	25	1,654	16	7,428	22
Total	49,278	22,660	100	10,483	100	33,143	100

Source: JICA Study Team



Source: JICA Study Team

Figure 4.2.1 Estimated Water Availability in Central Highlands

Table 4.2.2 High Water Availability Area in Central Highlands

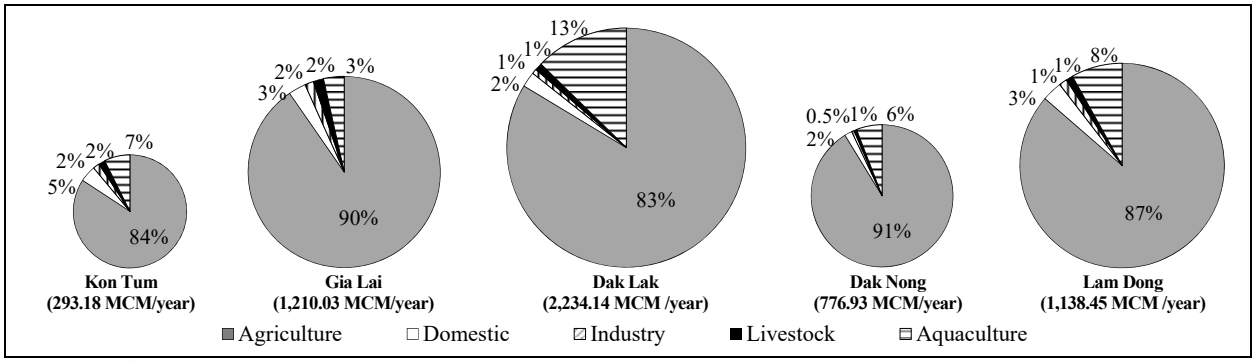
Province	High Availability Area of Surface Water	High Availability Area of Groundwater
Kon Tum	1) Along the main river channel of both the Se San River and the tributary of Dak Ba River (Sa Thai, Dak Ha, Kon Tum, Kon Ray, and Ia H'Drai districts in Kon Tum Province)	1) Middle and south parts of basin (Sa Thai, Dak Ha, Kon Tum, Kon Ray, and Ia H'Drai districts in Kon Tum Province)
Gia Lai	1) Along the main river channel of both the Se San River (Chu Pah and Ia Grai districts in Gia Lai Province) 2) Along the middle and downstream of main Ba River channel (Kong Chro, Ia Pa, Yun Pa, and Krong Pa districts in Gia Lai Province)	1) Downstream of the Se San River (Chu Pah and Ia Grai districts in Gia Lai Province) 2) Middle and western parts of the Ba River basin (Kong Chro, Ia Pa, Yun Pa, and Krong Pa districts in Gia Lai Province)
Dak Lak	1) In the northern part of Srepok River basin, which is a tributary of Ea H'leo River and Ea Sup River (Ea Sup, Ea H'leo, Krong Buk, and Krong Pak districts in Dak Lak Province)	1) Northern part of the Srepok River basin, which is a tributary of the Ea H'leo River and Ea Sup River (Ea Sup, Ea H'leo, Krong Buk, and Krong Pak districts in Dak Lak Province)
Dak Nong	1) In the northeast of the Dong Nai River basin (Dak Glong and Dak R'lap districts in Dak Nong Province) 2) Northwest and southwest of downstream parts	1) Downstream part of the Srepok River basin
Lam Dong	1) Northwest and southwest of the Dong Nai River downstream part (Dam Rong, Lam Ha, Bao Lam, and Cat Tien districts in Lam Dong Province)	1) Northeast of the Dong Nai River basin 2) Northwest of the Dong Nai River basin 3) Southwest of downstream part of the Dong Nai River basin

Source: JICA Study Team

4.2.2 Water Demand

(1) Share of Water Demand by Sector

In Central Highlands, agricultural water demand occupies 83 to 91% of the total water demand in each province in 2015/16. Among the other four purposes, the water demand for aquaculture is the highest sector ranging 3% in Gia Lai Province to 13% in Dak Lak Province. Each share of domestic, industrial, and livestock water demand is less than that of the aquaculture water use. The proportion of water demands are as follows:



Source: JICA Study Team

Figure 4.2.2 Share of Water Demand by Sector in 2015/16

(2) Exploitation Ratio of Surface Water and Groundwater

During the drought period in 2015/16, water demand depends on the surface water and groundwater, which were estimated at 4,480 MCM/year and 1,173 MCM/year in Central Highlands, respectively. Groundwater demand in Dak Lak Province was 530 MCM/year, which accounts to 45% of the total demand for Central Highlands. The surface water demand in Dak Lak was approximately 38% of the total demand. Water demand in Kon Tum Province is the lowest in both surface and groundwater at about 5%. In Lam Dong Province, water demand for groundwater is very small but surface water demand increased up to 26%. Comparing the water demand by purposes and provinces, the share of surface water is generally larger than that of the groundwater except Dak Lak Province, where the share of groundwater is larger than that of the surface water due to the domestic and livestock use. The rate of water sources exploited in Central Highlands in 2015 to 2016 are as follows:

Table 4.2.3 Rate of Water Sources Exploited by Each Sector in 2015/16

(Unit: MCM/year)

Province	Agriculture		Domestic		Industry		Livestock		Fishery		Total	
	SW*	GW*	SW	GW	SW	GW	SW	GW	SW	GW	SW	GW
Kon Tum	196.2	50.8	10.2	3.4	4.2	1.1	3.8	1.8	21.6	0	236.1	57.1
Gia Lai	819.1	274.6	23.5	12.0	14.4	3.6	12.9	8.0	42.0	0	911.8	298.2
Dak Lak	1,383.6	484.8	16.5	29.3	11.6	2.9	9.5	12.9	283.2	0	1,704.3	529.8
Dak Nong	447.4	261.5	8.6	4.7	3.3	0.8	3.1	1.8	45.7	0	508.1	268.8
Lam Dong	983.3	0	24.5	11.5	11.6	2.9	8.3	4.3	92.1	0	1,119.8	18.7
C. Highlands	3,829.6	1,071.6	83.3	60.9	45.2	11.3	37.6	28.7	484.5	0	4,480.1	1,172.6

Note*: SW means surface water, GW means groundwater
Source: JICA Study Team

(3) Distribution of Water Demand

In Central Highlands, agriculture water demand depends on the surface water for about 77.8%, on average that varies from 71.4% in the Se San River basin to 88.6% in the Dong Nai River basin in 2015/16. The second water demand is for fishery but is mainly from surface water with a quantity of 360.8 MCM/year. Water demand for domestic use from both surface and groundwater takes the third place with about 103.2 MCM/year. Surface water demand for industrial use in Central Highlands varied by different river basins, from 6.3 MCM/year in the Se San River basin to 10 MCM/year in the Dong Nai River basin and much higher than groundwater demand.

The surface and groundwater demands in Kon Tum and Dak Nong provinces are not high compared with the other provinces in Central Highlands (Ref. AT 4.2.3 and AT 4.2.4). In 2015/16, groundwater demand in Dak Lak was 53% of the total demand for Central Highlands, meanwhile surface water demand is slightly lower with 48.7% of the total. Water demand in Kon Tum Province is the lowest in both surface and groundwater demand, at about 4% and 5%, respectively. In Lam Dong Province, water demand from groundwater was very small, but it increased for the surface water demand, which was 20%.

Table 4.2.4 Estimated Water Demand in Central Highlands in 2015/16

River Basin		Se San		Ba		Srepok		Dong Nai		Total	
		MCM/year	%	MCM/year	%	MCM/year	%	MCM/year	%	MCM/year	%
Domestic	Surface Water	12.1	68.8	10	54.9	18.3	46.4	19.1	68.2	59.5	57.7
	Groundwater	5.5	31.3	8.2	45.1	21.2	53.8	8.9	31.8	43.8	42.4
	Total	17.6	100.0	18.2	100.0	39.4	100.0	28	100.0	103.2	100.0
Industrial	Surface Water	6.3	79.7	7.3	80.2	10.9	79.6	10	80.0	34.5	79.9
	Groundwater	1.6	20.3	1.8	19.8	2.9	21.2	2.5	20.0	8.8	20.4
	Total	7.9	100.0	9.1	100.0	13.7	100.0	12.5	100.0	43.2	100.0
Live Stock	Surface Water	4	64.5	7.3	56.2	10.3	48.1	5.4	66.7	27.0	55.4
	Groundwater	2.2	35.5	5.7	43.8	11.1	51.9	2.7	33.3	21.7	44.6
	Total	6.2	100.0	13	100.0	21.4	100.0	8.1	100.0	48.7	100.0
Fishery	Surface Water	18.4	100.0	51.7	100.0	222.9	100.0	67.8	100.0	360.8	100.0
	Groundwater	0	0.0	0	0.0	0	0.0	0	0.0	0.0	0.0
	Total	18.4	100.0	51.7	100.0	222.9	100.0	67.8	100.0	360.8	100.0
Agriculture	Surface Water	370.4	71.4	677.1	80.7	1,598.40	73.1	918.8	88.6	3,564.7	77.8
	Groundwater	148.1	28.6	161.5	19.3	587.8	26.9	118.8	11.4	1,016.2	22.2
	Total	518.5	100.0	838.6	100.0	2,186.20	100.0	1,037.60	100.0	4,580.9	100.0
Total	Surface Water	411.2	72.3	753.4	81.0	1860.8	74.9	1021.1	88.5	4046.400	78.8
	Groundwater	157.4	27.7	177.2	19.0	623	25.1	132.9	11.5	1090.500	21.2
	Total	568.6	100.0	930.6	100.0	2483.6	100.0	1154	100.0	5136.900	100.0

Source: JICA Study Team

Based on the estimate for water demand by the respective districts in Central Highlands, the districts were categorized as follows:

Table 4.2.5 Number Districts of Water Demand Classification in 2015/16

(unit: No. of District)

Province	< 5 MCM/year		5~10 MCM/year		10~25 MCM/year		>=25 MCM/year	
	Surface Water	Groundwater	Surface Water	Groundwater	Surface Water	Groundwater	Surface Water	Groundwater
Kon Tum	1	8	0	0	6	2	3	0
Gia Lai	0	7	0	1	3	4	14	5
Dak Lak	0	2	0	1	0	4	15	8
Dak Nong	0	0	0	0	0	3	8	5
Lam Dong	0	12	0	0	1	0	11	0
Total	1	29	0	2	10	13	51	18

Source: JICA Study Team

4.2.3 Result of Water Balance in 2015/16

People living in Central Highlands are increasingly facing the drought and extreme water shortage. The shortage of surface and groundwater in the four river basins were assessed. In the Se San River basin, surface water

shortage is smaller than other basins and groundwater shortage is estimated at 19.2 MCM/year. In the Ba River basin, surface water shortage is estimated at 50.6 MCM/year and groundwater shortage is at 71.0 MCM/year. In the Srepok River basin, water shortage of surface water and groundwater is very high compared with the other basins. The surface water shortage of the Srepok River basin is estimated at 320.6 MCM/year and groundwater shortage is at 232.0 MCM/year. In the Dong Nai River basin, surface water shortage is high at 116.8 MCM/year, but groundwater shortage is not so high at 13.7 MCM/year in 2015/16. The surface water shortage occurred in the eastern and southern part of Central Highlands. In Dak Lak Province, surface water shortage is happening. In Dak Nong Province, Krong No District faced water shortage. In Lam Dong Province, southern part of Da Lat, Lam Ha, and Duc Trong districts faced a heavy surface water shortage.

Table 4.2.6 Results of Water Balance in Central Highlands in 2015/16

River Basin	Catchment Area (km²)	Water Source	Water Availability	Water Demand (MCM/year)						Water Balance (Shortage)
				Domestic	Industrial	Live Stock	Fishery	Agriculture	Total	
Se San	11,377	Surface Water	5,162	12.1	6.3	4.0	18.4	370.4	411.2	-8.7
		Groundwater	2,733	5.5	1.6	2.2	0.0	148.1	157.4	-19.2
		Total	7,895	17.6	7.9	6.2	18.4	518.5	568.7	-27.9
Ba	10,779	Surface Water	2,162	10.0	7.3	7.3	51.7	677.1	753.3	-50.6
		Groundwater	2,075	8.2	1.8	5.7	0.0	161.5	177.3	-71.0
		Total	4,238	18.2	9.1	13.0	51.7	838.6	930.5	-121.6
Srepok	17,887	Surface Water	7,181	18.3	10.9	10.3	222.9	1,598.4	1,860.8	-320.6
		Groundwater	4,020	21.2	2.9	11.1	0.0	587.8	623.0	-232.0
		Total	11,201	39.4	13.7	21.4	222.9	2,186.2	2,483.7	-552.7
Dong Nai	9,236	Surface Water	5,774	19.1	10.0	5.4	67.8	918.8	1,021.1	-116.8
		Groundwater	1,654	8.9	2.5	2.7	0.0	118.8	132.9	-13.7
		Total	7,428	28.0	12.5	8.1	67.8	1,037.6	1,153.9	-130.4
Total	49,278	Surface Water	20,280	59.3	34.5	27.1	360.8	3,564.7	4,046.4	-496.7
		Groundwater	10,483	43.8	8.8	21.7	0.0	1,016.2	1,090.5	-335.9
		Total	30,762	103.2	43.2	48.8	360.8	4,580.9	5,136.9	-832.6

Source: JICA Study Team

Dak Lak Province was most seriously affected, where 67% of the districts faced water shortage of more than 25.0 MCM/year. The total water shortage in Dak Lak are estimated at 586 MCM/year, which is equal to 26.2% of the total water demand. The total surface water and groundwater shortage are estimated at 329 MCM/year and 258 MCM/year, respectively. Kon Tum faces the shortage at 3.4% for surface water and 2.4% for groundwater demands. In Lam Dong Province, surface water shortage was very high at about 131 MCM/year. Gia Lai Province was short of more than 54.5 MCM/year of groundwater and 19.5 MCM/year of surface water.

The groundwater shortage occurred in the middle and west of Central Highlands, especially in Dak Lak, Gia Lai, and Dak Nong provinces. In Dak Lak Province, heavy groundwater shortage was observed at the middle and western parts. In Gia Lai Province, groundwater shortage occurred in the middle and northwest parts. In Lam Dong and Kon Tum provinces, heavy groundwater shortage was not observed in 2015/16 (Ref. AT 4.2.9).

Table 4.2.7 Water Shortage by Provinces in Central Highlands in 2015/16

Province	Water Shortage (MCM/year)			Water Demand (MCM/year)			Water Shortage % in 2015/16		
	Total	SW	GW	Total	SW	GW	Total	SW	GW
Kon Tum	9.49	8.11	1.38	293.18	236.10	57.09	3.2	3.4	2.4
Gia Lai	74.02	19.52	54.50	1,210.03	911.82	298.21	6.1	2.1	18.3
Dak Lak	586.41	328.53	257.89	2,234.15	1,704.32	529.83	26.2	19.3	48.7
Dak Nong	64.98	37.34	27.64	776.93	508.14	268.78	8.4	7.3	10.3
Lam Dong	130.84	130.63	0.22	1,143.19	1,122.13	21.06	11.4	11.6	1.0
Total	865.74	524.12	341.63	5,657.48	4,482.52	1,174.96	15.3	11.7	29.1

Source: JICA Study Team

Based on the above assessment, the respective districts in the five provinces were classified by the volume of water shortage and are as follows:

Table 4.2.8 Number of Districts by Water Shortage Volume in Central Highlands in 2015/16

(Unit: No. of District)

Province	< 0.5 MCM/year			0.5~10 MCM/year			10~25 MCM/year			>=25 MCM/year		
	Surface Water	Ground water	Total (both)	Surface Water	Ground water	Total (both)	Surface Water	Ground water	Total (both)	Surface Water	Ground water	Total (both)
Kon Tum	8	9	7	2	1	3	0	0	0	0	0	0
Gia Lai	6	8	4	11	7	11	0	2	2	0	0	0
Dak Lak	2	3	0	3	3	1	6	4	4	4	5	10
Dak Nong	4	0	0	3	7	5	1	1	3	0	0	0
Lam Dong	2	12	2	5	0	5	3	0	3	2	0	2
Total	22	32	13	24	18	25	10	7	12	6	5	12

Source: JICA Study Team

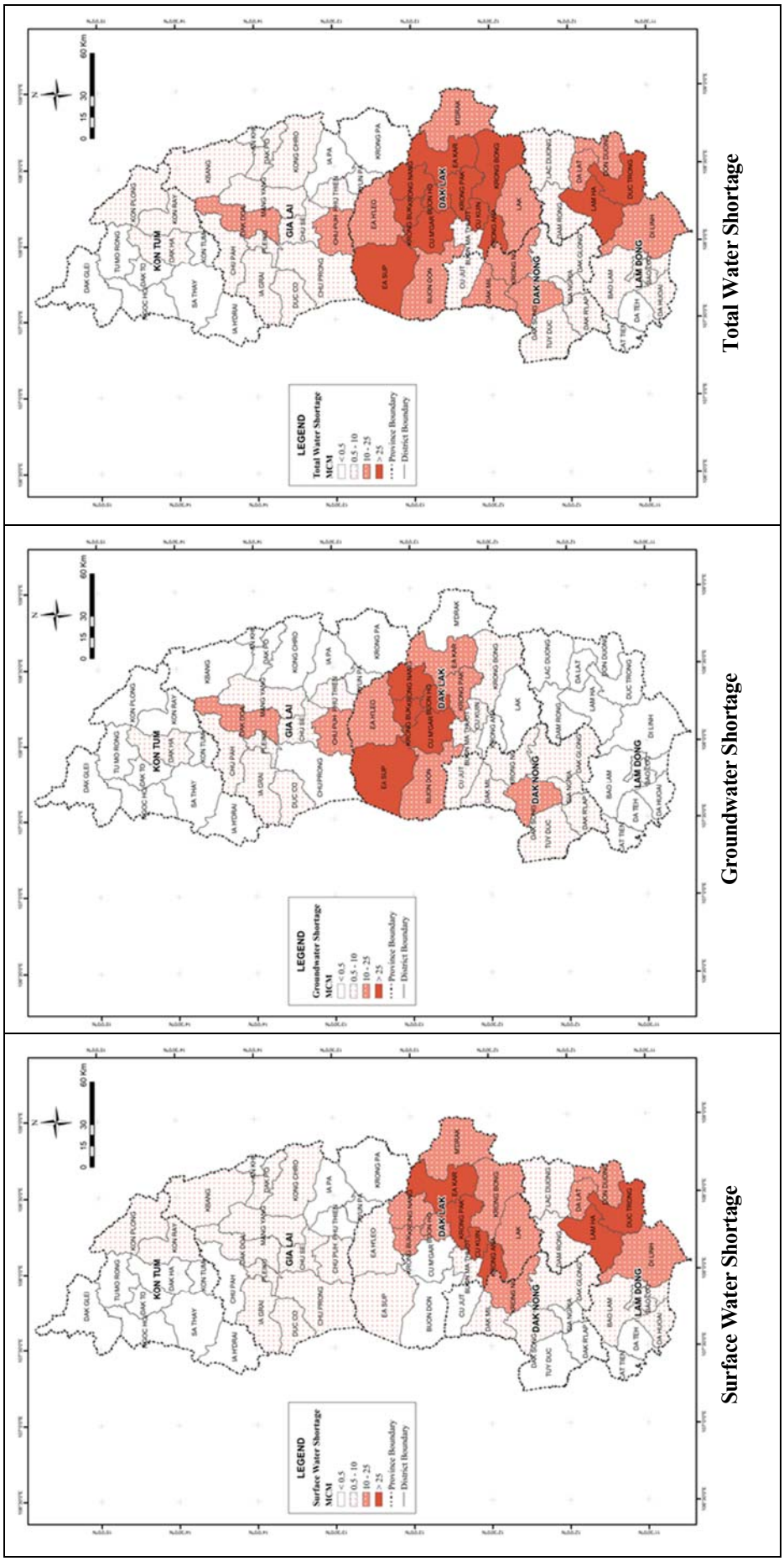


Figure 4.2.3 Water Shortage in Central Highlands in 2015/16

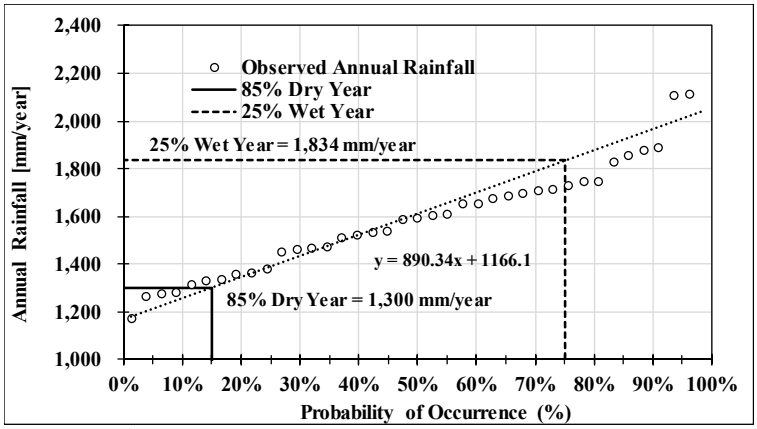
Source: JICA Study Team

4.3 Water Balance in Dry and Wet Years

4.3.1 Definition of Dry and Wet Years

In the water balance study, verification of the annual wet and dry condition is necessary from the hydrological view point. Based on the result of the water balance study under the dry year condition, the districts and seasons are identified where and when water shortage occurs and directions for necessary development are prepared by the JICA Study Team. Regarding the wet year conditions, the situation of water availability is assessed. If there are enough water, further utilization measures are to be considered. Otherwise, if there are water shortage even under wet year condition, then JICA Study Team will propose viable countermeasures to mitigate water shortage since it means that water shortage always occurs in Central Highlands.

To decide the wet and dry years, extremely abnormal years shall be excluded and reasonable years normally happening need to be identified. The definition of dry year was referred from the National Technical Regulation on Hydraulic Structures - The Basic Stipulation for Design (QCVN04-05: 2012/BNNPTNT), that is commonly used in Vietnam. On the other hand, wet year was defined based on the Vietnamese Standard for Hydrological Calculation QPTL C-6-77. In this water balance study, dry and wet years were defined as 85% and 25% of dependable year, respectively. Those are probability of long term annual rainfall records of 39 years from May 1977 to April 2016. The schematic diagram of definition of dry and wet years and the calculated dry and wet years for each basin are as follows:



Source: JICA Study Team

Figure 4.3.1 Definition of Dry and Wet Years

Table 4.3.1 Dry and Wet Years of River Basin

River Basin	Maximum Dry Year during past 39 years	85% Dry Year	25% Wet Year	Maximum Wet Year during past 39 years
Se San	1977 May - 1978 April	2015 May - 2016 April	2005 May - 2006 April	2011 May - 2012 April
Ba	2004 May - 2005 April	1994 May - 1995 April	1986 May - 1987 April	1998 May - 1999 April
Srepok	2004 May - 2005 April	2012 May - 2013 April	1988 May - 1989 April	1999 May - 2000 April
Dong Nai	2004 May - 2005 April	2015 May - 2016 April	2007 May - 2008 April	1979 May - 1980 April

Note: Maximum dry and wet years were recorded during 1977 May to 2016 April (39 years) at the representative rainfall stations.
Source: JICA Study Team

Based on the statistical data above, drought event 2015/16 is not the driest year. However, this event caused the most serious damage. Under the enlarged water demand, the drought damages become larger than those in the past, especially in agriculture. According to Dzung (2016)[6], the cultivated area in Central Highlands in 1990 is recorded at 4,399,000 ha; however, the cultivated area in 2000 and 2014 became twice and five times, respectively. This significant increase in water demand resulted in serious water shortage in Central Highlands.

4.3.2 Purpose of Water Balance Study in Dry and Wet Years

By reproducing the water balance in the dry and wet years that will occur in the future using the current water demand and land use conditions in 2015/16, meteorological and hydrological conditions in dry and wet years, the imbalance areas of water availability and demand are assessed quantitatively.

[6] Source: http://nature.org.vn/vn/wp-content/uploads/2016/07/220716_TS.Dung_TapdoanCaycon.pdf

Through the water balance assessment in dry and wet years of each river basin, the areas where water shortages occur in dry or wet years could be identified. The areas where water shortage occurred could be identified even in wet year conditions. Water shortage by sub-basins and districts in wet and dry years is also quantitatively assessed. The main purposes of the water balance assessment in the dry year calculation are as follows:

i) Identify areas quantitatively where water shortages occur that caused more serious droughts than the drought of 2015/16 or normal year by using current water demand and land use.

ii) Estimated quantitatively total water balance in dry year for the four river basins by sub-basin or for provinces by district at the probability of dry year occurring once every 6.7 years (85% probability occurrence).

While, the main purpose of forecast calculating the water balance in the wet year is as follows:

i) Identify areas quantitatively where water shortages occur even in the year of comparatively abundant annual rainfall by using current water demand and land use of 2015/16.

ii) Estimated total water balance in wet year condition for the four river basins by sub-basin or for provinces by district at probability of wet year occurs once every four years (25% probability occurrence).

iii) Identify areas where flood damage may have occurred in the high surface water availability areas in wet year, and it is possible to estimate and forecast quantitatively these flood damage areas.

4.3.3 Water Availability in Dry and Wet Years

Surface water and groundwater availability (safety groundwater availability) in dry year and wet year were assessed by using the SWAT Model, GW Model, and WEAP Model of the 92 sub-basins. Total surface water availability in Central Highlands in the dry years was estimated at 22.7 billion m^3/year and wet years at 33.4 billion m^3/year. Total groundwater potential in Central Highlands in dry and wet years were estimated at 11.6 billion m^3/year and 14.3 billion m^3/year, respectively. The surface water availability is high along the middle and downstream parts of the main river channel. The groundwater availability in the dry and wet years are high along the main river channel.

Table 4.3.2 Surface Water Availability in Central Highlands

River Basin	Catchment Area (km^2)	Water Source	Water Availability (MCM/year)		
			2105/16	Dry Year	Wet Year
Se San	11,377	Surface Water	5,162	5,162	9,056
		Groundwater	2,733	2,733	4,206
		Total	7,895	7,895	13,261
Ba	10,779	Surface Water	2,162	3,640	5,495
		Groundwater	2,075	1,863	2,369
		Total	4,238	5,504	7,864
Srepok	17,887	Surface Water	7,181	7,114	9,998
		Groundwater	4,020	5,305	4,672
		Total	11,201	12,419	14,670
Dong Nai	9,236	Surface Water	5,774	5,774	8,848
		Groundwater	1,654	1,654	3,087
		Total	7,428	7,428	11,935
Total	49,278	Surface Water	20,280	21,691	33,396
		Groundwater	10,483	11,555	14,334
		Total	30,762	33,246	47,731

Source: JICA Study Team

Surface water availability of dry and wet years in the Se San River basin, along the main river channel (both of the Se San River and tributary of the Dak Ba River) has high surface water availability. In the Ba River basin, it has high surface water availability also along the middle and downstream parts of the main Ba River channel. In the Srepok River basin, the downstream part of the Srepok River main channel has high surface water availability. In the Dong Nai River basin, the middle and downstream parts of the Dong Nai River main channel have high surface water availability. Meanwhile, for the groundwater availability of dry and wet years, there is a similar trend of surface water availability, along the main river channel had high groundwater availability. The sites which had relatively available water resources in the dry year are as follows (Ref. AT 4.3.2 and AT 4.3.3):

Table 4.3.3 High Water Availability Area in Central Highlands in Dry Year

Province	High Availability Area of Surface Water	High Availability Area of Groundwater
Kon Tum	1) Along the main river channel both of the Se San River and tributary of the Dak Ba River (Sa Thai, Dak Ha, Kon Tum, Kon Ray, and Ia H'Drai districts in Kon Tum Province)	1) Middle and south parts of the Se San River basin (Sa Thai, Dak Ha, Kon Tum, Kon Ray, and Ia H'Drai districts in Kon Tum Province)
Gia Lai	1) Along the main river channel both of the Se San River and tributary of the Dak Ba River (Ia Grai District in Gia Lai Province) 2) Along the middle and downstream of the main Ba River channel (Kong Chro, Ia Pa, Yun Pa, and Krong Pa districts in Gia Lai Province)	1) Middle and south parts of the Se San River basin (Chu Pah and Ia Grai districts in Gia Lai Province) 2) Middle and west parts of the Ba River basin (Kong Chro, Ia Pa, Yun Pa, and Krong Pa districts in Gia Lai Province) 3) Northern part of the Srepok River basin, which is a tributary of the Ea H'leo River and Ea Sup River (Chu Prong and Chu Puh districts in Gia Lai Province)
Dak Lak	1) Downstream of the Srepok River main channel (Ea Sup, Ea H'leo, Krong Buk, and Krong Pak district in Dak Lak Province)	1) Norther part of the Srepok River basin, which is tributary of Ea H'leo River and Ea Sup River (Ea Sup and Ea H'leo districts in Dak Lak Province)
Dak Nong	1) Middle and downstream of the Dong Nai River main channel, (Dak Glong and Dak R'lap districts in Dak Nong Province)	1) Three parts of the Dong Nai River basin, i.e., in north-east, north-west and south-west of downstream part
Lam Dong	1) Middle and downstream of the Dong Nai River main channel, (Dam Rong, Lam Ha, Bao Lam, and Cat Tien districts in Lam Don Province)	1) Three parts of the Dong Nai River basin, i.e., in north-east, north-west, and south-west of downstream part

Source: JICA Study Team

4.3.4 Water Demand in Dry and Wet Years

The water balance study shall be conducted to envisage water resources management and development directions in the future. Even though the wet and dry years are defined as a past condition, water demands in 2015/16 are applied, since the water demands in Central Highlands tend to increase. Surface water demands in Kon Tum and Dak Nong provinces are not high compared with the other provinces. Dak Lak Province has the highest surface water demand. The groundwater demand in Kon Tum and Lam Dong provinces were relatively low compared with the other provinces. Dak Lak Province has the highest groundwater demand. Gia Lai and Lam Dong provinces have relatively high groundwater demand in the dry year as follows (Ref. AT 4.3.8 and AT 4.3.9):

Table 4.3.4 Number Districts of Water Demand Classification in Dry and Wet Years

(Unit: No. of Districts)

Province	< 5 MCM/year				5~10 MCM/year				10~25 MCM/year				>=25 MCM/year			
	Surface W.		Groundwate		Surface W.		Groundwater		Surface W.		Groundwater		Surface W.		Groundwater	
	Dry Year	Wet Year	Dry Year	Wet Year	Dry Year	Wet Year	Dry Year	Wet Year	Dry Year	Wet Year	Dry Year	Wet Year	Dry Year	Wet Year	Dry Year	Wet Year
Kon Tum	1	1	8	8	0	0	0	1	6	7	2	1	3	2	0	0
Gia Lai	0	0	7	7	0	0	1	2	1	4	5	4	16	13	4	4
Dak Lak	0	0	1	2	0	0	2	1	0	0	4	6	15	15	8	6
Dak Nong	0	0	0	0	0	0	1	0	1	1	5	5	7	7	2	3
Lam	0	0	12	12	0	0	0	0	1	2	0	0	11	10	0	0
Total	1	1	28	29	0	0	4	4	9	14	16	16	52	47	14	13

Source: JICA Study Team

4.3.5 Water Balance in Dry and Wet Years

(1) Dry Year

The surface water shortage occurred in the eastern and southern part of Central Highlands. In Kon Tum Province, surface water shortage was not serious except for the eastern part of the province. In Gia Lai Province, eastern part of province faced surface water shortage. In Dak Lak Province, surface water shortage in the eastern and western parts were very serious. In Dak Nong Province, a part of the eastern province faced surface water shortage. In Lam Dong Province, south eastern part faced heavy surface water shortage (Ref. AT 4.3.17).

The groundwater shortage occurred in the middle and west parts of Central Highlands, especially in Dak Lak and Gia Lai provinces. In Dak Lak Province, heavy groundwater shortage in several districts was identified. In Gia Lai Province, groundwater shortage in the western part of the province was observed. In Kon Tum, Dak Nong, and Lam Dong provinces, heavy groundwater shortages were not identified in the dry and wet years.

Table 4.3.5 Results of Water Balance in Central Highlands in Dry Year

River Basin	Catchment Area (km²)	Water Source	Water Availability (MCM/year)	Water Demand (MCM/year)						Water Balance (Shortage)
				Domestic	Industrial	Livestock	Fishery	Agriculture	Total	
Se San	11,377	Surface Water	5,162	12.1	6.3	4.0	18.4	370.4	411.2	-8.7
		Groundwater	2,733	5.5	1.6	2.2	0.0	148.1	157.4	-19.2
		Total	7,895	17.6	7.9	6.2	18.4	518.5	568.7	-27.9
Ba	10,779	Surface Water	3,640	10.0	7.3	7.3	51.7	889.1	965.3	-111.0
		Groundwater	1,863	8.2	1.8	5.7	0.0	95.3	111.0	-43.0
		Total	5,504	18.2	9.1	13.0	51.7	984.4	1,076.3	-154.1
Srepok	17,887	Surface Water	7,114	18.3	10.9	10.3	222.9	1,647.6	1,909.9	-74.6
		Groundwater	5,305	21.2	2.9	11.1	0.0	484.0	519.1	-140.7
		Total	12,419	39.4	13.7	21.4	222.9	2,131.6	2,429.1	-215.3
Dong Nai	9,236	Surface Water	5,774	19.1	10.0	5.4	67.8	918.8	1,021.1	-116.8
		Groundwater	1,654	8.9	2.5	2.7	0.0	118.8	132.9	-13.7
		Total	7,428	28.0	12.5	8.1	67.8	1,037.6	1,153.9	-130.4
Total	49,278	Surface Water	21,691	59.3	34.5	27.1	360.8	3,825.9	4,307.6	-311.0
		Groundwater	11,555	43.8	8.8	21.7	0.0	846.2	920.5	-216.6
		Total	33,246	103.2	43.2	48.8	360.8	4,672.1	5,228.0	-527.6

Source: JICA Study Team

In these areas, it is considered that excessive water withdrawal is made for a limited amount of water resources. In particular, irrigation water accounting for most of the water demand seems to be excessive. Some areas face water shortage that is more serious than the drought of 2015/16. The areas that experienced the occurrence of water shortage was faced with an imbalance between water demands and water availability. In these areas, reduction of irrigation water demand, e.g., introduction of water saving irrigation, is necessary.

(2) Wet Year

The surface water shortage occurred mainly in the eastern and southern parts of Central Highlands but in limited districts. In Gia Lai Province, the eastern part faced some water shortage. In Dak Lak Province, surface water shortage in the southeast and northwest districts occurred. In Lam Dong Province, the southeast part faced a heavy surface water shortage. In Kon Tum and Dak Nong provinces, heavy surface water shortage has not occurred during the wet year. The groundwater shortage occurred only in the middle and west parts of Central Highlands, especially in Gia Lai and Dak Lak provinces. In Gia Lai Province, the western part of the province faced groundwater shortage. In Dak Lak Province, groundwater shortage was observed in all the areas, especially in Buon Don and Cu M'gar. In Kon Tum, Dak Nong, and Lam Dong provinces, heavy groundwater shortage were not identified during the wet year (Ref. AT 4.3.18).

Table 4.3.6 Results of Water Balance in Central Highlands in Wet Year

River Basin	Catchment Area (km²)	Water Source	Water Availability	Water Demand (MCM/year)						Water Balance (Shortage)
				Domestic	Industrial	Livestock	Fishery	Agriculture	Total	
Se San	11,377	Surface Water	9,056	12.1	6.3	4.0	18.4	298.8	339.6	-4.8
		Groundwater	4,206	5.5	1.6	2.2	0.0	73.4	82.7	-10.8
		Total	13,261	17.6	7.9	6.2	18.4	372.2	422.3	-15.6
Ba	10,779	Surface Water	5,495	10.0	7.3	7.3	51.7	374.5	450.8	-39.2
		Groundwater	2,369	8.2	1.8	5.7	0.0	71.7	87.4	-24.5
		Total	7,864	18.2	9.1	13.0	51.7	446.2	538.1	-63.6
Srepok	17,887	Surface Water	9,998	18.3	10.9	10.3	222.9	1,641.6	1,904.0	-32.0
		Groundwater	4,672	21.2	2.9	11.1	0.0	463.7	498.8	-112.1
		Total	14,670	39.4	13.7	21.4	222.9	2,105.3	2,402.8	-144.1
Dong Nai	9,236	Surface Water	8,848	19.1	10.0	5.4	67.8	746.5	848.8	-28.8
		Groundwater	3,087	8.9	2.5	2.7	0.0	60.8	74.8	0.0
		Total	11,935	28.0	12.5	8.1	67.8	807.2	923.6	-28.8
Total	49,278	Surface Water	33,396	59.3	34.5	27.1	360.8	3,061.4	3,543.0	-104.8
		Groundwater	14,334	43.8	8.8	21.7	0.0	669.5	743.8	-147.3
		Total	47,731	103.2	43.2	48.8	360.8	3,730.9	4,286.8	-252.2

Source: JICA Study Team

In these areas, it is considered that even the water availability under wet year condition cannot satisfy the water demand in Central Highlands. In other word, the chronic water shortage is observed in the region. To overcome such situation, enhancement of water availability and reduction of water demand, especially irrigation water demand, shall be considered.

Based on the assessment done by comparing the estimate of surface water availability in wet year with the record of flood damages in Central Highlands in the recent seven years, the flood-affected areas were presumed. According to the flood damage records, the most serious impact was observed in Ea Sup District in Dak Lak Province located downstream of the Srepok River basin, where water availability is not so high, but the specific discharge drastically changed in the district (Ref. AT 4.3.15). On the other hand, the river map (Ref. AT 3.1.1)

shows that some branch rivers of the Srepok River confluent with the main river within the district area. It can be considered that the flow quantity of branches, as well as the main stream in wet year, is generally more and water level of confluence is higher than usual. If heavy rains occurred in the upstream area in such situation, overflow and flood event may occur easily at the area. Needless to say, establishment of flood protection and evacuation plans absolutely requires flood analysis with an hourly data of rainfall and river water level. However, enough hourly data is currently unavailable in Central Highlands. Therefore, further investigation is necessary to assess the validity of the above hypothesis.

There is another flood-prone area at the downstream of the Dong Nai River in Lam Dong Province, where water availability is very high. This area shall also be investigated to identify the causes of flood vulnerability. Through further surveys that are to be conducted in those flood-prone areas, the direction of countermeasures against flood at similar areas in Central Highlands shall be prepared by the JICA Study Team.

(3) District Classification

Dak Lak Province experienced the most serious damage, that six districts faced water shortage of more than 25.0 MCM/year. The total water shortage in Dak Lak is estimated at 362 MCM/year that is equal to 15.3% of the total water demand in dry year. The total surface and groundwater shortages are estimated at 180 MCM/year and 182 MCM/year, respectively. Kon Tum faced the shortage at 3.4% for surface water and 2.9% for groundwater demands in dry year. In Lam Dong Province, surface water shortage was very high at about 127 MCM/year in dry year. Gia Lai Province also experienced water shortage of more than 38 MCM/year of groundwater and 14 MCM/year of surface water in dry year.

Table 4.3.7 Water Shortage by Provinces in Central Highlands in Dry and Wet Years

Year	Province	Water Shortage (MCM/year)			Water Demand (MCM/year)			Water Shortage (%)		
		Total	SW	GW	Total	SW	GW	Total	SW	GW
Dry Year	Kon Tum	9.78	8.11	1.67	293.18	236.10	57.09	3.3	3.4	2.9
	Gia Lai	51.87	14.00	37.87	1,254.48	997.95	256.53	4.1	1.4	14.8
	Dak Lak	361.67	179.91	181.76	2,369.65	1,892.48	477.17	15.3	9.5	38.1
	Dak Nong	14.38	13.90	0.48	440.48	278.39	162.09	3.3	5.0	0.3
	Lam Dong	127.54	126.93	0.61	1,143.19	1,122.13	21.06	11.2	11.3	2.9
	Total	565.24	342.84	222.40	5,500.98	4,527.05	973.93	10.3	7.6	22.8
Wet Year	Kon Tum	0.73	0.01	0.73	237.57	199.53	38.04	0.3	0.0	1.9
	Gia Lai	43.59	16.80	26.79	977.11	766.79	210.32	4.5	2.2	12.7
	Dak Lak	198.42	66.49	131.93	1,828.00	1,478.78	349.22	10.9	4.5	37.8
	Dak Nong	5.36	0.47	4.89	578.31	392.78	185.53	0.9	0.1	2.6
	Lam Dong	34.18	33.56	0.62	1,002.48	981.86	20.62	3.4	3.4	3.0
	Total	282.27	117.32	164.95	4,623.47	3,819.73	803.73	6.1	3.1	20.5

Source: JICA Study Team

Based on the above assessment, the respective districts in the five provinces were classified by the volume of water shortage and are as follows:

Table 4.3.8 Number of Districts by Water Shortage in Dry and Wet Years

(Unit: No. of Districts)

Year	Province	< 0.5 MCM/year			0.5~10 MCM/year			10~25 MCM/year			>=25 MCM/year		
		Surface Water	Ground water	Total (Both)	Surface Water	Ground water	Total (Both)	Surface Water	Ground water	Total (Both)	Surface Water	Ground water	Total (Both)
Dry Year	Kon Tum	8	9	7	2	1	3	0	0	0	0	0	0
	Gia Lai	7	7	3	10	10	14	0	0	0	0	0	0
	Dak Lak	6	3	2	5	4	4	1	6	3	3	2	6
	Dak Nong	5	8	5	3	0	3	0	0	0	0	0	0
	Lam Dong	2	11	1	5	1	6	3	0	3	2	0	2
	Total	28	38	18	25	16	30	4	6	6	5	2	8
Wet Year	Kon Tum	10	10	10	0	0	0	0	0	0	0	0	0
	Gia Lai	8	7	3	9	10	14	0	0	0	0	0	0
	Dak Lak	9	2	2	3	7	5	3	5	6	0	1	2
	Dak Nong	8	6	6	0	2	2	0	0	0	0	0	0
	Lam Dong	7	11	6	4	1	5	1	0	1	0	0	0
	Total	42	36	27	16	20	26	4	5	7	0	1	2

Source: JICA Study Team

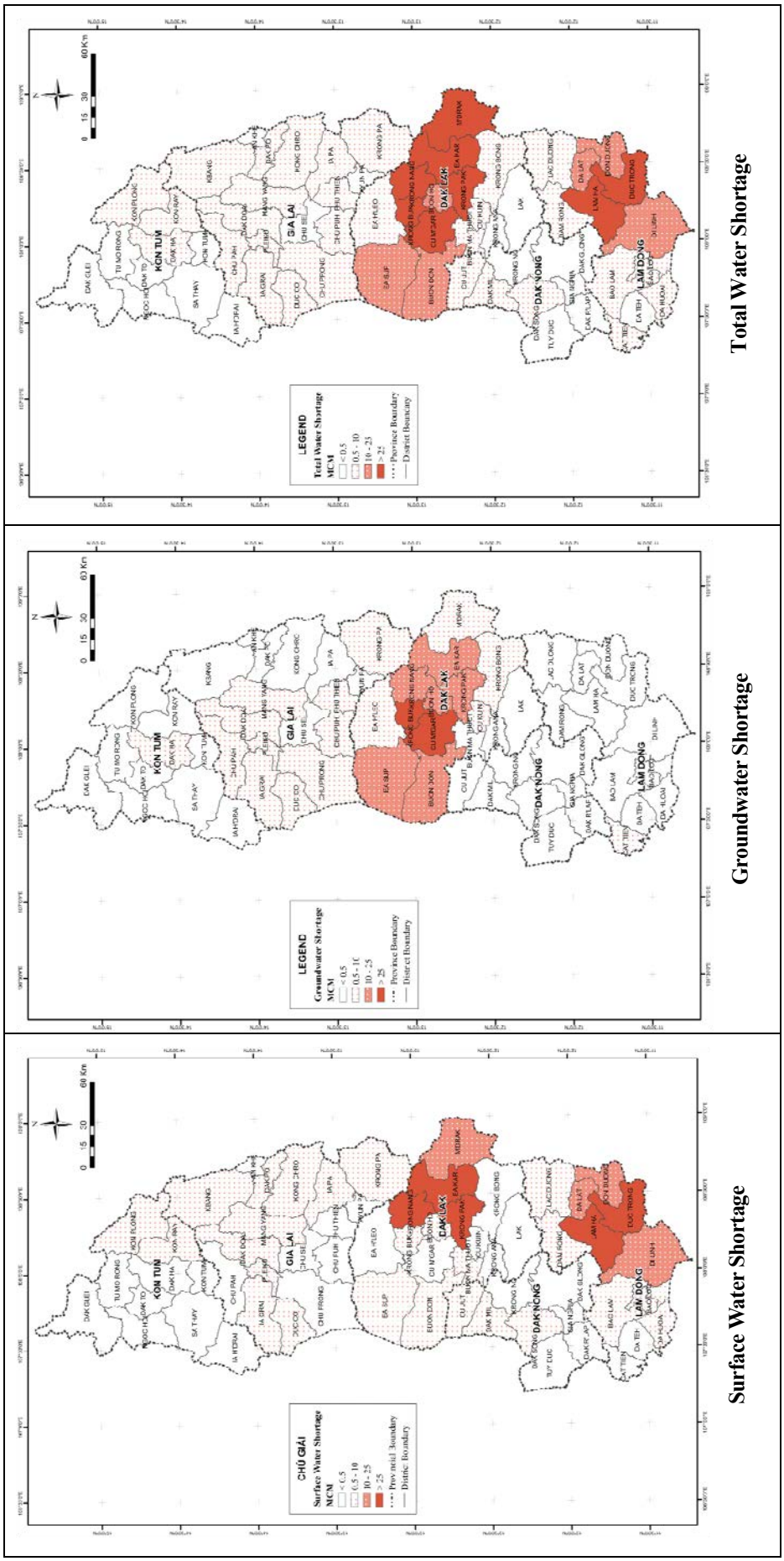


Figure 4.3.2 Water Shortage in Central Highlands in Dry Year

Source: JICA Study Team

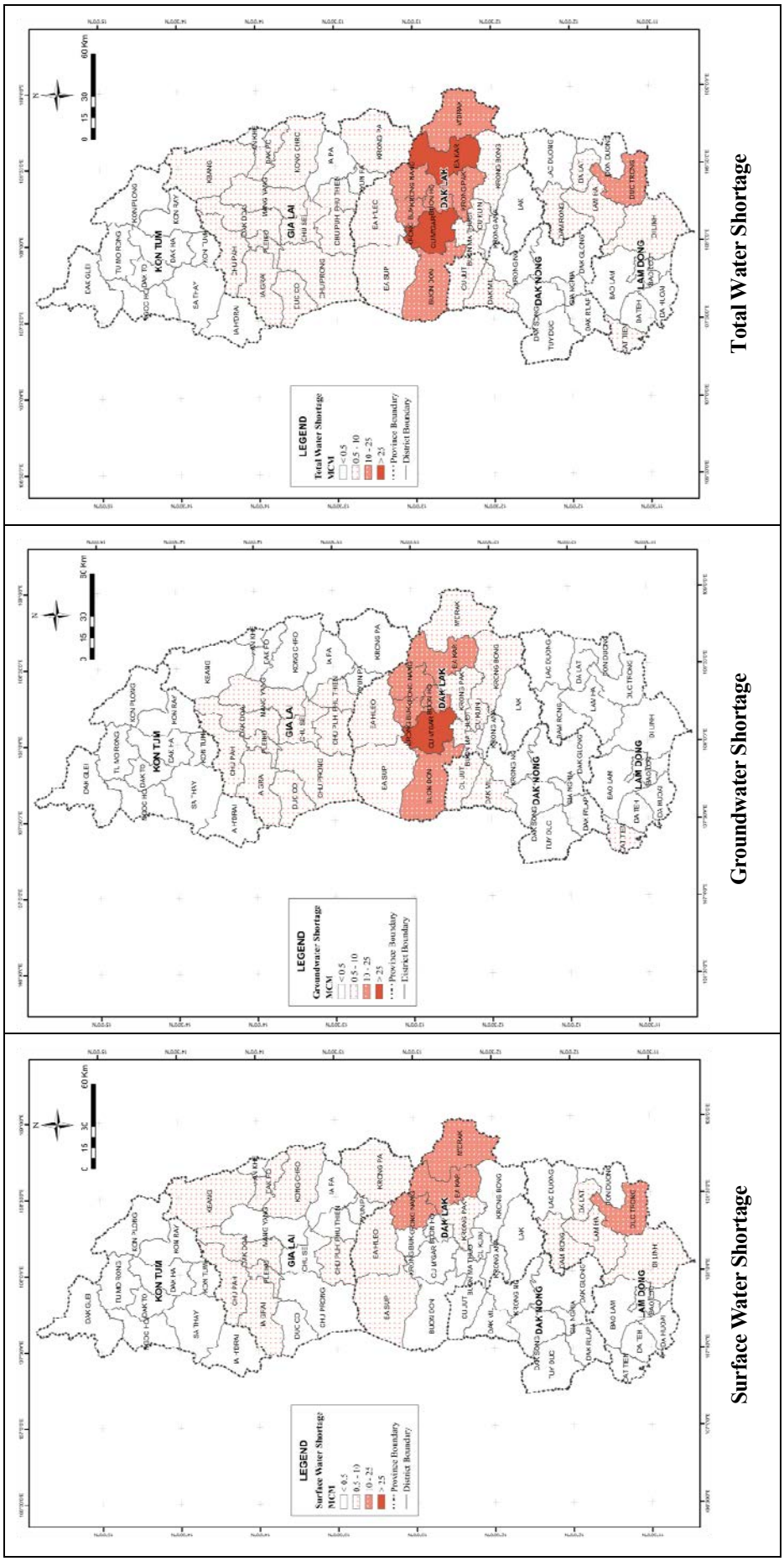


Figure 4.3.3 Water Shortage in Central Highlands in Wet Year

Source: JICA Study Team

4.4 Disaster Risk of Provinces and Districts

4.4.1 Disaster Risk Assessment of the Five Provinces

Based on the assessment of water resources in Central Highlands, the JICA Study Team evaluated the disaster risk of the five provinces. The average rate of damaged areas by droughts and floods in the recent seven years is applied to evaluate their disaster risks as follows:

Table 4.4.1 Evaluation Criteria on Disaster Risk

Risk Class	Average Damage Area (%)	
	Drought	Flood
1. Low	<1%	<0.1%
2. Moderate	1~2.5%	0.1~0.5%
3. High	2.5~5%	0.5~1.5%
4. Very high	>5%	>1.5%

Source: JICA Study Team

The drought risks in Kon Tum and Dak Nong provinces were categorized as "Low" level. Gia Lai and Lam Dong provinces were classified into "Moderate Level" and "High Level", respectively. The highest risk of "Very High Level" was applied to Dak Lak Province. The risk of Central Highlands, namely; average of the five provinces, was recognized as "High Level". Regarding flood risk, Lam Dong Province was classified as "Very High Level". The flood risks in Kon Tum and Gia Lai provinces were classified as "Moderate Level". Dak Lak and Dak Nong provinces were categorized as "High Level" and "Low Level", respectively. Considering the total risk of drought and flood, Dak Lak and Lam Dong provinces were of higher risk than the other provinces.

Table 4.4.2 Risk Class of Five Provinces

Province	Risk Class	
	Drought	Flood
Kon Tum	1	2
Gia Lai	2	2
Dak Lak	4	3
Dak Nong	1	1
Lam Dong	3	4
Central Highlands	3	3

Source: JICA Study Team

4.4.2 Disaster Risk of Districts

(1) Drought and Water Shortage

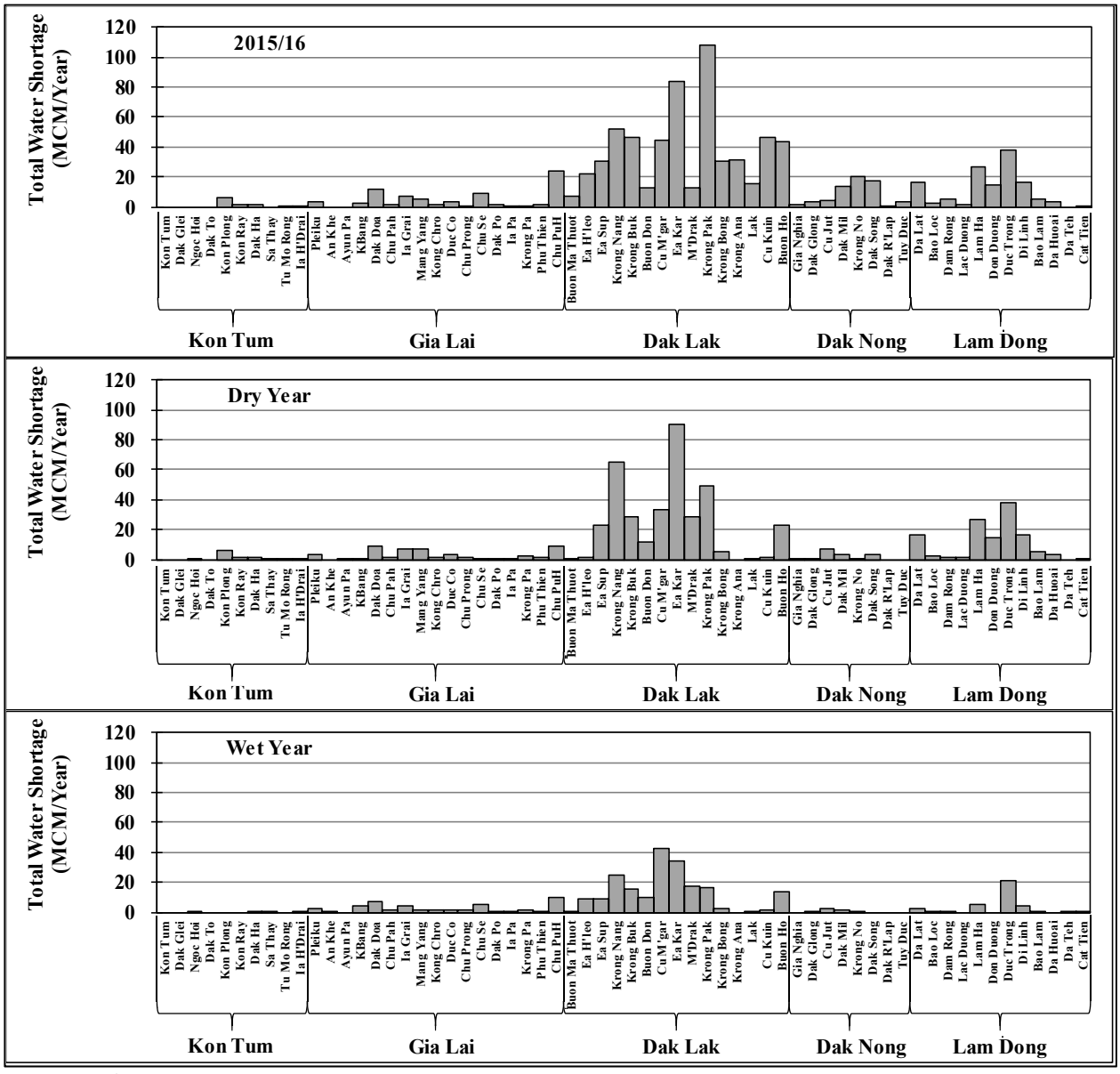
The districts classified high total water shortage both for the surface and groundwater in Central Highlands, and are shown below. Dak Lak Province faced a serious water shortage both at surface and groundwater in 2015/16 during the dry year. Even in the wet year, Cu M'gar and Ea Kar districts in Dak Lak Province might face high water shortage. In Lam Dong Province, Lam Ha and Duc Trong districts faced high water shortage in 2015/16, shown as follows:

Table 4.4.3 High Water Shortage by District in Central Highlands

Province	Year	Water Shortage of 10 ~ 25 MCM/year	Water Shortage of more than 25 MCM/year
Kon Tum	2015/16	-	-
	Dry Year	-	-
	Wet Year	-	
Gia Lai	2015/16	Dak Doa and Chu PuH	-
	Dry Year	-	
	Wet Year	-	
Dak Lak	2015/16	Ea H'leo, Buon Don, M'Drak, and Lak	Krong Nang, Krong Buk, Cu M'gar, Ea Kar, Krong Pak, Krong Bong, Krong Ana, Cu Kuin, Buon Ho, and Ea Sup
	Dry Year	Buon Ho, Ea Sup, Buon Don	Krong Nang, Krong Buk, Cu M'gar, Ea Kar, M'Drak, and Krong Pak
	Wet Year	Krong Nang, Krong Buk, Buon Don, M'Drak, Krong Pak, and Buon Ho	Cu M'gar and Ea Kar
Dak Nong	2015/16	Dak Mil, Krong No, and Dak Song	-
	Dry Year	-	-
	Wet Year	-	
Lam Dong	2015/16	Da Lat, Don Duong, and Di Linh	Lam Ha and Duc Trong
	Dry Year	Da Lat, Don Duong, and Di Linh	Lam Ha and Duc Trong
	Wet Year	Duc Trong	Duc Trong

Source: JICA Study Team

During the wet year, available surface water was enough, but groundwater was far from sufficient in Cu M'gar District of Dak Lak Province. It is considered that uncontrolled development of groundwater to irrigate the extended perennial crops' field is underway. On the other hand, the water availability of surface water and groundwater in wet year is not enough in Ea Kar District in Dak Lak. More than 25% of the total water demand from surface water are used for fishery and more than 20% of that from groundwater are consumed for domestic use. The common issues of both districts are land use change and groundwater development and exploitation. Monitoring and regulation to control these are essential for sustainable water use.



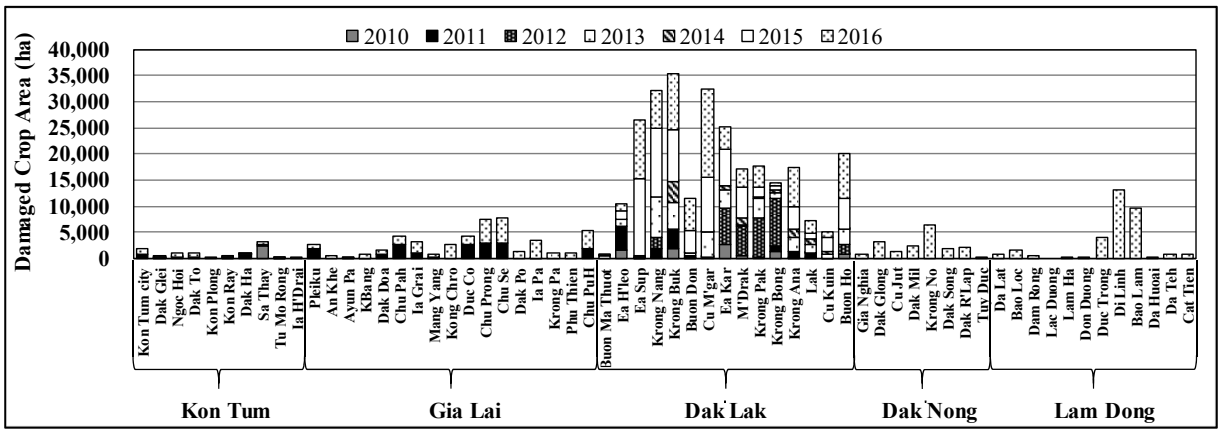
Source: JICA Study Team

Figure 4.4.1 Total Water Shortage by Districts in 2015/16, Dry and Wet Years

The drought damage in 2015/16 was serious as shown in the figure above. Most of the districts in Dak Lak Province were affected by the droughts in 2015/16.

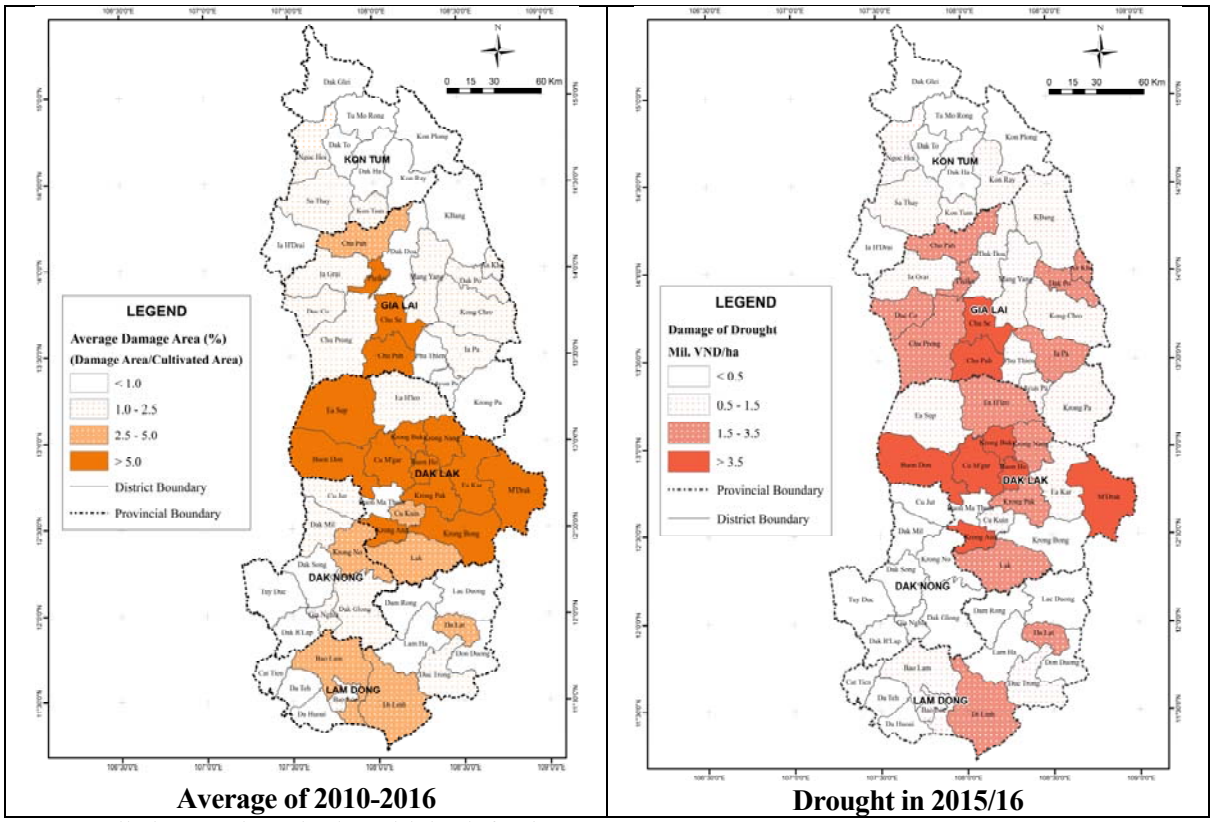
The crop damage value per total cultivated area in the district in 2015/16 is described in the following figure. The Gia Lai and Dak Lak provinces faced serious crop damages in 2015/16, where crop damage per crop area was more than VND 3.5 million/ha in 2015/16. In Gia Lai Province, Chu Se and Chu Puh districts faced high drought damages which was more than VND 3.5 million per ha of the crop area in 2015/16. In Dak Lak Province, Buon Don, Cu M'gar, Krong Buk, Buon Ho, M'Drak, and Krong Ana districts faced high drought damage which was more than VND 3.5 million per ha of the crop area in 2015/16. Krong No District in Dak Nong Province

and Bao Lam and Di Linh districts in Lam Dong Province faced area drought damages of more than 5,000 ha/year in average from 2010 to 2016.



Source: Statistical Book of Provinces.

Figure 4.4.2 Damaged Crop Area by Drought in Central Highlands (2010-2016)

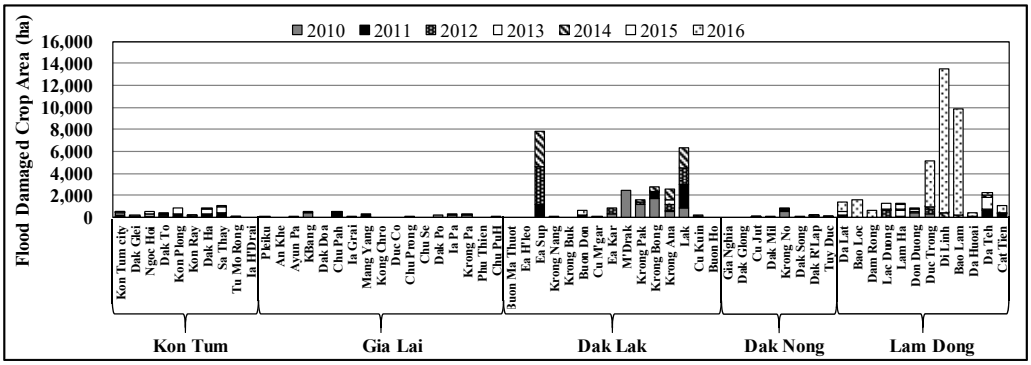


Source: Prepared by the JICA Study Team based on Statistical Book of Provinces.

Figure 4.4.3 Disaster Map of Drought in Central Highlands

Although the flood affected areas were observed in all provinces in Central Highlands, damages on households were recorded at districts of Dak Lak and Lam Dong only, especially in Ea Sup District in Dak Lak and Da Teh District in Lam Dong, which suffered serious damages.

In Lam Dong Province, which is located in Dong Nai River basin, flood damage in 2016 was most serious in the recent seven years. The return period of the annual maximum daily rainfall of Da Lat Rainfall Gauging Station in 2016 was at 15.2 years (=1/15) and the maximum daily rainfall was at 201.5 mm/day. Due to lack of flood protection and flood control facilities, these areas were affected by flood.



Source: Statistical Book of Provinces.

Figure 4.4.4 Damaged Crop Area by Flood in Central Highlands (2010-2016)

4.4.3 Necessity of a Detailed Survey in Selected Districts

The JICA Study Team conducted water balance study based on the water demand at the district level and water availability at sub-basin level, hydrological phenomena, such as flood and groundwater utilization should be investigated for verification of the status and formulation of necessary countermeasures for improving situation more concretely. Furthermore, for the purpose of prioritizing the project plans prepared for the five provinces, the detailed survey shall be implemented by the JICA Study Team to grasp the development needs at the local level and preparation of project scope in accordance with the conditions at the site.

Since the target area of the Study is too large to visit and investigate, a specific target area shall be selected. Considering the results of the review of the status of districts on water shortage, the JICA Study Team first picked 13 districts in Central Highlands. Among the 13 districts, the JICA Study Team selected seven districts in consideration of the seriousness of water shortage and disaster damages of droughts and floods, and are as follows:

Table 4.4.4 Selected Districts to Conduct Detailed Survey by Water Shortage and Flood

Province	District	Year	Water Shortage (MCM/year)			Average Damage Area (%) 2010-2016 *1)		Evaluation of Risks				Selected District
			Total	SW	GW	Drought	Flood	SW	GW	Drought	Flood	
Kon Tum	Kon Plong	2015/16	6.55	6.55	0	0.51	1.44	X	-	-	X	-
		Dry Year	6.55	6.55	0							
		Wet Year	0	0	0							
	Kon Ray	2015/16	1.35	1.28	0.06	0.53	0.23	X	-	-	X	-
		Dry Year	1.35	1.28	0.06							
		Wet Year	0	0	0							
	Dak Ha	2015/16	1.21	0	1.21	0.68	0.52	-	X	-	XX	Selected
		Dry Year	1.21	0	1.21							
		Wet Year	0.43	0	0.43							
Gia Lai	Chu Puh	2015/16	24.06	4.88	19.18	6.67	0.04	X	XX	XXX	-	Selected
		Dry Year	9.35	0.00	9.35							
		Wet Year	9.69	3.83	5.86							
	Dak Doa	2015/16	11.98	1.72	10.27	0.84	0	X	XX	-	-	-
		Dry Year	9.52	1.45	8.07							
		Wet Year	6.78	2.29	4.49							
Dak Lak	Cu M'Gar	2015/16	44.61	0.18	44.43	6.79	0.03	-	XXX	XXX	-	-
		Dry Year	33.62	0.23	33.39							
		Wet Year	42.52	0.21	42.31							
	Ea Kar	2015/16	83.60	63.60	20.00	5.44	0.18	XXX	XXX	XX	X	Selected
		Dry Year	90.05	66.57	23.48							
		Wet Year	34.31	19.65	14.66							
	Ea Sup	2015/16	30.36	2.87	27.48	8.65	2.56	X	XXX	XXX	XXX	Selected
		Dry Year	22.82	2.66	20.15							
		Wet Year	9.24	6.76	2.48							
Dak Nong	Krong No	2015/16	19.9	18.46	1.45	1.82	0.26	XX	X	X	X	Selected
		Dry Year	0.05	0.05	0							
		Wet Year	0.09	0.09	0							
	Dak Song	2015/16	17.89	7.34	10.55	0.59	0.01	X	XX	-	-	-
		Dry Year	3.33	3.33	0							
		Wet Year	0	0	0							
Lam Dong	Lam Ha	2015/16	27.15	27.15	0	0	0.36	XX	-	-	X	-
		Dry Year	27.15	27.15	0							
		Wet Year	5.23	5.23	0							
	Di Linh	2015/16	16.46	16.46	0	3.75	3.88	XX	-	XX	XXX	Selected
		Dry Year	16.46	16.46	0							
		Wet Year	4.09	4.08	0							
	Duc Trong	2015/16	37.67	37.67	0	2.21	2.57	XXX	-	XX	XXX	Selected
		Dry Year	37.67	37.67	0							
		Wet Year	21.19	21.19	0							

Note: 1) Average damaged crop area per total cultivated area (ha/ha=%) during 2010 to 2016. "SW" means surface water, "GW" means groundwater. "X" means moderate risk, "XX" means high risk and "XXX" means very high risk. Gray colored cells are main purpose of field survey.

Source: JICA Study Team

In those areas, the JICA Study Team conducted field survey consisting of i) an interview survey with the concerned government officers and rural residents including farmers to obtain the additional information on the actual constraints and development needs, ii) reconnaissance at the areas that were seriously and frequently impacted by disasters and struggling with water shortage to identify project scopes for improvement of the current status.

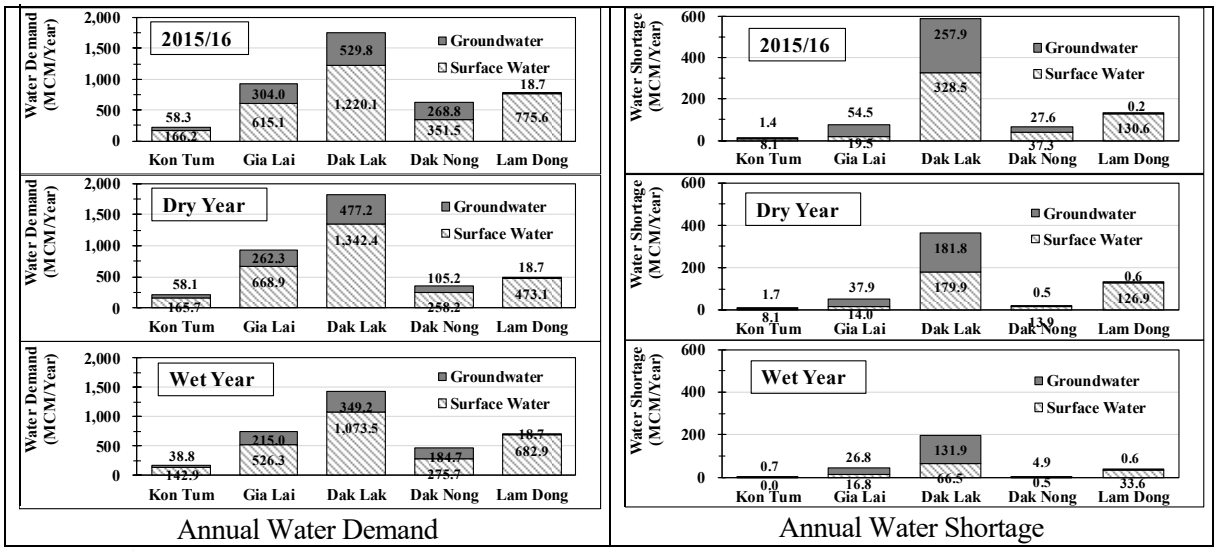
CHAPTER 5 WATER RESOURCES UTILIZATION AND MANAGEMENT PLAN

5.1 Issues

5.1.1 Outline of Water Shortage, Drought, Flood, and Other Disasters in Central Highlands

Based on the result of water balance study in dry and wet years, the impact of drought from 2015 to 2016 and disaster record from 2010 to 2016, the situation of drought, water shortage, flood and other disasters are assessed.

Water demands in Dak Lak and Gia Lai provinces are very high even in wet year compared with other provinces. While, water shortage in Dak Lak Province is very high even in wet year. Dak Lak is the most vulnerable area affected by drought as well as other natural disasters, where the damaged area by drought was around 13,000 to 95,000 ha and generally more than half of the total damaged area in Central Highlands in the last seven years. Although Lam Dong Province suffers from drought every year since 2010, the damaged areas were fewer than 2,000 ha except in 2016. Gia Lai and Dak Nong provinces are sometimes facing drought, however, the damaged areas in one drought event reached to more than 17,000 ha.



Source: JICA Study Team

Figure 5.1.1 Water Demand and Shortage in Central Highlands

On the other hand, flood analysis is difficult to be conducted in Central Highlands due to lack of hydrological data such as hourly rainfall and water level of the rivers. It is one of the most serious issues to tackle in flood control since the actual situation under heavy rain could not be revealed without enough record.

According to the disaster records from 2010 to 2016, the situation of flood is outlined to capture the provincial and district trends. The southern part of Kon Tum Province was affected correspondingly by flood disasters for recent seven years, but the damages were not serious. In Gia Lai Province, the eastern part of the Ba River basin and western part of the Srepok River basin faced flood damage. In Dak Lak Province, north-western and south-eastern part in the Srepok River basin had a serious flood damage. In Dak Nong Province, upstream of the Dong Nai River basin faced flood damage. All parts of Lam Dong Province faced flood damage, as well as serious drought damage.

5.1.2 Causes of Water Shortage, Drought, Flood, and Other Disasters

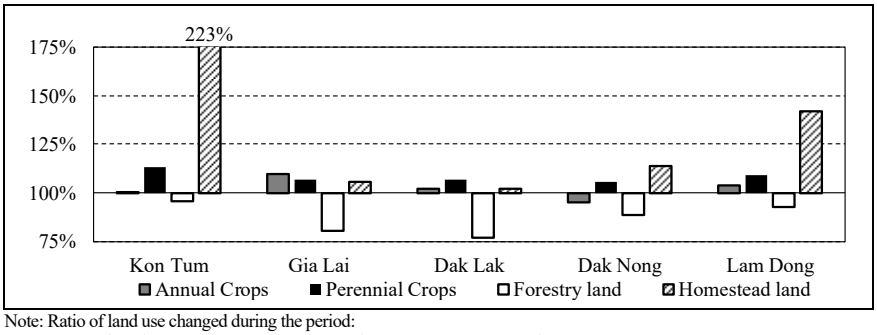
1) Land Use

The shares of areas of annual crops (20%), perennial crops (18%), and residential area (21%) in Dak Lak Province are higher than the other provinces, especially the residential area is very large. Therefore, water demand of domestic and irrigation water in Dak Lak is higher. The shares of cropped area in Dak Lak is coffee at 67% and pepper at 9% among the total cropped area for perennial crops in the province that is also

higher than the other provinces. The cropped area in Gia Lai is also similar to Dak Lak. Due to the above conditions, water shortage in the Dak Lak and Gia Lai is very high even in wet year. Moreover, groundwater irrigation for coffee and pepper in Dak Lak and Gia Lai is high at 44.0% and 39.5%, respectively, compared with the other provinces.

In addition to the current conditions above, the trends of water demand are assessed through the change of land use. In recent years, the residential area was drastically expanded in Central Highlands, especially in Kon Tum and Lam Dong at 223% during 2012 to 2016 and 142% during 2013 to 2016, respectively. The cropped area of perennial crops also increased, particularly in Kon Tum and Lam Dong at 13.5% from 2012 to 2016 and 9.4% from 2013 to 2016, respectively. The annual crops' areas increased in the five provinces except in Dak Nong. Gia Lai extended the area of annual crops at 9.5% from 2012 to 2016. On the other hand, the forest area shrank in all provinces. In Gia Lai and Dak Lak, deforested area was at around 20% of the total forest area in 2012 to 2016.

Deforestation, shifting land use from forest to cropped areas and the increasing residential area may lead to reduced volume of rechargeable groundwater[1] and increased surface discharge from the replaced areas. Finally, it results in more severe flood including flashflood at the upstream area. In Gia Lai Province, the cropped area of annual crops expanded at 10% in the last five years with deforestation at 20% in the same period. The flood damaged area in Dak Lak Province becomes riskier than before due to the drastic deforestation in the province. The following figure shows the transition of land use by provinces from 2012 to 2016:



Note: Ratio of land use changed during the period:
Kon Tum & Gia Lai: 2012 to 2016, Dak Lak & Dak Nong: 2012 to 2015 and Lam Dong :2013 to 2016
Source: JICA Study Team

Figure 5.1.2 Transition of Land Use in Central Highlands (2012-2016)

2) Agriculture

The existing operation and maintenance (O&M) organizations of the irrigation systems such as Irrigation Management Company (IMC), district administration, etc., are not able to execute O&M activities sufficiently. In Central Highlands, degradation of irrigation facilities and farmers' tendency to irrigate more than crop water requirement were reported[2]. Irrigation efficiency is lower and the irrigation water demand is increased. In the water balance study by the Japan International Cooperation Agency (JICA) Study Team, irrigation efficiency of 0.65 was applied, that means 35% of water were lost during conveyance and distribution to crop fields. Moreover, water users' groups (WUGs) are very limited at the area less than 10% of district irrigation systems. Without participation of beneficiaries for O&M of the irrigation system, irrigation water saving as well as proper O&M of the system could not be implemented.

3) Socioeconomic Condition

In Kon Tum and Dak Nong provinces, the migration rates from outside provinces were higher than the other provinces in these years and those immigrants lived in the rural area more than the urban area. Increase of rural population tends to extend their residential area with deforestation and expansion of cultivated areas. In addition to deforestation and land reclamation, they may intend to live in flood-prone area because the areas

[1] Nguyen Thi Ngoc Quyen, et al. (2014), International Soil and Water Conservation Research.
[2] Phan Thanh Dinh, et al. (2017), International Journal of Agricultural Science and Research.

preferable for living and cropping were already occupied by the local people plus their lack of knowledge where the risky areas are located.

The water supply systems are less developed in Gia Lai than those in the other provinces. The scarce water supply fatally affects human livelihood and livestock in the drought period. The flood also increases the damages on people and their properties as well as crop production. In Kon Tum and Dak Nong provinces, the conditions of road maintenance are poor leading to frequent isolation of rural areas during the flood period.

4) Climate Change

In accordance with the recent announcement by the scientists, rainfall in Vietnam will increase from 5% to 15% in the future. The increase is not only in annual rainfall but also in the intensity of rainfall. Intensive rainfall and its frequent occurrence increase the damage of flood and other disasters such as flashflood and landslide. On the other hand, the rainfall tends to be unstable and decreases in the dry season. From summer of 2014 to spring of 2016 was the "El Niño" period on that same period of 2015-2016, Central Highlands faced a serious drought.

5.1.3 Identified Eight Issues

Analyzing the above causes, the JICA Study Team identified the eight key issues as follows:

1) Water Demand

Along with the rapid population growth, urbanization and reclamation of cropped area, water demand in Central Highlands has been increased in all sectors and reached to 5,657 MCM/year in 2015/16. Among them, irrigation water demand shared more than 80% of the total water demand. Despite the large share of irrigation water demand, O&M of the irrigation systems is not properly made and water saving practices are rarely implemented.

2) Water Utilization

Due to the limitation of the farmers' knowledge on crop water requirement and uncontrolled usage and development of groundwater in Central Highlands, overuse of irrigation water prevailed.

3) Natural Condition

During the five-year period from 2012 to 2016, 14% of the total forestry area in Central Highlands (about 400,000 ha) was lost. Such deforestation may accelerate landslide and limit groundwater recharge. Those negative impacts are to be enhanced by climate change because the rainfall intensity is predicted to increase in the rainy season and decrease in the dry season.

4) Infrastructure

Based on information from the provinces and site survey, existing flood control facilities and flood evacuation preparation are not enough. Furthermore, only 12 flood projects are planned in the mid-term investment plan 2016-2020.

5) Farmers' Livelihood

Although water saving irrigation is useful to reduce irrigation water demand and some advanced farmers have already introduced it, majority of farmers have constraints in investing water saving facilities. In addition, due to the limited improvement of farming technologies and crop diversification, the quality of agricultural products and their sales prices are low.

6) O&M of Irrigation Systems

Since the financial and human resources are not sufficient in IMC, Provincial People's Committee (PPC), and District People's Committee (DPC), who are in-charge of O&M of provincial and district irrigation systems, irrigation facilities are not well-operated and maintained. In spite of the necessity to involve WUG

for tertiary and field facilities, organizational or collective activities are rarely conducted. Moreover, the demarcation of responsibility between IMC and WUG seems uncertain.

7) Observation and Monitoring of Water Resources

For mitigating disaster damages, the disaster-prone and disaster-vulnerable area are to be identified by water balance study and flood analysis based on the data real-time meteorological and hydrological recorded at the stations. In addition, flood forecasting and warning systems are useful for further mitigation of the damages. However, those stations are not sufficiently developed in Central Highlands.

8) Observation and Monitoring of Water Resources (Surface Water and Groundwater)

Observation of meteorology, hydrology, and groundwater level is insufficient. In addition, dam/reservoir operation is recorded only at 74 major reservoirs. Consequently, water resources monitoring activities for assessing water balance in the catchment area have not been undertaken.

5.2 Development Direction for Water Resources Management and Disaster Prevention

5.2.1 Common Countermeasures for Water Resources Management and Disaster Prevention

Based on the current conditions relating to water resources management, disaster situation and water balance, the JICA Study Team proposed directions for the five provinces as follows:

Table 5.2.1 Disaster Risk Level and Countermeasures for Water Resources Management

Disaster	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
Drought Risk	Level 1. Low	Level 2. Moderate	Level 4. Very High	Level 1. Low	Level 3. High
Flood Risk	Level 2. Moderate	Level 2. Moderate	Level 3. High	Level 1. Low	Level 4. Very High
Common Countermeasure	• Promote total management of water use • Water saving irrigation • Optimize land use and crops' cultivation • Enhance monitoring system on climate and hydrology • Optimize forest management for recharging groundwater • Enhance monitoring system of groundwater exploitation and promote water saving measures • Establish water balancing assessment and early alarming system in the local area • Relocate residents from flood-prone area • Establish coordination system for domestic and industrial water use				

Source: JICA Study Team

The development directions and necessity and urgency of those countermeasures were assumed to differ among the five provinces and drought- and flood-prone areas. Therefore, the JICA Study Team conducted the site survey at the representative drought and flood-prone areas for further assessment and concretization of priority projects.

5.2.2 Development Strategy

Through the site survey, the JICA Study Team found that the needs of farmers and villagers, especially the needs of non-structural countermeasures, have significant locality; and current priority project plans are not satisfactorily matched with them. Particularly, there was a clear difference among the plans and needs regarding urgency to implement the countermeasures against disasters. While the priority projects collected from the relevant provincial organizations focused mainly on structural development, the JICA Study Team considered implementation of non-structural development in parallel with the structural one. Moreover, the maturity of the priority projects that were prepared by the provincial departments concerned for the period of 2020 onward is not enough to implement them in the near future expecting immediate effects.

Considering the urgency for mitigating disaster damages, the effect of countermeasures should be immediately realized in short- and mid-terms. Therefore, since obtaining financial supports from outsources, such as the official development assistance (ODA), take much time, the project pursuing immediate and local benefit should be initially implemented by using the provincial budget. On the other hand, the large-scale project could be implemented with careful examination of technical and economic feasibility. In conclusion, preparing development directions based on the study results were deemed to be more realistic and useful for Central Highlands rather than the prioritization of the existing priority projects.

In order to ensure the immediate implementation of disaster prevention projects, the JICA Study Team sets the following basic strategies:

1) Initiatives of project planning and implementation shall be taken by the provinces in Central Highlands.
2) The projects to be planned shall be implemented basically by the provincial budget and resources through reallocation of available budget.
3) Attraction and participation of private investment shall be promoted considering the benefits of local residents and farmers.

5.2.3 Development Directions

Based on the results of the study including the site survey, the JICA Study Team assessed the necessary countermeasures considering those relations and effects; and organized the following four development directions:

1. Irrigated Agricultural Modernization
2. Strengthening Farmers' Organization for Sustainable Irrigation Management
3. Community-based Rural Livelihood Improvement in Flood-prone Area
4. Community-based Monitoring for Effective Utilization of Local Water Resources

Socioeconomic Situation

1) Water shortage (shortfall of 15.3% in water demand in 2015/16 *1)
2) Urbanization (8.28% of residential land in the region *2)
3) Rapid population increase (2009~2013 = +1.65 %/year *3)
4) People (immigrants) live in flood-vulnerable area
5) Unstable livelihood in the flood-prone areas

Source:
*1: JICA Study Team
*2: MONRE
*3: General Statistics Office of Vietnam / Statistical Yearbook of Vietnam

(1) Water Demand

1) Water demand has been increased in all sectors (total water demand in 2015/16 is 5,657 MCM/year *1).
2) The irrigation water shares more than 80% of total demand.
3) Water demand for agriculture is not controlled and efforts for reduction are not effectively done yet.

(2) Water Utilization

1) No effective control in groundwater use.
2) Farmers' knowledge on crop water requirement is limited and overuse of irrigation water is prevailed.
3) No effective water sharing.

(3) Natural Condition

1) Deforestation (lost nearly 14% of the forest area (about 400,000 ha) in 2012 to 2016*3).
2) Climate Change (Average temperature rise to 1.7 ~ 2.4 °C at the end of the 21st century from 2015. Annual rainfall will increase at 2~10% and rainfall intensity will increase in the rainy season and dry season rainfall will decrease*2).

(4) Infrastructure

1) Limited flood control facility and flood evacuation preparation (only 12 flood projects in mid-term investment project 2016-2020).

(5) Farmers' Livelihood

1) Farmers' financial constraints for investing water saving facilities.
2) Limited improvement of farming technologies and crop diversification.
3) Low quality and low sale prices of agricultural products.

(6) O&M of Irrigation Systems

1) Limit of IMC and PPC's financial and human resources.
2) No organizational or collective actions for O&M.
3) Uncertainness of demarcation of responsibility between IMC and farmer's organizations.

(7) Observation and Monitoring of Water Resources

1) Limited real-time meteorological (17) and hydrological (16) stations.
2) Limited flood forecasting and warning system.

(8) Observation and Monitoring of Water Resources (Surface and groundwater)

1) Insufficient collection of meteorological and hydrological (MH), groundwater level data, and records on dam/reservoir (74 major reservoirs) operation.
2) There have been no water resource monitoring activities for assessing water availability and estimating water shortage in the catchment area

(1) (2) (5)

Countermeasures

1) Prepare guidelines for introducing water saving facilities and O&M of pipeline system.
2) Implement the Training of Trainer (TOT) for DARD and district staff on irrigated agricultural modernization.
3) Repair and rehabilitate canals with lining and piping, introduce water saving facilities at farmers' level, and develop or rehabilitate small-scale reservoirs and ponds.
4) Develop access road to reduce transportation cost.
5) Promote collaboration between farmers and private sectors through contract farming.
6) Train farmers to improve farming technology and marketing activities.
7) Disseminate appropriate varieties (short growing period, drought tolerant) and water saving cropping pattern.
8) Conduct water balance analyses, share the results with districts, communes, and farmers and coordinate with them to minimize peak irrigation water demand.

Effects

1) Capacity of staff on agricultural extension and irrigation in the target districts is enhanced.
2) Investment by traders, local enterprises, and organic promotion companies for improving farming technology, marketing, etc. are promoted.
3) Irrigation system and access road are developed.
4) Quality of products and farming technology are improved.
5) Water demand in peak dry season is decreased and risk of water shortage is mitigated.

Direction #1: "Irrigated Agricultural Modernization"

(1) (2) (6)

Countermeasures

1) Prepare provincial policy on support of farmers for sustainable O&M of irrigation systems.
2) Prepare guidelines for farmers to reduce overuse of surface and groundwater.
3) Monitor groundwater utilization.
4) Implement TOT on O&M for DARD and district staff.
5) Provide guidance training to farmers on irrigation scheduling and O&M of irrigation facilities.
6) Organize farmers' water user groups and strengthen their roles and functions.
7) Promote utilization of water saving facilities and improve farming technologies in cooperation of private sectors.

Effects

1) Capacity of DARD and district staff on O&M of irrigation sysrtems is enhanced.
2) Farmers' participation in water management and O&M of irrigation facilities are extended and enhanced.
3) Appropriate irrigated farming is executed under the cooperation of private sectors.

Direction #2: "Strengthening Farmer's Organizations for Sustainable Irrigation Management"

(3) (4) (7)

Countermeasures

1) Prepare guideline for participatory approach on prevention of flood damages.
2) Prepare and implement TOT programs for district staff, village people, community groups and Steering Committee for Disaster Prevention and Control.
3) Increase technical capacity of DONRE and the National Center for Hydro-Meteorological Forecasting (HMF) for flood forecasting and analysis.
4) Linkage with MH monitoring at sub-basin level.
5) Upgrade tools and sources for communication and sharing information up to the village level.
6) Promote private investment and cooperation between private sectors and villagers for establishing MH monitoring system and information dissemination.
7) Assess existing land use plan and make necessary revision and relocate residents in flood-prone areas.
8) Introduce livelihood improvement activities in the flood-prone areas.

Effects

1) MH data are monitored and assessed, and warning and evacuation systems including shelters for emergency are established.
2) Flood forecasts and analyses are conducted and useful information are shared with districts, communes and villagers.
3) All relevant sectors participate in real-time MH monitoring system, its O&M, early warning system for flood and evacuation.
4) Local people's livelihood in the flood-prone area is stabilized and improved.

Direction #3: "Community-based Rural Livelihood Improvement in Flood-prone Area"

(1) (2) (8)

Countermeasures

1) Assess the existing data on MH, GW, and locally monitored information on water resources.
2) Prepare guidelines and systems for water resources monitoring and assessment activities, including linkage with wider area on water resources assessment information, water balance assessment, early drought warning system and information dissemination to districts, communes, farmer groups (FGs), and villagers.
3) Prepare and implement training program for establishing monitoring and assessment systems (O&M of MH, GWL monitoring systems and dam/reservoir operation).
4) Promote business matching activities between private firms and districts/FGs.
5) Enhance collaboration between villagers and private sectors, and encourage private investments for introducing MH and GWL monitoring systems.

Effects

1) Water resources are well monitored and assessed locally for valid water resources utilization.
2) Drought forecasts and analyses are conducted and the results are shared with districts, communes, and villagers for reduction of drought damages.
3) Capacity of district and commune staff is enhanced.
4) Private participation in early warning system for drought is established.

Direction #4: "Community-based Monitoring for Effective Utilization of Local Water Resources"

Figure 5.2.1 Outline of Development Directions for Water Resources Management and Disaster Prevention in Central Highlands

(1) Development Directions for Water Use

1) Irrigated Agricultural Modernization (Ref. AT 5.2.1)

(a) Water Saving Irrigation

Since the agricultural water demand occupies about 80% in Central Highlands even during the wet year, countermeasures to reduce irrigation water demand may be necessary. In order to reduce the demand, improvement and rehabilitation of irrigation facilities and development of pipeline system were proposed to increase irrigation efficiency of surface water and groundwater. The irrigation water demand mainly consists of the crop water requirement and losses. The crop water requirement is determined by crop type and natural condition that are difficult to control. Meanwhile, 35% of irrigation water was considered to be lost during conveying and distributing water from water sources to crops. It means that about 27% (= 80% x 35%) of the total water demand in the region is not utilized. Therefore, irrigation water saving is highly efficient countermeasure against drought.

Even though the improvement and rehabilitation of irrigation facilities and construction of pipeline systems are implemented, those irrigation systems may not be efficiently functioned and are unsustainable without proper O&M. As JICA and the Ministry of Agriculture and Rural Development (MARD) promoted, Participatory Irrigation Management (PIM) is useful to realize adequate O&M of irrigation system by farmers and it should be disseminated with training programs for farmers and other local stakeholders, such as irrigation division of the Department of Agriculture and Rural Development (DARD), district staff, IMC, and non-governmental organization (NGO). It is practically impossible for those organizations to operate and manage the irrigation facilities scattering in rural areas. Therefore, the participation of farmers in O&M of irrigation system is inevitable.

(b) Increase of Agricultural Productivity and Products' Values

For dissemination of water saving facilities and equipment, the current income of common farmers could not afford their investment. The current crops' varieties and farming practices could not produce high value and marketable products that may increase producers' income. In addition to the agricultural extension activities, cooperation with private companies such as traders, processers, etc. will be a key to accelerate modernization of irrigated agriculture. For attracting and promoting investment by private sector, improvement of rural road to reduce the transportation cost will be also one of the key factors. Participation of local communities and private sectors for irrigation water saving, increase of productivity and value of products need to be promoted. To connect private sector and farmers closely, contract farming can be a useful mechanism.

Furthermore, since the private sectors may possess the advanced technology of farming and marketing activities, farmers can obtain the technology through cooperation with them.

(c) Optimization of Land Use and Cultivation

Since the current land use plans of the five provinces were not prepared in consideration of water balance, farmers reclaimed cropped fields even though there were drought or flood-prone areas. Despite the lack of water, farmers could change their crops to other crops needing more irrigation water and need to develop groundwater wells, especially at hilly areas. For the purpose to control such situation, reassessment of their land use plans and cropping need to be made and countermeasures for appropriate and sustainable agricultural production activities need to be promoted at the local level.

To minimize drought damages to annual and perennial crops, short growing varieties both for dry and wet seasons for annual crops and drought tolerant varieties both for annual and perennial crops are recommended. Those varieties are extended as extension activities in Gia Lai and Dak Lak provinces. Early planting of annual crops both in the wet and dry seasons could reduce drought risks, crop diversification with high value and reduction of irrigation water requirement, shade tree planting in coffee, and pepper production to reduce evaporation, no planting coffee and pepper at no irrigation area are recommended and applied at some provinces (Ref. Section 3.4.3).

Deforestation is common problem among the five provinces, especially in Gia Lai and Dak Lak. Although the government organizations monitor and regulate illegal activities, further measures are necessary to control them. Even though the governments have limited budget and human resources, participation of the rural people including free migrants and the irrigation beneficiaries at the lower part of the watershed might be necessary for promoting watershed preservation and management activities. Watershed of the existing irrigation systems are deteriorated and available water resources, especially in the dry season, are decreasing due to deforestation and cultivation of forestry area.

Although the prediction of drought occurrence is important, it is still difficult to implement. To mitigate the unpredictable drought damages, diversification of crop varieties will be useful measures to diversify the drought risk. Another crop varieties and cropping pattern shall be adopted on the basis of water balance of the area.

(d) Coordination with Other Sectors

Increasing industrial and domestic water demand with industrialization and urbanization brought conflicts between those sectors and agricultural sector regarding water use, especially groundwater exploitation. To avoid such conflicts and to minimize peak water demand, a mechanism to coordinate every sector is required and the priority water use and sharing under drought situation shall be agreed. The local government units have responsibility to coordinate with them for technical assistance from the provincial departments, such as the Department of Natural Resources and Environment (DONRE), Department of Industry and Trade (DOIT), Department of Construction (DOC), and DARD.

2) Strengthening Farmers' Organizations for Sustainable Irrigation Management (Ref. AT 5.2.2)

(a) Organizational Development for Improving O&M of Irrigation System

After the construction of irrigation systems, operation and maintenance (O&M) of the irrigation systems become another issue to maintain the function of the systems. Under the irrigation systems, only the local farmers benefitted while farmer beneficiaries will not contribute for O&M of major irrigation facilities under the current irrigation policy. Not only for O&M of the major irrigation facilities, O&M of on-farm facilities could not be maintained by the farmers themselves in general. Irrigation subsidy is mainly used by the government sector such as IMC, districts, etc., however they are not capable to sufficiently execute water delivery and maintain the irrigation systems.

Responsibilities of farmer beneficiaries need to be reconsidered before the initiation of new irrigation projects. Sustainable irrigation development may be realized through further participation of farmer beneficiaries and their contribution for O&M activities. There are no beneficiaries in the irrigation development except for farmer beneficiaries in the service area. Rainfed or outside farmers do not receive benefit by a specific irrigation system.

Unlike the water supply systems, irrigation water delivery could not be properly made without consensus and coordination among farmers except for pipe irrigation systems that are very limited at present. The existing farmers' organizations at the local level may be potential organizations for proper irrigation water distribution and maintaining irrigation facilities. There are many local organizations in the rural area, but active water users' groups and organizations are very limited in Central Highlands. Promotion of establishing and activating water users' groups by a unit of turnout or lower irrigation canal is essential for sustainable irrigation development.

(b) Capacity Improvement for Guiding Farmers and Groups

To promote grouping and organizing farmer beneficiaries, improvement of the government capacity for guiding farmer beneficiaries on irrigation systems may be indispensable. Those capacities are limited at DARDs and districts at present. On the other hand, beneficiary farmers' dependence on the government will be a constraint for the organizational development. Growing cooperation among farmer beneficiaries could not be instantly made. The government guidance and provision of assistance to potential farmer beneficiaries are essential. Experienced trainers need to be deployed for practical trainers' training in Central Highlands.

By using opportunities to rehabilitate or improve the irrigation systems, organizing water users' groups and activating them could be one of the components and an essential condition for irrigation investment. Before

initiation of irrigation development at the feasibility study, the guidance to the farmer beneficiaries need to be made. Based on the result and assessment of farmers' responses on organizing water users' groups, investment for irrigation development could be formally decided.

(c) Promotion of Sustainable Irrigation Development under Collaboration between the Government and Beneficiaries' Organizations

Establishing and activating total O&M organization per irrigation system may be the target for sustainable irrigation development. At initiation, responsibility demarcation among the government sectors such as IMC, district administration, and water users' groups and their associations shall be made. For effective O&M of the system in the future, delegation or man of responsibility or management transfer for O&M of major irrigation facilities could be made depending on beneficiaries' capacity. Some of the irrigation subsidies may be allocated to the water users' groups and their association.

(2) Development Directions for Water Resources Management and Flood Prevention

1) Community-based Rural Livelihood Improvement in Flood-prone Area (Ref. AT 5.2.3)

(a) Enhancement of Monitoring System on Climate and Hydrology

The JICA Study Team proposed to develop hydrological monitoring system to conduct flood analysis. Based on the analysis, development of infrastructure including flood protection, flood control, and any other investment shall be planned. To establish valid plan for flood protection, the enhancement of hydrological monitoring system is essential.

(b) Prediction of Water Balance and Development of Early Warning System

- Based on the climate and hydrological data obtained by the enhanced monitoring system, the water balance study shall be implemented for the districts with high risk. The result shall be shared with officers of communes in-charge of irrigation and agriculture. Since people cannot determine when they should evacuate without flood early warning system, establishing hydrological monitoring system is indispensable. Flash flood is also a major problem in the upstream area of Central Highlands.

(c) Measures for Flood-prone Area

1. Coordination of Local Organizations and Flood Early Warning System

Even though the rural people receive flood early warning in advance, disordered evacuation may be another risk of damage. The evacuation shall be guided by local organizations such as commune peoples' committee. The past lessons learned need to be assessed and practical flood early warning system and evacuation procedures shall be prepared.

2. Relocation from Flood-prone Area

If the people live in the flood-prone area where protection measures are difficult to apply, relocation of people from the area will be one of the mitigation measures against flood damages. Needless to mention, the social and environmental situation of the concerned areas shall be considered.

3. Provision of Livelihood Support Programs

Under the frequent flood damages at the flood-prone area, the livelihood of farmers and residents is at low level. There may be free migrants and minority people. Depending on their selection of resettlement at safe area, government supports will be indispensable. Livelihood support at settled safe areas is essential to protect their return to the original flood-prone area. Even though a shortage of support fund and activities is common in Central Highlands, priority of budget provision and support execution need to be made.

2) Community-based Rural Monitoring for the Effective Utilization of Local Water Resources (Ref. AT 5.2.4)

(a) Enhancement of Monitoring System of Groundwater Exploitation and Promotion of Water Saving Measures

According to the result of interview survey conducted by the JICA Study Team, construction and exploitation of wells were not monitored and controlled even though DONRE mandated to regulate those activities. For the purpose of mitigating drought damages, groundwater exploitation shall be regulated for saving groundwater utilization and exploitation.

(b) Monitoring and Optimization of Dam Operation based on Local Water Balance

Through the data collection and field survey, the JICA Study Team found that operation of dams and reservoirs was rarely recorded. Therefore, validity of dam operation could not be assessed. Enhancing the monitoring system, dam operation shall be recorded to assess the validity and establish the optimized operation plan considering water demand of the area.

(c) Optimization of Forest Management for Recharging Groundwater

In view of increasing groundwater recharge, designation of the preserved forest based on the zoning through groundwater analysis may be necessary for drought mitigation. The measure shall be considered in parallel with necessary means for deforestation control and afforestation shall be implemented according to the forestry preservation plans. Although the governments are implementing afforestation projects and monitoring of deforestation for long time, the achievement is limited and further promotion will be indispensable.

5.2.4 Infrastructure Development

The provincial public investment projects were already prepared up to 2020 and the further projects were listed, even though their project scopes were not formulated yet. Infrastructure development may be planned and implemented on the basis of the four development directions above at specific locations to be selected. Under the current situation of a shortage of investment fund, a large-scale infrastructure projects may not be easily implemented in the near future both by local and ODA fund.

Depending on the sites or districts to be nominated for execution of the four development directions, priority infrastructure development may be formulated considering the local priority needs. Based on sample site investigation at the drought and flood-prone districts and communes in Central Highlands in November 2017, proposed infrastructures identified are summarized as follows:

(1) Improvement of Irrigation Facilities (Ref. AT 5.2.1 & AT 5.2.2 - Water Saving and PIM)

The following irrigation facilities and infrastructures were identified through the field surveys at the drought prone areas:

- Small-scale reservoir (rehabilitation) or small-scale tanks
- Concrete lining of canal or installation of pipeline system
- Improving access road (commune and district roads)
- Development or improvement of groundwater wells and pipeline system
- Dissemination of water saving irrigation equipment under tie-up with private sector such as traders, processers, etc.)

(2) Flood Protection Works (Ref. AT 5.2.3 - Flood and Monitoring)

For the purpose of flood protection and control, the JICA Study Team proposed a development of embankment at the critical point in the flood-prone area. Protecting the whole flood-prone area shall be made on the basis of economic efficiency, social and environmental considerations. The area to be developed shall be determined through the flood analysis. The following infrastructures may be recommended:

- River dike with rural road

- Flood protection facilities (gabion, concrete block masonry, etc.)
- Evacuation shelters
- Metrological and hydrological equipment
  - Telemetric automatic rainfall and river water level gauges
  - MH data and information real-time monitoring device
  - X band radar rainfall monitoring device
  - Loud speakers and communication device

(3) Groundwater Wells and Pipeline (Ref. AT 5.2.4 - Monitoring Water Resources)

The scarcity of domestic water is a detrimental issue for the people. During the drought in 2015/16, the provinces constructed new dug wells and tube wells at the rural area to supply domestic water to rural people since many wells used in these areas dried up. Development of rural water supply system shall be implemented on the basis of groundwater analysis; as well as the availability and needs for development considering sharing and coordination with agricultural and other utilization. The following monitoring devices of groundwater are necessary:

- Telemetric automatic groundwater level gauges
- Real-time monitoring device of MH data and information

CHAPTER 6 CONCLUSION

6.1 Provincial Action Planning for Preparatory Work

Based on the four development directions, the five provinces respectively prepared their action plans for preparatory works necessary to implement the development projects for disaster prevention. The five provinces stated the objectives, the development directions related to each objective, and detailed activities to achieve it with organizations in charge and time frame. Their plans commonly consisted of five steps: (i) Study on the need for investment, current conditions and problems, (ii) Select the target-site area based on the regulated land use, environment, social and resettlement impacts, damaged area, affected people and frequency of natural disasters, (iii) Identify technology and method applied in the project, (iv) Study preliminary plans, and (v) Estimate total budget with fund sources. The detailed activities and organizations in charge at each step are also similar among the five provinces as described below:

Table 6.1.1 Summary of Action Plan

	Objectives	Detailed Activities	Organizations in Charge
(i)	Study on the need for investment, current conditions and problems	• Study the socio-economic condition, need for investment, and advantages and disadvantages in the projected area • Assess the causes and damages of natural disaster • Identify flood-prone areas • Survey and assess rural infrastructure, local capacity and current projects related to drought warning • Assess the training program on operating the drought early warning system • Review the local development plans, policy, and achievement on disaster prevention • Organize workshops with community participation • Interview with local people • Promote the local participation • Estimate the cost of preparation works and find source of the budget • Assess the status of water use and water balance • Conduct surveys to identify the difficulties of surface water access • Propose the solutions to improve access to surface water and mobilize people's participation in monitoring activities	• DARD • DPI • DONRE • DPC • CPC • Steering Committee for Natural Disaster Prevention and Control • Meteorology Center
(ii)	Select the target site based on the land use, environment, social and resettlement impacts, damaged area, affected people and frequency of natural disasters	• Use the results of water balance study and flood assessment made by JICA to identify the target areas • Conduct Meeting with relevant departments under PPC and target DPCs • Organize community consultation meetings to revise project outline and activities • Promote the cooperation and participant of private companies • Organize expert's consultancy based on the result of community meetings to formulate project outline and decide the priority activities • Assess the priority activities • Confirm with relevant departments on priority projects in each target area, schedule and financial requirement and submit to PPC to approve the preparation action plan • Proposed priority projects, such as: ✓ Upgrade drainage canal and convert systems in flood-prone areas ✓ Upgrade access roads of production areas ✓ Build revetment to protect river bank erosion ✓ Develop domestic water system ✓ Establish flood warning system ✓ Upgrade irrigation canal and small reservoir systems ✓ Develop irrigation system run by solar energy ✓ Construct MH stations and groundwater observatory systems ✓ Establish WUGs ✓ Conduct geological survey to identify groundwater potential areas	• DARD • DPI • DONRE • DPC • CPC • Steering Committee for Natural Disaster Prevention and Control

Objectives	Detailed Activities	Organizations in Charge
	✓ advise local people to use and exploit groundwater ✓ Establish automatic surface water and groundwater calculation system	
(iii) Identify technology and method applied in the project	• Introduce project overview • Study the investment necessity and the scale of project investment • Identify the target area and the technical requirements of the project • Prepare project schedule, budget plan, and implementing organization • Consider the beneficiaries' participation through planning, construction, and O&M • Organize workshop to inform project objectives and activities • Assign responsibility for stakeholders • Prepare personal management plan	• DARD • DPI • DONRE • DPC • CPC •
(iv) Study preliminary plans	• Implement the action plan • Implement the approved projects • Select consultants and supporting organizations to implement project • Prepare project document and submit to PPC for approval • Monitor the implementation of the project activities • Assess the project impact • Conduct trainings for local people in the project area • Introduce and apply technologies of the project	• DARD • DPI • DONRE • DPC • CPC
(v) Estimate total budget with fund sources	• Prepare plan for using counterpart fund	• DPI • DOF

Source: JICA Study Team

The Survey team reviewed the plans and advised the provinces to concretize their plans practically considering the time frame and fund sources.

6.2 Recommendation

(1) General

Of the four development directions mentioned in Chapter 5, the two development directions, i.e. “Irrigated Agricultural Modernization” and "Community-based Monitoring for Effective Utilization of Local Water Resources", are considered as priority development directions considering actual situation of rural area and local needs for disaster prevention measures. Available local fund and scheme of ODA for two development directions will accelerate drought prevention in the Central Highlands.

These two development directions consist of institutional and infrastructural development require investment not only from public sector but also from private sector. Since it is difficult in the Central Highlands to forecast the disaster occurrence, the projects for disaster prevention based on the directions should be carried out as soon as and as much as possible. In Vietnam, due to the complex and time-consuming procedure to apply ODA, it is impossible to expect the immediate implementation by the assistance. Therefore, introduction of private investment related to disaster prevention is recommended. To attract private sector, rural residences and farmers should share the benefit with them. Contract farming is one of the practical and popular way for sharing farmers’ and the firms’ benefit. Local government and agencies, such as PPCs, DARDs, DPIs, etc. in the five provinces, shall support them on establishing platform for coordinate.

(2) Irrigated Agricultural Modernization

As illustrated in Figure 5.2.1 of previous chapter, the development direction aims to reduce irrigation water demand, effective water use, and improvement of farmers’ livelihood. For achieving these purposes, infrastructural development to disseminate water saving irrigation, such as drip and sprinkler irrigation, is necessary to utilize the limited water resources through decreasing irrigation water demand. While some of advanced farmers in the Central Highlands have already introduced water saving irrigation, most of farmers as well as provincial and district staff in charge of irrigation and agricultural extension are not familiar to the irrigation method. Therefore, guidelines, manuals, and training programs to introduce, operate, and manage the irrigation system shall be prepared.

In addition, rural road connecting farm and market is also necessary to reduce transportation cost and attract private investment. The farmers producing in remoted area from consuming area and isolated due to poor accessibility have less opportunity to collaborate with private sector because higher transportation cost would discourage them to work with the farmers in such situation.

Through these infrastructure and institutional development, farmers' livelihood in the target area of the project based on the development direction will be improved.

(3) Community-based Monitoring for Effective Utilization of Local Water Resources

The project based on the development direction will bring about efficient water use through appropriate monitoring and management of surface water and groundwater. Current monitoring system is insufficient to manage water resources to satisfy water demand due to not only the lack of facilities, such as meteorological and hydrological station, but also the shortage of human resources.

Therefore, in order to develop "Community-based Monitoring for Effective Utilization of Local Water Resources", enhancement of monitoring system of both of infrastructure and organization is required. Through reviewing the monitored data of meteorology and hydrology and analyzing water balance in the Central Highlands, an early warning system on drought and preparation and dissemination of guidelines on early alarming to districts, communes, farmers, and residents in rural area shall be urgently made. The monitoring system could be jointly established under collaboration with potential private investors who have technologies and investment plans.

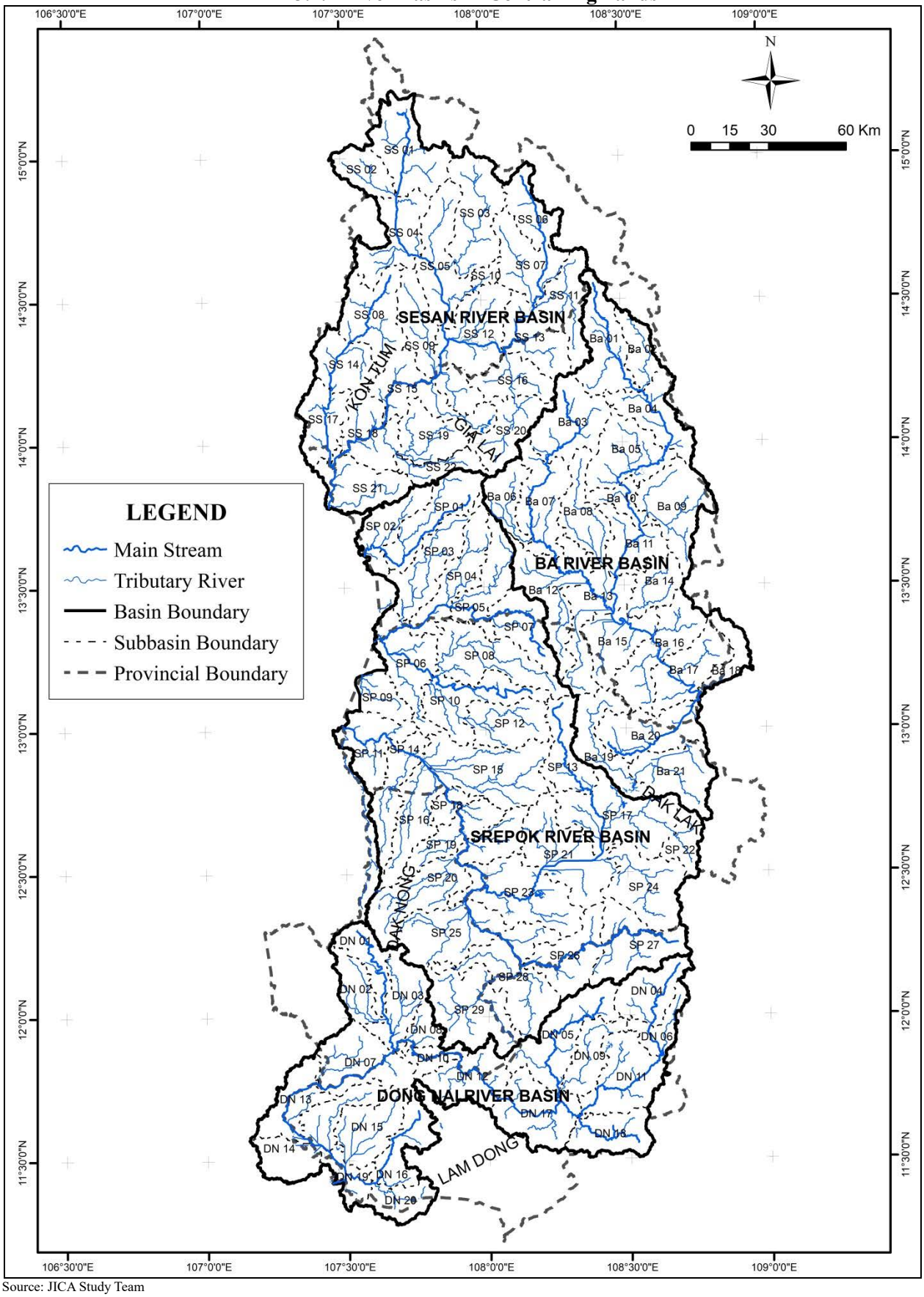
Attachment

AT 2.2.1 Criteria of NTP for New Rural Development

No.	Criteria	Content
1	Planning and planning implementation	Obtain a new rural development master plan formulated according to Joint Circular No. 13/2011/TTLT-BXD-BNNPTNT-BTN&MT: The Ministry of Construction, Ministry of Agriculture and Rural Development and Ministry of Natural Resources and Environment shall stipulate the formulation and appraisal of the new rural development master plan which is approved by competent authorities and widely spread to villages.
		Make public the drawings of the master plan to residents; complete the planting of boundary markers for infrastructural constructions according to the approved master plan.
		Issue regulations on planning management approved by competent authorities;
2	Traffic	100% of arterial commune roads, inter-commune roads shall be paved with cement concrete or asphalt
		Hardened village roads shall reach regional prescribed proportion
		100% of hamlet, alley roads shall be hardened (no muddiness caused in rainy seasons)
		Hardened in-field roads shall meet regional prescribed proportion
3	Irrigation	Reach regional prescribed ratio of canal solidification (except areas where solidification is inapplicable)
		Maintain an irrigation that basically meets requirements of production and welfare.
4	Rural electricity	Maintain a system to ensure technical requirements of electricity sector;
		Achieve regional prescribed ratio of households using electricity frequently and safely
5	Schools	Reach regional prescribed ratio of schools equipped with facilities reaching national standards
6	Education	Achieve universalization of lower-secondary education
		Achieve lower secondary graduation ratio and trained labor ratio as regional prescribed
7	Cultural facilities	Maintain a cultural house and a commune-level sporting center reaching the standards as stipulated in the Minister of Culture, Sports and Tourism's Circular No. 12/2010/TT-BVHTTDL dated December 22, 2010.
		100% of villages have a cultural house and sporting center meeting standards as stipulated in the Minister of Culture, Sports and Tourism's Circular No. 06/2011/TT-BVHTTDL dated March 08, 2011.
8	Culture	70% of villages which have been recognized as the recipient of the title "Cultural Village" and have held such title for at least five consecutive years
9	Rural market	Technical level: Maintain sufficient rural market constructions (market class 3) as stipulated in TCVN 9211:2012 enclosed with the Minister of Science and Technology's Decision No. 3621/QD-BKHCN dated December 28, 2012 on public announcement of national standards.
		Market management: - Maintain a management organization; - Establish market rules stipulated by the People's committees of communes and published for management and handling of violations; - Put into use control scales, measuring equipment for consumers to inspect quantities of goods by themselves; - Goods and services traded at the market are not subject to prohibition as regional prescribed
10	Post offices	Maintain at least one point of postal and telecommunications services meeting standards as prescribed in the Minister of Information and Communications' Decision No. 463/QD-BTTTT dated March 22, 2012.
		Ensure access to the Internet.
11	Housing	Ensure no more households living in temporary or leaky houses;
		Reach a minimum regional proportion of households owning houses meeting standards as stipulated by the Ministry of Construction.
12	Incomes	Annual average income reaches the minimum rate as regional prescribed
13	Poor households	Proportion of poor households is below the minimum level as regional prescribed
14	Labor force	90% of regularly employed labor force
15	Production organization	At least one cooperative or artel which are registered and operate effectively according to laws and sign a business cooperation contract with enterprises
16	Health	The commune's medical facilities reach national standards
		70% of participants in medical insurance
17	Environment	The proportion of households using clean and hygienic water as prescribed meets the rate as regional prescribed
		90% of production and trade facilities in the administrative division meets environmental standards (Remaining 10% is in the process of improving)
		Village roads, hamlets, alleys and landscape of households are green, clean and beautiful without environmental degradation activities;
		Graveyards are arranged and constructed within the approved planning;
		Waste matters, wastewater is collected and treated as prescribed.
18	Socio-political organization system	100% of public officials and civil servants in the commune meet standards as prescribed in Ministry of Home Affairs' Circular No. 06/2012/TT-BNV dated October 30, 2012;
		Maintain sufficient organizations in the grassroots-level political system as prescribed;
		The commune's Party Committee meets the standard "spotless and strong" as stipulated in the Instruction No. 07-HD/BTCTW dated October 11, 2011 issued by the Commission for Mass Organization;
		The commune's socio-political unions are recognized to have achieved the title "progressive organizations".
19	Social security	Ensure no organizations or/and individuals carry out activities undermining the Communist Party, Government and the economy; ensure no illegal preaching be conducted to large crowds for a long time
		Ensure no existence of disorderly social events or gatherings and debaucheries in the administrative division
		70% of the villages are recognized to having met standards on security and order
		Annually, the commune's police authorities achieve at least the title "progressive unit"

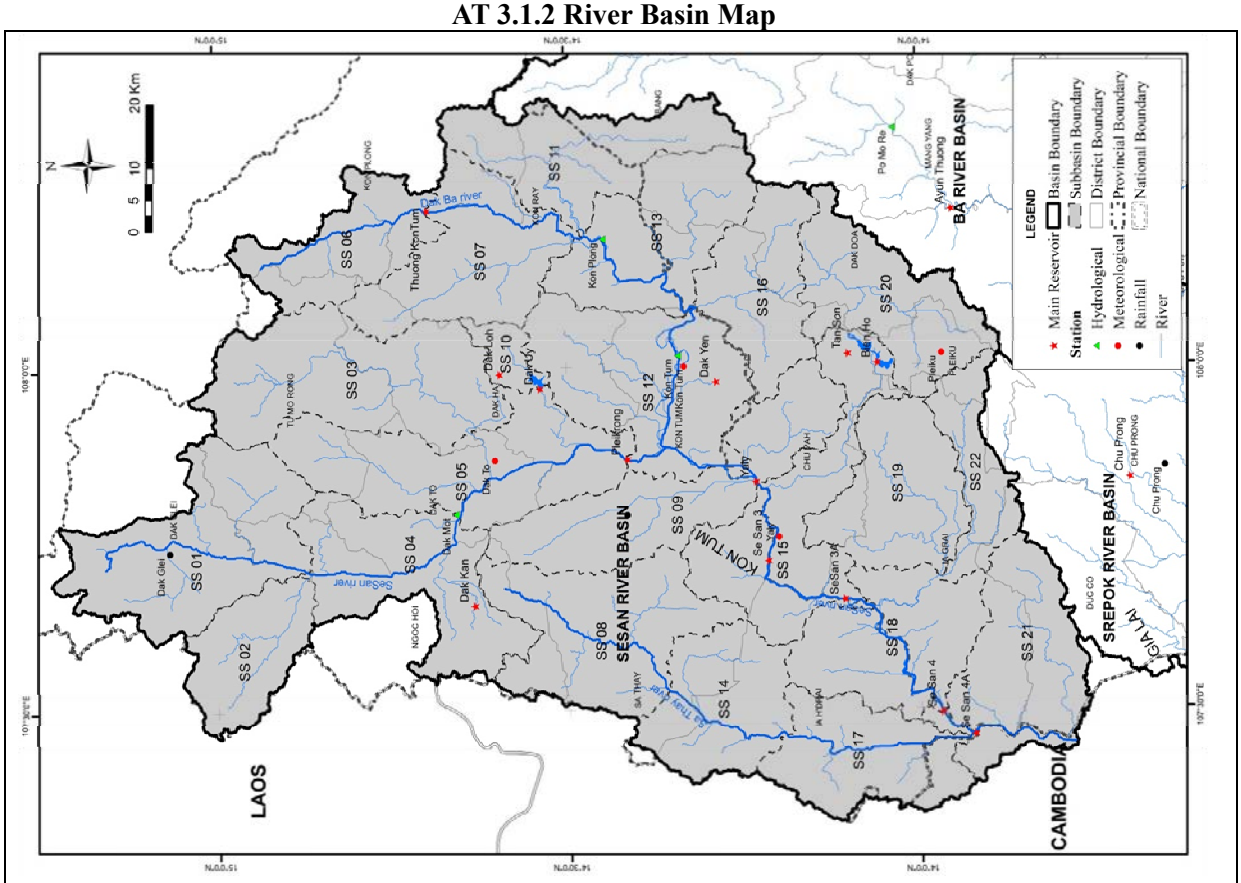
Source: Circular No. 41/2013/TT-BNNPTNT dated October 4th, 2013, by MARD instructions on application of national set of criteria for new rural development

AT 3.1.1 River Basins in Central Highlands

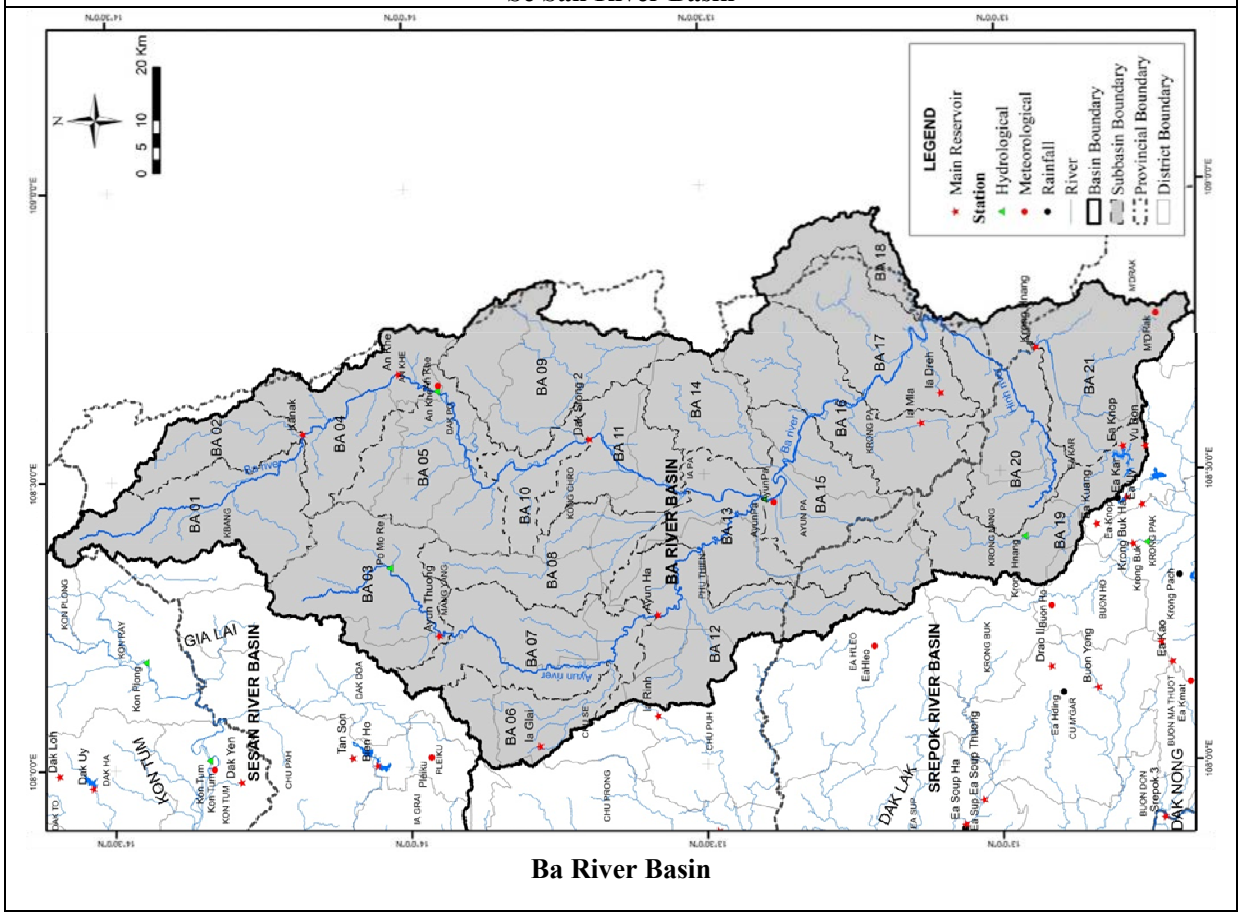


Source: JICA Study Team

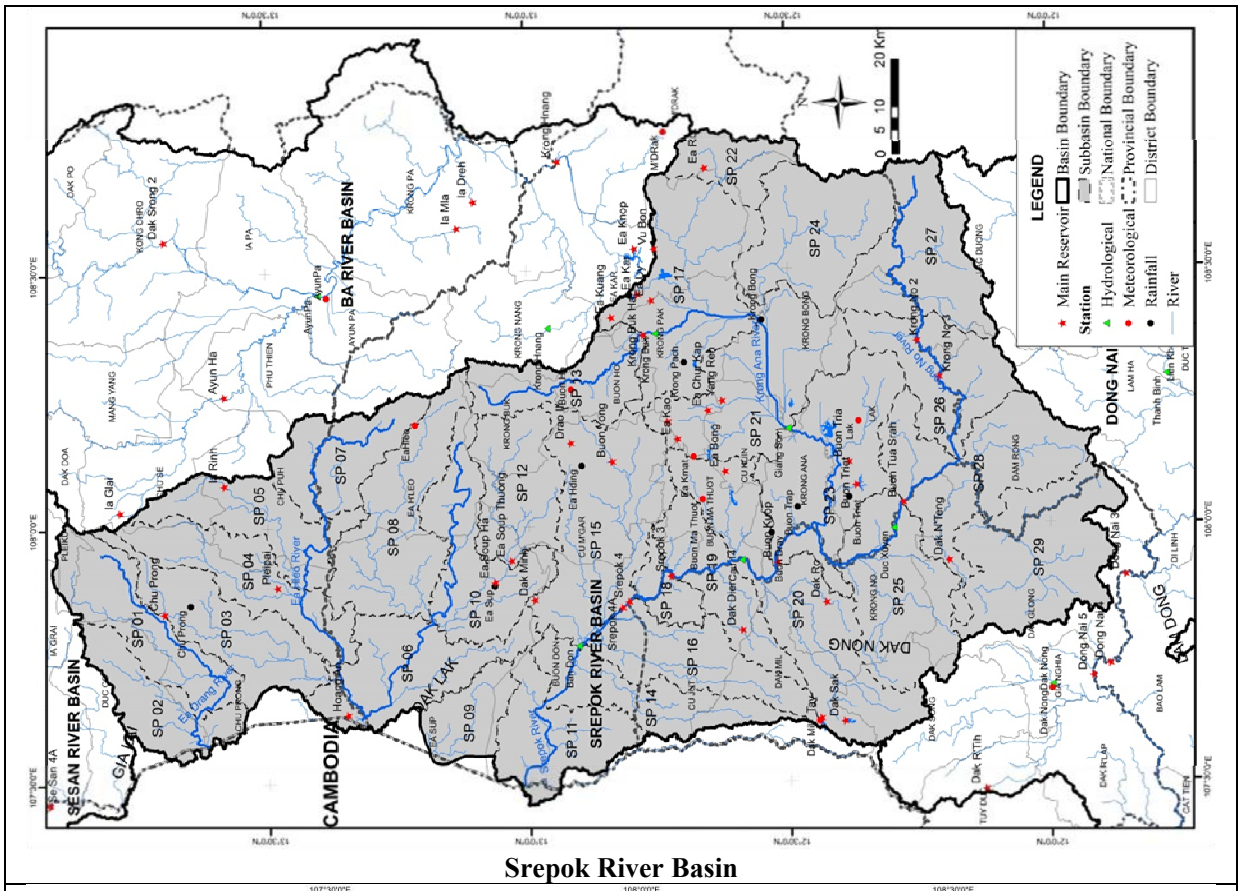
AT 3.1.2 River Basin Map



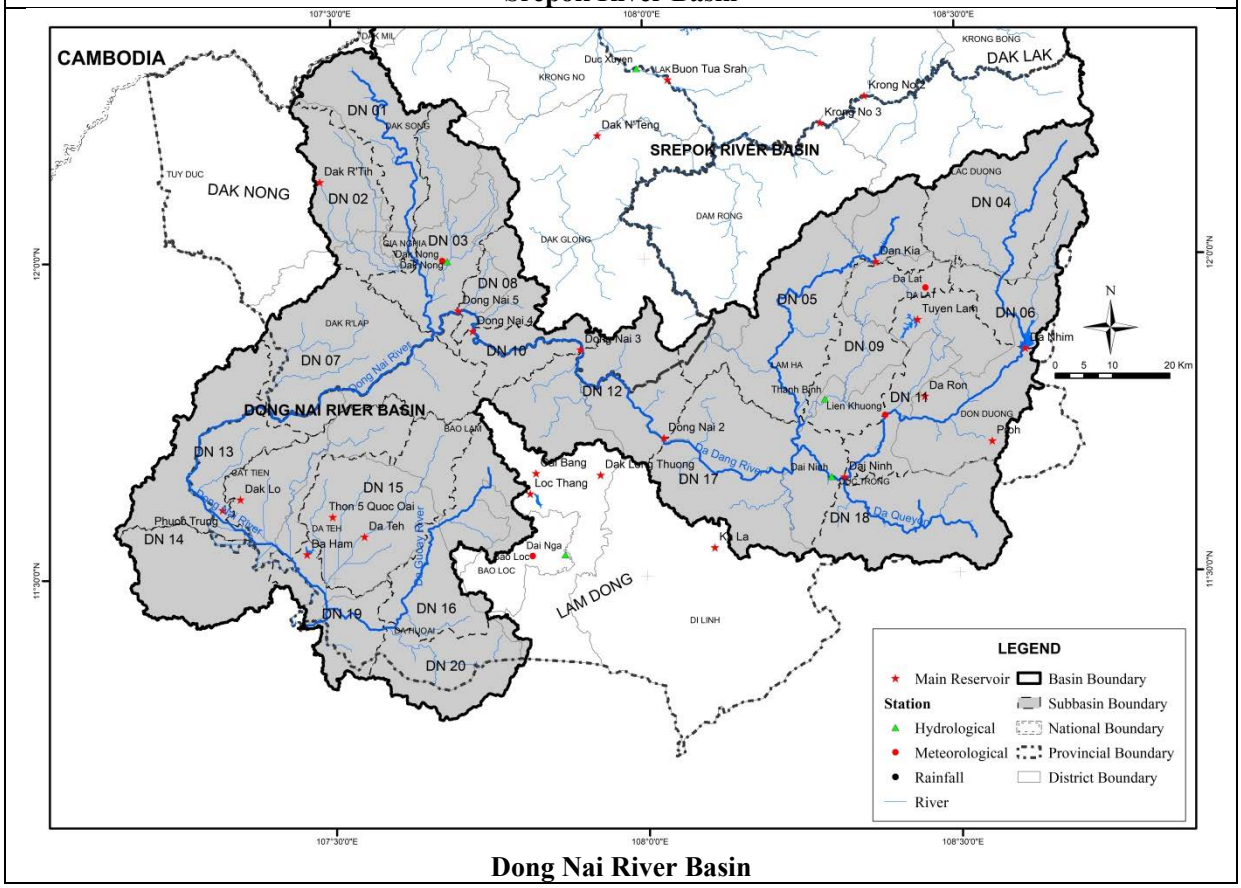
Se San River Basin



Ba River Basin



Srepok River Basin



Dong Nai River Basin

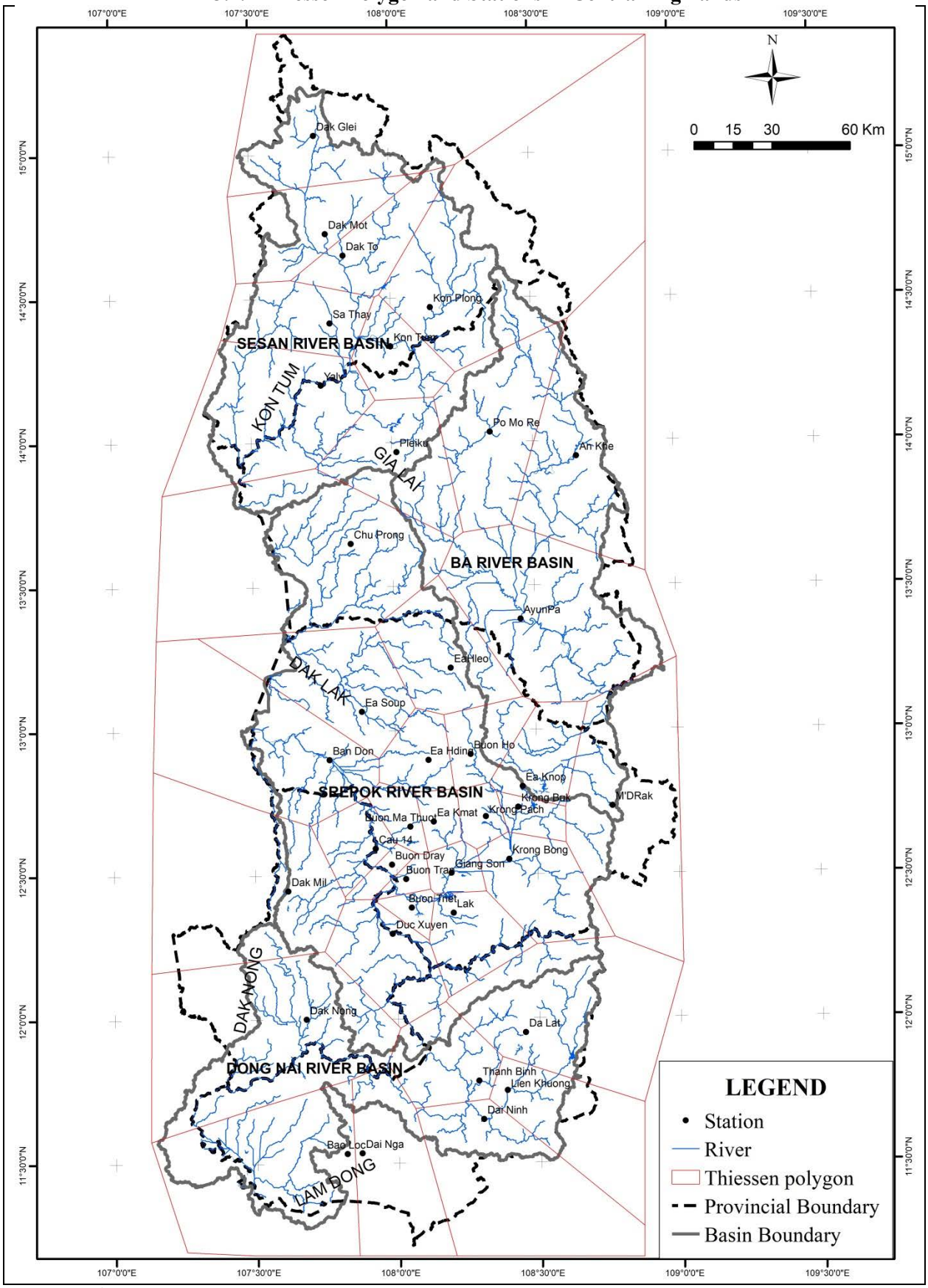
Source: JICA Study Team

AT 3.1.3 List of Hydrological and Meteorological Stations in Central Highlands

No.	ID No.	Stations	Longitude	Latitude	Type	District	Province	Elevation (m)
1	HKT03	Kon Tum	108.02	14.33	Hydrological	Kon Tum	Kon Tum	523
2	HKT02	Kon Plong	108.14	14.47	Hydrological	Kon Ray	Kon Tum	661
3	HKT01	Dak Mot	107.77	14.75	Hydrological	Dak To	Kon Tum	634
4	RKT02	Kon Tum	108.00	14.33	Meteorological	Kon Tum	Kon Tum	523
5	RKT06	Sa Thay	107.78	14.42	Rainfall	Sa Thay	Kon Tum	561
6	RKT01	Dak To	107.83	14.65	Meteorological	Dak To	Kon Tum	608
8	RKT05	Dak Glei	107.75	15.08	Rainfall	Dak Glei	Kon Tum	739
9	RGL02	AyunPa	108.47	13.47	Hydrological	Ia Pa	Gia Lai	144
10	HGL01	An Khe	108.65	13.95	Hydrological	An Khe	Gia Lai	386
11	HGL03	Po Mo Re	108.35	14.03	Hydrological	Mang Yang	Gia Lai	670
12	RGL02	AyunPa	108.45	13.38	Meteorological	Ayun Pa	Gia Lai	145
13	RGL06	Chu Prong	107.85	13.65	Rainfall	Chu Prong	Gia Lai	303
14	RGL03	Pleiku	108.02	13.97	Meteorological	Pleiku	Gia Lai	779
15	RGL04	Yaly	107.75	14.20	Meteorological	Chu Pah	Gia Lai	490
16	RGL01	An Khe	108.66	13.95	Meteorological	An Khe	Gia Lai	418
17	RDL18	Krong Buk	108.43	12.77	Hydrological	Krong Pak	Dak Lak	437
18	RDL05	Lak	108.20	12.37	Meteorological	Lak	Dak Lak	458
19	RDL13	Buon Triet	108.05	12.39	Rainfall	Lak	Dak Lak	548
20	RDL12	Buon Trap	108.03	12.49	Rainfall	Krong Ana	Dak Lak	430
21	RDL11	Buon Dray	107.98	12.54	Rainfall	Krong Ana	Dak Lak	447
22	HDL02	Giang Son	108.19	12.50	Hydrological	Krong Bong	Dak Lak	544
23	RDL10	Krong Bong	108.40	12.55	Rainfall	Krong Bong	Dak Lak	431
24	HDL04	Krong Hnang	108.39	12.96	Hydrological	Krong Nang	Dak Lak	582
25	RDL01	Buon Ma Thuot	108.05	12.67	Meteorological	Buon Ma Thuot	Dak Lak	464
26	RDL04	Ea Kmat	108.13	12.68	Meteorological	Krong Pak	Dak Lak	536
27	HDL01	Ban Don	107.77	12.90	Hydrological	Buon Don	Dak Lak	194
28	RDL06	M'DRak	108.77	12.73	Meteorological	M'Drak	Dak Lak	438
29	RDL07	Krong Pach	108.32	12.75	Rainfall	Krong Pak	Dak Lak	499
31	RDL16	Ea Knop	108.45	12.80	Rainfall	Ea Kar	Dak Lak	491
32	RDL15	Ea Hding	108.12	12.90	Rainfall	Cu M'gar	Dak Lak	559
33	RDL02	Buon Ho	108.27	12.92	Meteorological	Buon Ho	Dak Lak	693
34	RDL17	Ea Sup	107.88	13.07	Rainfall	Ea Sup	Dak Lak	173
35	RDL03	EaHleo	108.20	13.22	Meteorological	Ea H'leo	Dak Lak	624
36	HDN03	Dak Nong	107.68	12.00	Hydrological	Gia Nghia	Dak Nong	589
37	RDN02	Dak Mil	107.64	12.45	Meteorological	Dak Mil	Dak Nong	755
38	HDN01	Duc Xuyen	107.99	12.28	Hydrological	Krong No	Dak Nong	446
39	HDN02	Cau 14	107.93	12.60	Hydrological	Cu Jut	Dak Nong	303
40	RDN01	Dak Nong	107.68	12.00	Meteorological	Gia Nghia	Dak Nong	616
41	RLD01	Bao Loc	107.82	11.53	Meteorological	Bao Loc	Lam Dong	811
42	HLD01	Dai Nga	107.87	11.53	Hydrological	Bao Loc	Lam Dong	746
43	HLD02	Dai Ninh	108.30	11.65	Hydrological	Duc Trong	Lam Dong	856
44	RLD03	Lien Khuong	108.38	11.75	Meteorological	Duc Trong	Lam Dong	955
45	HLD03	Thanh Binh	108.28	11.78	Hydrological	Duc Trong	Lam Dong	866
46	RLD02	Da Lat	108.45	11.95	Meteorological	Da Lat	Lam Dong	1472

Source: HMS/MONRE

AT 3.1.4 Thiessen Polygon and Stations in Central Highlands



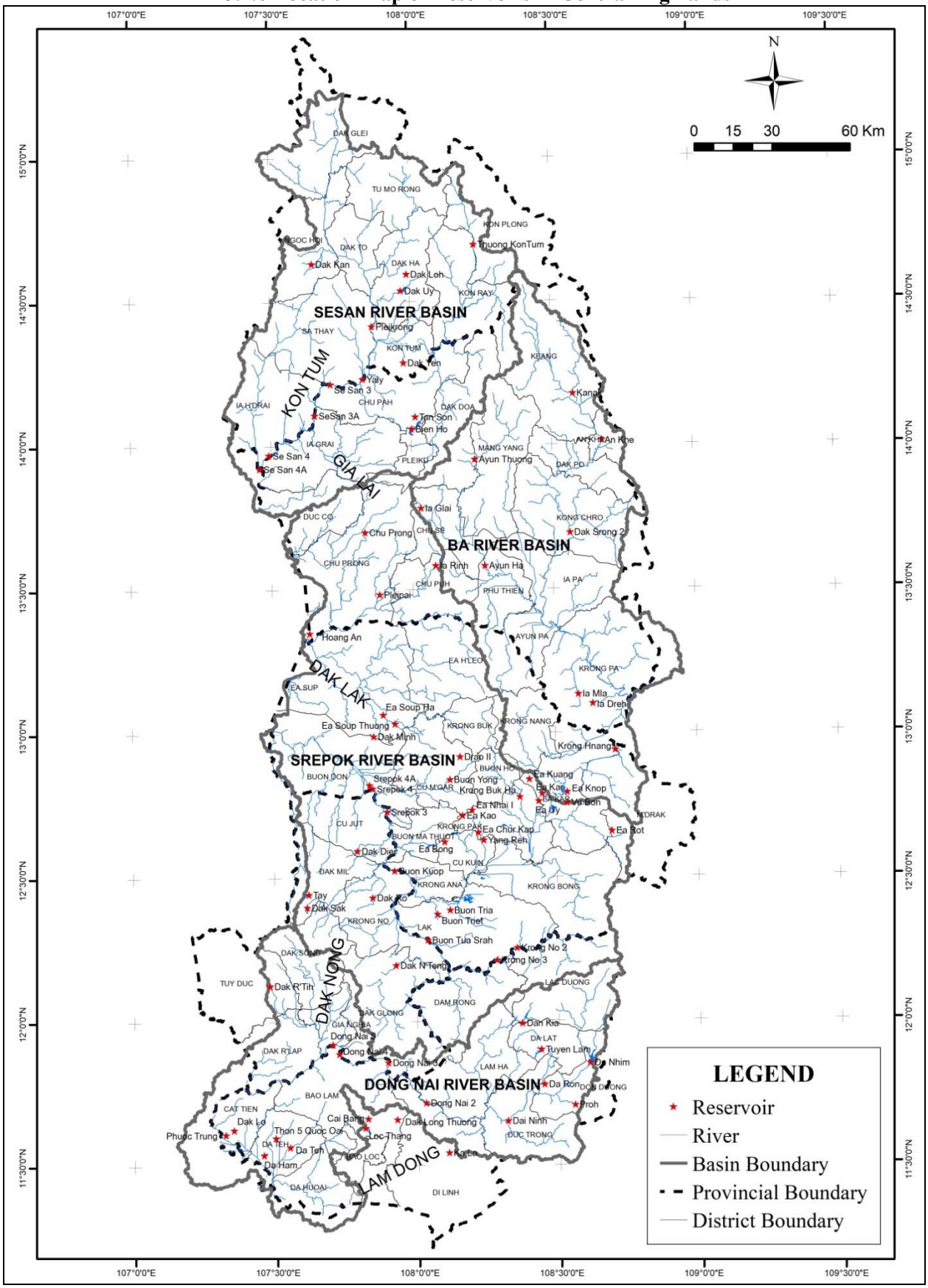
Source: JICA Study Team

AT 3.1.5 Major Reservoirs in Central Highlands

No.	River Basin	Name of Reservoir	Water Level (El.m)			Storage Volume (10^6 m^3)				Purpose of Dam				Operation Start Year
			Normal WL	Surcharge WL	Dead WL	Normal WL	Surcharge WL	Dead WL	Effective Volume	Hydro-power	Irrigation /Domestic	Flood Control	Divert water to other basin	
1	Se San	Thuong Kon Tum	1,160.00	1,161.90	1,138.00	145.52	158.45	42.46	115.99	x	x	x	x	2014
2	Se San	Dak Yen	556.70	557.26	544.70	6.12	6.57	0.22	6.34		x			
3	Se San	Dak Loh	148.82	149.96	141.50	13.63	15.94	1.28	14.66		x			
4	Se San	Dak Uy	640.30	641.45	625.00	29.72	33.00	3.83	29.18		x			
5	Se San	Dak Kal	649.60		644.20	3.20		0.71	2.49		x			
6	Se San	Tan Son	780.00	782.60	764.80	4.19	5.28	0.31	4.97		x			
7	Se San	Yaly	515.00	518.00	490.00	1,065	1,307	528	779	x	x	x		1996
8	Se San	Pley Krong	570.00	573.40	537.00	1,048.69	1,244.87	100.65	1,144.22	x	x	x		2009
9	Se San	Se San 4	215.00	217.86	210.00	893.34	1,079.13	629.14	449.99	x	x	x		
10	Se San	Se San 4a	155.20	155.20	150.00	13.13	13.13	5.74	7.40					
11	Se San	Bien Ho	745.00	746.47	738.00	12.40	41.50	1.50	40.00		x			
12	Se San	SeSan 3	304.50	309.20	303.20	86.70	102.00	82.90	19.10	x	x	x		2007
13	Se San	SeSan 3a	239.00	239.00	238.5	80.60	80.60			x				2007
14	Ba	Ka Nak	515.00	515.32	485.00	313.74	319.54	28.25	291.29	x	x	x		
15	Ba	An Khe	429.00	429.88	427.00	15.85	19.51	10.25	9.26	x	x		x	2011
16	Ba	Ayun Ha	204.00	209.92	195.00	253.00	528.80	52.00	476.80	x	x	x	x	2011
17	Ba	La Glai	576.00	576.00	567.00	3.60		0.80	2.80		x			
18	Ba	La'Mla	215.00	215.90	196.80	54.15	58.76	4.95	53.81		x			
19	Ba	Krong Buk Ha	483.00	484.01	469.00	109.34	120.92	13.60	107.32		x	x		2013
20	Ba	Krong Hnang	255.00	255.86	242.50	171.56	185.30	59.28	126.03	x	x			2011
21	Ba	Vu Bon	448.10	448.63	445.00	5.07	6.11	1.15	4.96		x			
22	Ba	Ia Dreh	189.55	191.33	182.04	5.35	7.54	0.46	7.08	x				
23	Ba	Dak Srong 2	243.00	248.78	242.00	85.80		80.60	5.20	x				2009
24	Ba	Ayun Thuong	580.00	580.00	579.00	4.54	4.54	4.02	0.52	x				2011
25	Srepok	Buon Tua Shar	487.50	487.82	465.00	786.87	798.72	264.29	534.43	x	x	x		2008
26	Srepok	Buon Kuop	412.00	414.50	409.00	63.24	87.10	48.55	38.55	x	x	x		2009
27	Srepok	Srepok 3	272.00	275.00	268.00	218.99	276.75	156.13	120.62	x	x	x		2010
28	Srepok	Srepok 4	207.00	210.48	204.00	25.94	38.60	17.50	21.09	x	x	x		2011
29	Srepok	Dak N'teng	765.00	767.11	755.00	25.49	34.35	5.02	29.33	x				
30	Srepok	Krong No 2	620.00	620.30	618.00	8.79	9.03	7.43	1.60	x				2017
31	Srepok	Krong No 3	555.00	559.58	554.50	18.64	28.05	17.76	10.29	x				2010
32	Srepok	Chu Prong	473.70	474.10	461.50	4.13	4.35	0.32	4.03		x			
33	Srepok	Hoang An	657.00	658.20	647.00	6.80		0.80	6.00		x			
34	Srepok	Ia Ring	689.00	690.31	672.00	10.76		0.58	10.18		x			
35	Srepok	Pleipai	207.60	209.05	203.30	20.91	30.53	3.68	26.85		x			
36	Srepok	Yang Reh	438.80	439.50	432.00	6.30		0.90	5.40		x			
37	Srepok	Ea Uy	195.81	196.00	190.00	6.30	6.75	1.80	4.95		x			
38	Srepok	Ea Kuang	194.30	194.80	193.90	3.70	4.58	3.03	1.55		x			
39	Srepok	Srepok 4A	186.59		185.50					x				2014
40	Srepok	Ea Bong	455.50	457.00	446.30	8.76	17.58	0.60	16.98		x			
41	Srepok	Drao II	600.80		598.50	3.30		0.50	2.80		x			
42	Srepok	Dak Mil	203.00		201.00	7.77		3.57	4.19		x			
43	Srepok	Buon Tria	195.80	197.20	192.00	3.98	6.74	0.50	6.24		x			
44	Srepok	Ea Suop Ha	196.50	197.20	193.40	9.28	11.80	3.21	8.59		x			1980
45	Srepok	Ea Nhai I	190.80		190.10	10.98		8.03	2.95		x			
46	Srepok	Ea Kar	198.80		197.50	10.95		5.81	5.14		x			
47	Srepok	Ea Kao	420.00	421.33	414.00	17.76	22.40	4.00	18.40	x				
48	Srepok	Buon Triet	443.00		440.00	21.30		3.00	18.30		x			
49	Srepok	Ea Soup Thuong	217.58	218.62	205.40	143.00	162.00	10.65	151.35		x			2004
50	Srepok	Ea Rot	502.00	502.20	489.30	18.43	18.43	1.73	16.70		x			2016
51	Srepok	Ea Chur Kap	507.50	509.00	505.50	11.20	20.50	5.10	15.40	x				
52	Srepok	Buon Yong	195.80		193.00	15.24		5.00	10.24		x			
53	Srepok	Dak Lo	148.20	149.96	141.50	12.12	15.94	1.28	14.66		x			
54	Srepok	Dak Dier	377.40	379.00	371.00	5.92	8.57	0.42	8.15		x			
55	Srepok	Tay	398.90	399.30	396.50	3.33		0.50	2.83		x			
56	Srepok	VuBon	448.10	448.63	445.00	5.07	6.11	1.45	4.67		x			
57	Srepok	Dak Sak	742.80	744.60	731.00	6.70		1.50	5.20		x			
58	Srepok	Krong Buk ha	483.00	484.01	469.00	109.34	120.92	13.60	107.32		x	x		2014
59	DongNai	TuyenLam	1,379.00	1,380.23	1,363.00	27.85	31.50	1.51	29.99		x			
60	DongNai	Proh	1,028.30	1,029.74	1,021.00	3.22	4.02	0.21	3.81		x			
61	DongNai	DakLo	148.82	149.96	141.50	13.63	15.94	1.28	14.66		x			
62	DongNai	PhuocTrung	156.10	157.34	144.20	3.19	3.72	0.06	3.65		x			
63	DongNai	Thon 5 Quoc Oai	158.21	159.80	148.50	3.94	4.72	0.49	4.23		x			
64	DongNai	DaTeh	150.00	156.60	142.50	22.11	52.82	3.11	49.71		x			
65	DongNai	DaRon	1,057.35	1,058.52	1,053.50	5.55	7.29	1.90	5.39		x			
66	DongNai	DanKia	1,423.00	1,425.36	1,414.80	10.70	15.93	0.34	15.59	x	x	x		
67	DongNai	DakRTin	618.00		603.00	137.12		38.91	98.21	x	x	x	x	2011
68	DongNai	Dai Ninh	880.00		860.00	319.77		68.04	251.73	x	x	x	x	2008
69	DongNai	DonDuong(DaNhim)	1,042.00	1,042.80	1,018.00	165.00	172.54	9.86	162.68	x	x	x		1964
70	DongNai	DongNai2	680.00	681.61	665.00	280.80	302.08	137.40	164.68	x	x	x		2014
71	DongNai	DongNai3	590.00	593.24	570.00	1,690.06	1,878.22	798.58	1,079.64	x	x	x		2012
72	DongNai	DongNai4	476.00	479.24	474.00	332.05	359.93	315.69	44.23	x	x	x		2013
73	DongNai	DongNai5	288.00		286.00	0.11		0.10	0.01	x	x	x		2015
74	DongNai	DaHam	142.68	143.50	138.40	6.40	7.66	1.24	6.41		x			

Source: MARD and MOIT

AT 3.1.6 Location Map of Reservoirs in Central Highlands

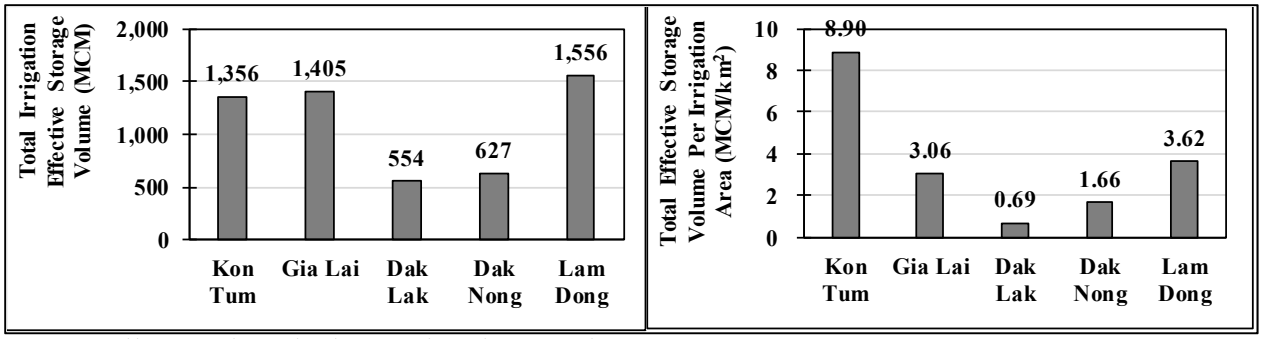


Source: MARD and MOIT

AT 3.1.7 Total Effective Storage Volume of Irrigation Purpose Reservoirs

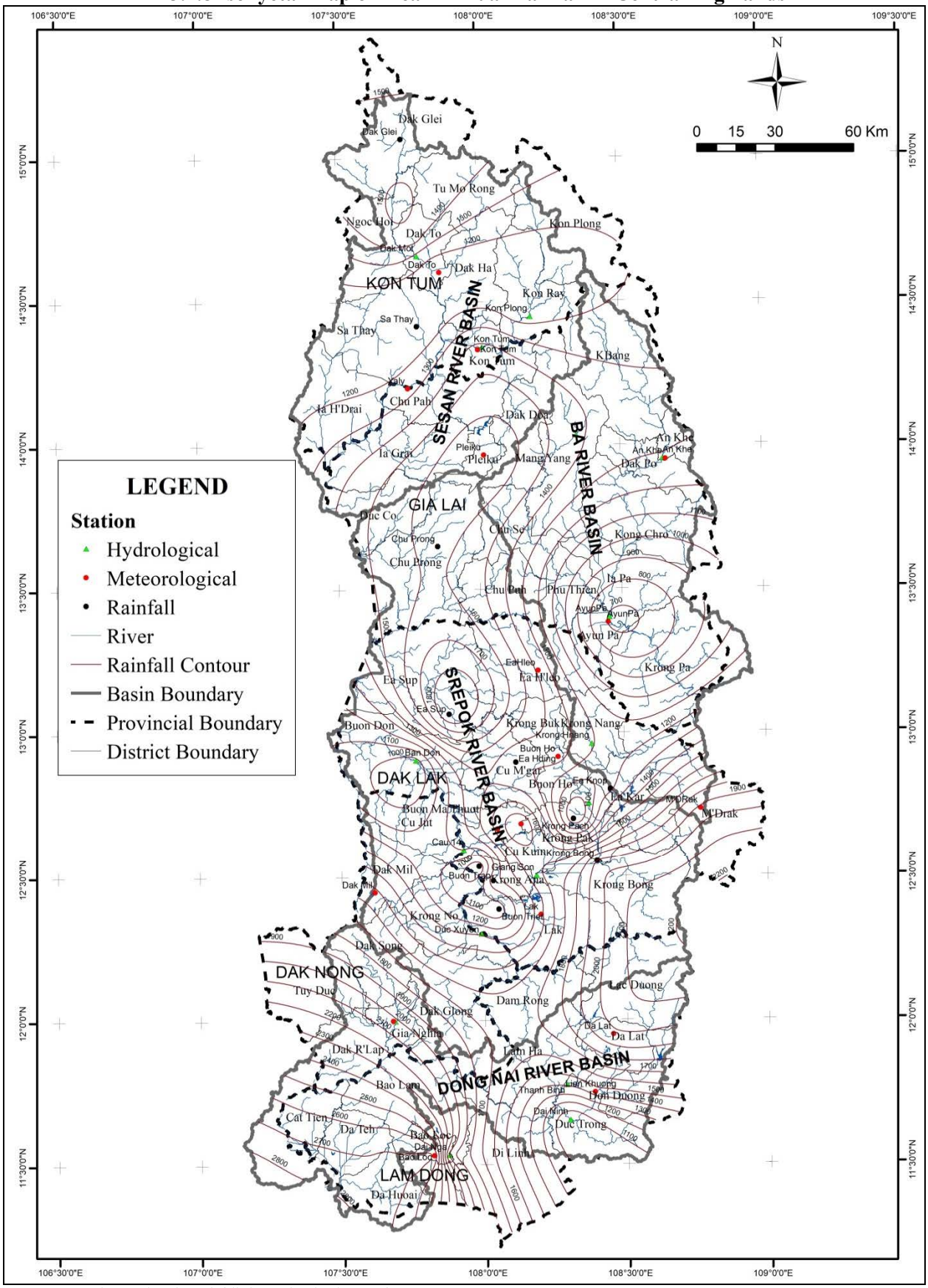
Province	Irrigated Area (km^2)	Number of Total Dams	Number of Irrigation Dams	Total Effective Volume (MCM)	Total Effective Volume per Irrigated Area (MCM/km^2)
Kon Tum	152.42	10	8	1,356	8.90
Gia Lai	458.57	15	12	1,405	3.06
Dak Lak	807.65	22	18	554	0.69
Dak Nong	378.62	9	8	627	1.66
Lam Dong	429.49	18	17	1,556	3.62
Total	2,226.75	74	63	5,499	17.93

Source: Prepared by JICA Study Team based on Reservoir Data by MARD and MOIT



Source: Prepared by JICA Study Team based on Reservoir Data by MARD and MOIT

AT 3.1.8 Isohyetal Map of Mean Annual Rainfall in Central Highlands



Source: JICA Study Team based on rainfall observation data by HMS/MONRE.

AT 3.1.9 Record of Stations in Central Highlands

(1) Kon Tum Station (Kon Tum Province) (El. 523 m) [RKT02]

Mean annual rainfall is at 1,970 mm/year. The mean monthly rainfall distribution has significantly appeared the wet and dry season. In the rainy season of May to October has rainfall of 89% (1,744 mm) of annual rainfall. Mean annual temperature is at 23.8 ºC and maximum and minimum monthly mean temperature are 25.9 ºC in April and 20.9 ºC in January, respectively.

(2) An Khe Station (Gia Lai Province) (El. 386 m) [RGL01]

Mean annual rainfall is at 1,465 mm/year. The mean monthly rainfall gradually increases from May and there is a peak in November. In the rainy season of May to October has rainfall of 68% (898 mm) of annual rainfall and still has rainfall in November and December. Mean annual temperature at Ayun Pa station is at 26.0 ºC and maximum and minimum monthly mean temperature are 28.4 ºC in April and 22.7 ºC in January, respectively.

(3) Ea Kmat Station (Dak Lak Province) (El. 536 m) [RDL04]

Mean annual rainfall is at 1,879 mm/year. The mean monthly rainfall distribution has significantly appeared the wet and dry season. In the rainy season of May to October has rainfall of 86% (1,621 mm) of annual rainfall. Mean annual temperature is at 23.7 ºC and maximum and minimum monthly mean temperature are 25.9 ºC in April and 21.1 ºC in January, respectively.

(4) Dak Nong Station (Dak Nong Province) (El. 589 m) [RDN01]

Mean annual rainfall is at 1,700 mm/year. The mean monthly rainfall distribution has significantly appeared the wet and dry season. In the rainy season of May to October has rainfall of 87% (1,482 mm) of annual rainfall. Mean annual temperature is at 22.9 ºC and maximum and minimum monthly mean temperature are 24.3 ºC in April and 20.6 ºC in January, respectively.

(5) Da Lat Station (Lam Dong Provence) (El. 1,472 m) [RDL02]

Mean annual rainfall is at 1,868 mm/year. The difference between rainy season and dry season is not clear, it is a long rainy season (from April to November) and a short dry season (from December to January). In the rainy season of May to October has rainfall of 78% (1,459 mm) of annual rainfall. Mean annual temperature is at 18.3 ºC and maximum and minimum monthly mean temperature are 19.8 ºC in May and 16.1 ºC in January, respectively. Due to high altitude of location, mean annual temperature and minimum temperature are cooler than other area in Central Highlands.

AT 3.1.10 Climate Data in Central Highlands

(1) Mean Monthly Temperature (ºC)

Province	Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average	Max.	Min.
Kon Tum	Dak To	19.1	21.5	23.2	24.5	24.6	24.1	23.5	23.2	23.0	22.1	21.2	19.4	22.5	24.6	19.1
	Kon Tum	20.9	22.7	24.7	25.9	25.8	25.1	24.5	24.4	24.2	23.7	22.5	21.2	23.8	25.9	20.9
Gia Lai	Yaly	20.4	21.6	23.7	25.3	25.5	24.9	24.1	23.9	23.5	23.2	22.5	21.1	23.3	25.5	20.4
	Ayun Pa	22.7	24.4	26.7	28.4	28.4	27.8	27.1	26.9	26.7	25.4	24.3	23.0	26.0	28.4	22.7
	Pleiku	19.5	20.8	22.9	24.3	24.1	23.2	22.7	22.6	22.7	22.2	21.1	19.8	22.2	24.3	19.5
Dak Lak	Buon Me Thuot	21.3	22.8	24.6	26.2	25.7	24.9	24.3	24.2	24.0	23.6	22.6	21.2	23.8	26.2	21.2
	Buon Ho	19.0	20.4	22.4	24.0	24.0	23.3	22.5	22.6	22.6	21.9	20.7	18.8	21.9	24.0	18.8
	Ea H'leo	19.8	21.6	23.7	25.3	25.1	24.2	23.4	23.2	23.2	22.7	21.9	20.1	22.8	25.3	19.8
	Ea Kmat	21.1	22.3	24.2	25.9	25.6	24.8	24.3	24.2	24.0	23.7	22.8	21.2	23.7	25.9	21.1
	Lak	21.2	22.8	24.7	26.2	26.2	25.3	24.9	24.8	24.4	24.0	23.2	21.7	24.1	26.2	21.2
	M'Drak	20.3	21.5	23.6	25.6	26.3	26.2	25.9	25.7	24.9	23.7	22.4	20.6	23.9	26.3	20.3
Dak Nong	Dak Glong	20.6	21.9	23.4	24.3	24.3	23.7	23.1	23.1	23.3	23.0	22.5	21.2	22.9	24.3	20.6
	Dak Mil	20.0	21.5	23.5	24.7	24.4	23.9	23.4	23.3	23.0	22.5	21.5	19.9	22.6	24.7	19.9
Lam Dong	Bao Loc	20.3	21.3	22.4	23.3	23.5	22.8	22.3	22.1	22.2	22.1	21.5	20.4	22.0	23.5	20.3
	Da Lat	16.1	16.9	18.3	19.2	19.8	19.2	19.1	18.8	18.8	18.6	17.7	16.6	18.3	19.8	16.1
	Lien Khuong	19.5	20.4	21.7	22.8	22.9	22.4	21.9	21.8	21.7	21.2	20.8	19.8	21.4	22.9	19.5

Source: JICA Study Team, based on observation data by HMS/MONRE

(2) Mean Monthly Wind Velocity (m/sec)

Province	Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average	Max.	Min.
Kon Tum	Dak To	0.96	0.82	0.93	0.71	0.59	0.69	0.60	0.63	0.49	0.73	1.05	1.07	0.77	1.07	0.49
	Kon Tum	2.10	1.94	1.80	1.43	1.08	1.04	1.05	1.06	0.96	1.28	2.64	2.25	1.55	2.64	0.96
Gia Lai	Yaly	1.60	1.53	1.53	1.47	1.40	1.33	1.38	1.44	1.47	1.53	1.60	1.60	1.49	1.60	1.33
	Ayun Pa	1.42	1.82	1.89	1.80	1.33	1.60	1.58	1.49	1.00	0.90	1.05	1.31	1.43	1.89	0.90
	Pleiku	3.40	2.81	2.60	2.21	2.51	2.80	3.02	3.15	2.04	1.90	2.66	2.98	2.67	3.40	1.90
Dak Lak	Buon Me Thuot	4.46	4.02	3.34	2.47	1.67	1.69	1.63	1.68	1.55	2.18	3.19	3.98	2.65	4.46	1.55
	Buon Ho	2.86	2.69	2.53	2.05	1.92	2.40	2.33	2.64	2.00	2.02	2.63	2.86	2.41	2.86	1.92
	Ea H'leo	3.21	2.79	2.21	2.00	1.71	2.50	2.50	2.57	2.14	2.21	3.07	3.71	2.55	3.71	1.71
	Ea Kmat	2.80	2.52	2.28	1.61	1.02	1.00	1.00	1.13	0.94	1.45	2.12	2.90	1.73	2.90	0.94
	Lak	2.14	1.82	1.53	1.17	1.15	1.14	1.26	1.04	1.05	1.29	2.14	2.74	1.54	2.74	1.04
	M'Drak	1.88	1.78	1.78	1.69	1.54	2.21	2.28	2.39	1.55	1.15	1.72	1.78	1.81	2.39	1.15
Dak Nong	Dak Glong	1.67	1.43	1.09	0.91	1.06	1.25	1.46	1.67	1.14	1.18	2.52	2.85	1.52	2.85	0.91
	Dak Mil	2.02	1.67	1.47	1.19	1.66	2.05	2.23	2.06	1.33	1.30	1.85	2.33	1.76	2.33	1.19
Lam Dong	Bao Loc	0.90	1.10	1.10	0.90	0.90	1.00	1.20	1.10	1.10	0.60	0.90	0.90	0.98	1.20	0.60
	Da Lat	2.60	2.10	1.80	1.30	1.30	1.80	1.80	1.90	1.40	1.80	2.70	3.00	1.96	3.00	1.30
	Lien Khuong	2.55	2.45	2.24	1.69	1.40	1.78	1.81	2.05	1.42	1.40	1.88	2.26	1.91	2.55	1.40

Source: JICA Study Team, based on observation data by HMS/MONRE

(3) Mean Monthly Humidity (%)

Province	Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average	Max.	Min.
Kon Tum	Dak To	74.03	71.34	72.66	76.28	82.42	86.95	88.69	89.62	88.25	84.67	80.19	76.77	80.99	89.62	71.34
	Kon Tum	70.59	68.33	68.39	71.76	78.85	83.89	84.98	86.08	85.58	81.27	76.56	73.24	77.46	86.08	68.33
Gia Lai	Yaly	71.09	69.79	71.10	73.50	79.13	83.14	84.45	85.51	85.68	80.68	77.74	74.03	77.99	85.68	69.79
	Ayun Pa	77.67	73.93	71.25	70.81	75.68	78.81	80.56	82.59	84.93	85.58	84.46	80.85	78.93	85.58	70.81
	Pleiku	77.33	74.10	72.53	75.36	83.61	87.22	90.45	91.45	90.09	86.10	82.23	79.25	82.48	91.45	72.53
Dak Lak	Buon Me Thuot	77.59	74.03	71.75	73.12	80.64	85.33	86.81	87.80	88.82	86.71	84.52	81.92	81.59	88.82	71.75
	Buon Ho	85.03	80.46	77.00	76.32	81.49	86.56	88.34	89.46	89.57	89.28	89.16	88.52	85.10	89.57	76.32
	Ea H'leo	79.62	75.10	73.43	74.00	80.91	86.27	88.56	89.40	88.73	86.21	85.73	84.03	82.67	89.40	73.43
	Ea Kmat	80.38	76.84	75.51	75.84	81.97	85.50	86.51	87.35	88.02	86.13	85.88	84.81	82.89	88.02	75.51
	Lak	77.29	75.75	74.91	75.88	80.16	83.44	84.43	85.45	86.30	85.41	82.89	81.39	81.11	86.30	74.91
	M'Drak	86.54	83.02	80.55	78.20	78.85	77.56	77.02	77.71	83.67	87.85	89.41	89.45	82.49	89.45	77.02
Dak Nong	Dak Glong	77.34	75.39	76.54	80.93	86.37	89.44	90.15	90.68	90.90	87.31	83.03	79.82	83.99	90.90	75.39
	Dak Mil	80.76	75.20	74.63	76.63	82.41	83.92	85.07	86.07	87.74	87.83	87.09	86.21	82.80	87.83	74.63
Lam Dong	Bao Loc	79.47	77.82	79.30	82.70	86.63	89.46	89.98	90.87	90.16	88.55	86.07	83.39	85.37	90.87	77.82
	Da Lat	80.04	76.85	77.81	82.46	86.72	88.30	88.66	89.25	89.56	87.73	84.49	82.87	84.56	89.56	76.85
	Lien Khuong	74.33	71.13	71.37	75.54	81.57	85.13	85.97	86.59	87.38	86.44	81.98	77.76	80.43	87.38	71.13

Source: JICA Study Team, based on observation data by HMS/MONRE

(4) Mean Monthly Sunshine Hours (hours)

Province	Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average	Max.	Min.
Kon Tum	Dak To	269	250	254	220	190	131	124	111	128	175	204	243	191	269	111
	Kon Tum	277	259	262	242	205	153	151	139	133	187	211	250	206	277	133
Gia Lai	Yaly	259	254	249	238	218	164	149	135	134	182	203	231	201	259	134
	Ayun Pa	196	226	268	255	251	208	208	192	171	164	155	147	203	268	147
	Pleiku	263	261	273	242	210	158	154	132	136	176	201	229	203	273	132
Dak Lak	Buon Me Thuot	254	255	271	253	228	183	184	165	152	167	174	186	206	271	152
	Buon Ho	222	234	256	244	237	203	195	177	157	161	161	164	201	256	157
	Ea H'leo	232	248	253	249	274	186	169	163	145	170	182	180	204	274	145
	Ea Kmat	243	251	262	252	227	186	172	168	156	171	173	175	203	262	156
	Lak	245	246	261	240	221	180	173	166	151	179	184	203	204	261	151
	M'Drak	135	186	237	247	240	213	212	200	169	140	102	88	181	247	88
Dak Nong	Dak Glong	254	242	253	224	192	145	146	130	127	168	195	227	192	254	127
	Dak Mil	197	217	218	206	203	168	166	166	132	153	148	137	176	218	132
Lam Dong	Bao Loc	213	213	225	202	185	144	145	127	122	141	163	181	172	225	122
	Da Lat	238	225	242	202	183	152	152	139	129	146	171	198	181	242	129
	Lien Khuong	262	248	257	234	195	159	163	148	142	154	178	209	196	262	142

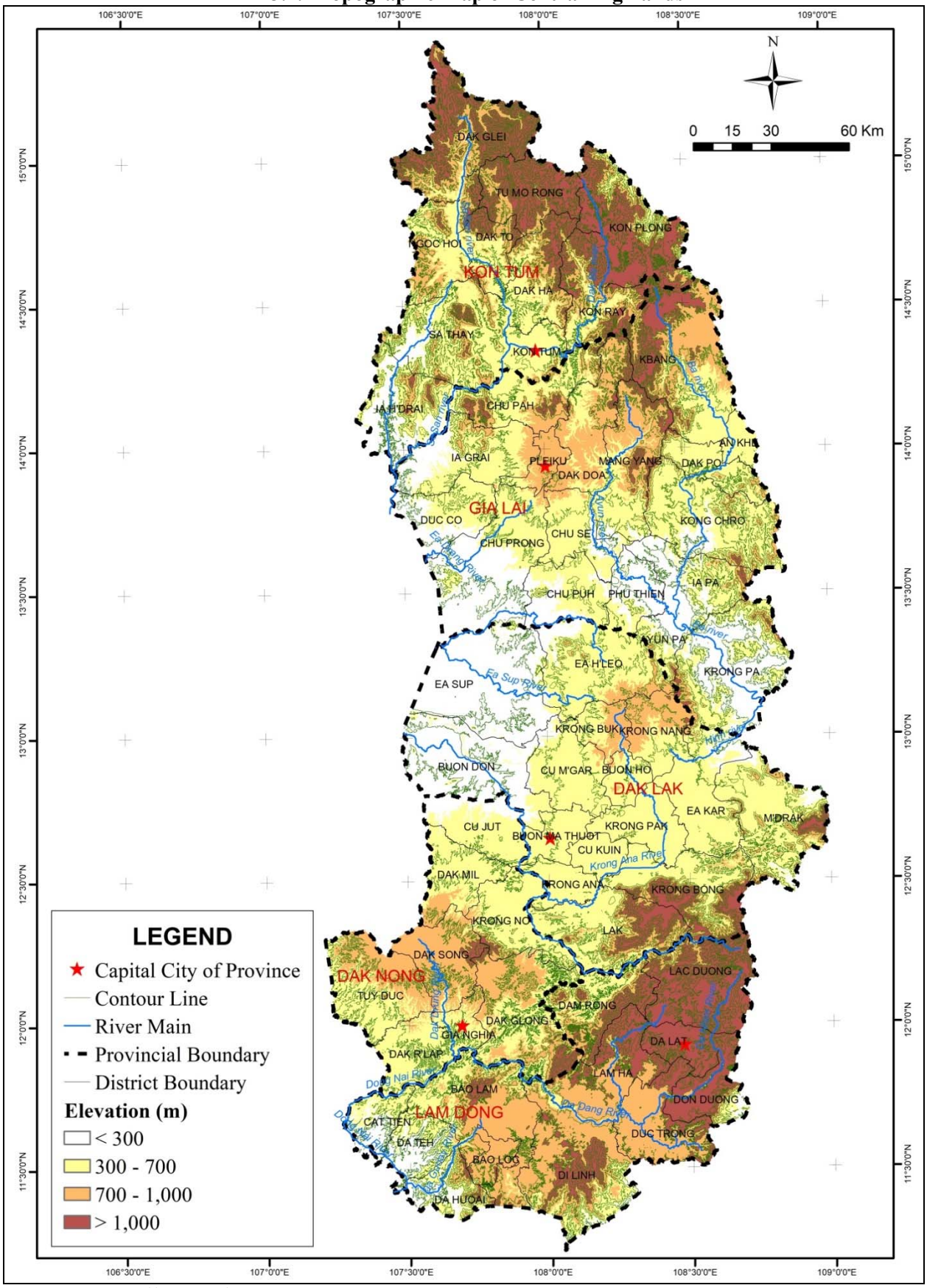
Source: JICA Study Team, based on observation data by HMS/MONRE

(5) Mean Monthly Evapotranspiration (mm/day)

Province	Station	Elevation (m)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average	Max.
Kon Tum	Dak To	608	3.39	3.75	4.18	4.32	3.86	3.77	2.88	3.33	3.43	3.44	3.40	3.19	3.58	4.32
	Kon Tum	523	3.89	4.33	4.97	4.79	4.49	4.01	3.25	3.78	3.71	3.78	3.90	3.76	4.06	4.97
Gia Lai	Yaly	490	3.54	4.25	4.55	4.63	4.59	3.98	3.71	3.97	3.78	3.65	3.21	3.18	3.92	4.63
	Ayun Pa	145	3.66	3.58	4.44	5.54	5.23	4.39	4.02	4.62	4.24	3.79	3.09	3.00	4.13	5.54
	Pleiku	779	3.50	4.23	4.54	4.80	4.37	3.77	3.03	3.53	3.44	3.57	3.46	3.43	3.81	4.80
Dak Lak	An Khe	418	3.15	3.16	3.75	4.91	5.39	4.77	4.41	4.74	4.14	3.75	2.84	2.60	3.97	5.39
	Buon Me Thuot	464	3.90	4.14	4.87	5.07	4.71	3.95	3.62	3.95	3.79	3.85	3.37	3.40	4.05	5.07
	Buon Ho	693	3.05	3.03	4.18	4.69	4.66	3.90	3.50	3.97	3.70	3.41	2.76	2.64	3.63	4.69
	Ea H'leo	624	3.47	3.72	4.42	5.07	4.73	3.76	3.26	3.83	3.73	3.64	3.08	3.02	3.81	5.07
	Ea Kmat	536	3.59	3.66	4.64	4.89	4.34	3.79	3.50	3.88	3.73	3.71	3.18	3.11	3.84	4.89
	Lak	458	3.71	4.19	4.67	5.03	4.73	3.91	3.71	4.01	3.86	3.78	3.30	3.46	4.03	5.03
Dak Nong	M'Drak	438	2.73	2.61	3.83	4.88	4.75	4.27	4.36	4.49	4.08	3.42	2.52	2.36	3.69	4.88
	Dak Glong		3.42	3.96	4.16	4.47	4.20	3.43	3.25	3.47	3.30	3.44	3.23	3.20	3.63	4.47
Lam Dong	Dak Mil	755	3.25	3.51	4.35	4.68	4.33	3.70	3.75	3.78	3.67	3.54	2.88	2.79	3.69	4.68
	Bao Loc	811	3.16	3.58	4.01	4.32	3.89	3.30	3.15	3.49	3.40	3.29	3.04	2.89	3.46	4.32
	Da Lat	1,472	3.01	3.42	3.71	3.72	3.32	2.95	2.76	3.17	2.84	2.96	2.88	2.87	3.14	3.72

Source: JICA Study Team based on rainfall observation data by HMS/MONRE.

AT 3.2.1 Topographic Map of Central Highlands



Source: MONRE, prepared by JICA Study Team

AT 3.2.2 Topography and Soil

(1) Topographical Zones in the Central Highlands Provinces

Basin	Area (ha)	Average Slope (m/m)	Average Slope Length (m)	Average Overland Manning's Coefficient
Sesan	1,137,678	0.236	14.967	0.115
Srepok	2,338,896	0.158	35.309	0.118
Ba	1,101,363	0.182	23.282	0.122
Dong Nai	923,555	0.241	15.659	0.113

Source: JICA Study Team

(2) Area of Soil Type by Province

Soil Type	Area (km^2)					
	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong	Total
ALISOLS	150.8				11.6	11.6
CAMBIC FLUVISOLS	25.1	18.7				0.0
CARISOLS	34.2					0.0
CHROMIC LUVISOLS		417.1	348.9	98.2	88.0	535.1
DYSTRIC FLUVISOL	54.2	555.8	336.2	67.4	411.4	815.0
DYSTRIC GLEYSOLS			20.1	96.9	253.3	370.4
FERRLIC ACRISOLS	5,859.2	5,032.9	5,879.5	1,973.8	5,902.8	13,756.1
HAPLIC ACRISOLS	28.8	3,622.9	1,888.2	69.9	47.1	2,005.2
HAPLIC ANDOSOLS			70.5	140.9		211.4
HUMIC ACRISOLS	3,344.7	761.5	887.0	139.4	1,318.7	2,345.1
HUMIC FERRALSOLS	148.5	254.2				0.0
LEPTOSOLS		1,019.3	410.1	60.5	31.8	502.4
RHODIC FERRALSOLS	52.0	3,741.4	2,966.3	3,323.6	940.3	7,230.2
UMBRIC GLEYSOLS		100.0	177.7	98.0		275.7
XANTHIC FERRALSOLS		25.3	173.5	453.6	803.4	1,430.5

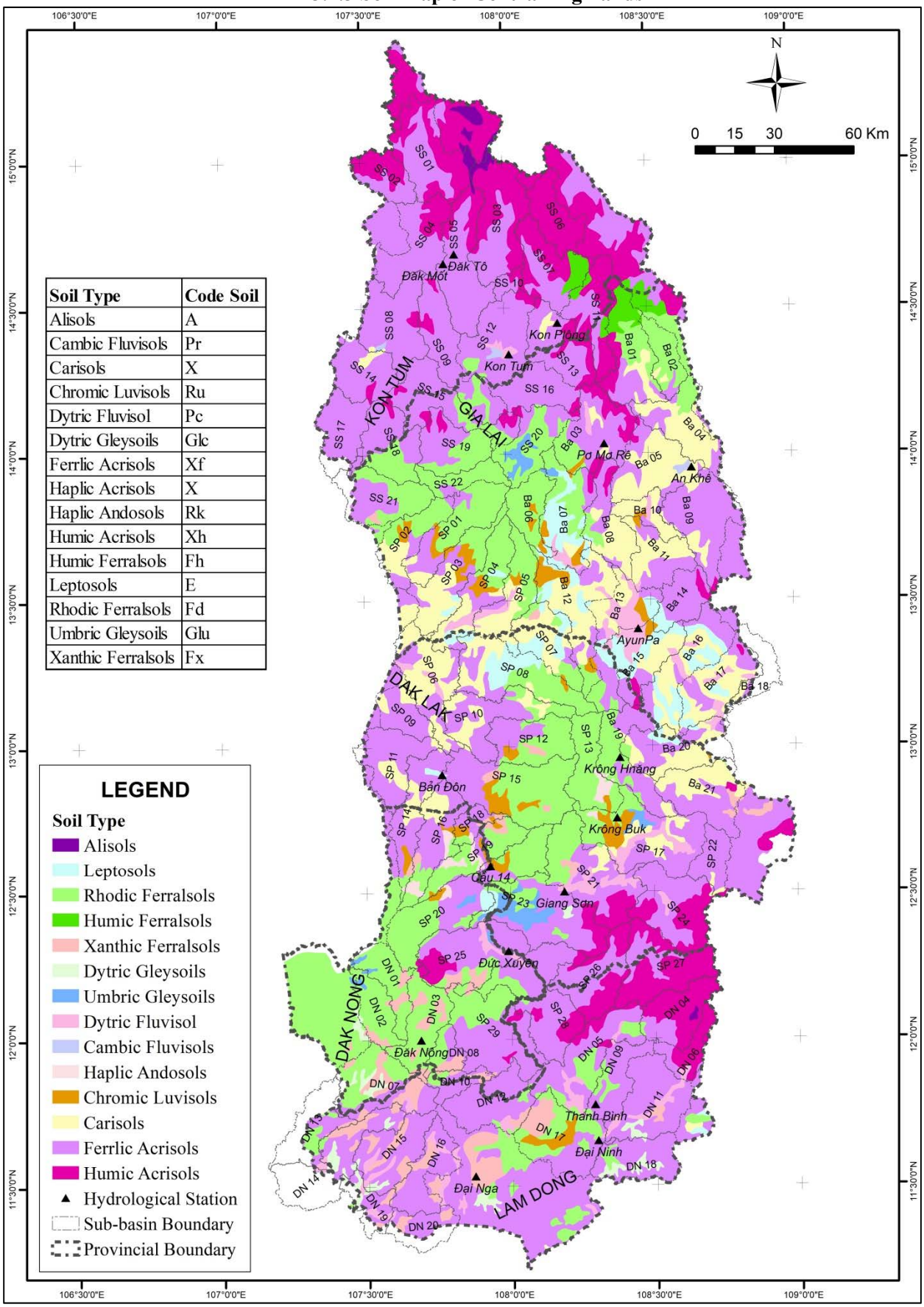
Source: MONRE

(3) Classification and Cartelistic of Typical Soils

Soil Type/Name	Unsaturated Hydraulic Conductivity *Ks* (cm/sec)	Residual Soil Water Content *r*(cm^3*cm^3)	Saturated Soil Water Content *s*(cm^3*cm^3)	Empirical Parameter α (cm^{-1})	Empirical Parameter *n*
Heavy clay	9.31E-04	0.140	0.404	0.007	1.617
Sandy clay	4.19E-04	0.126	0.426	0.018	1.447
Sandy clay loam	4.97E-04	0.202	0.409	0.028	1.409
Sandy loam	1.61E-03	0.166	0.435	0.009	1.865
Sand	3.14E-03	0.158	0.469	0.007	1.538
Light clay	9.56E-04	0.215	0.457	0.011	1.537
Clay loam	2.28E-04	0.199	0.383	0.044	1.481
Loam	1.72E-04	0.179	0.521	0.006	1.580
Silty clay	4.17E-04	0.258	0.450	0.013	1.530
Silty clay loam	3.61E-04	0.134	0.600	0.393	1.215

Source: Infiltration Characteristics of Tropical Soil based on Water Retention Data, Muhamad Askari, et.al., J.Jpan Soc. Hydrol. and Water Resource., Vol.21, No.3, May 2008, pp.215-227.

AT 3.2.3 Soil Map of Central Highlands



Soil Type	Code Soil
Alisols	A
Cambic Fluvisols	Pr
Carisols	X
Chromic Luvisols	Ru
Dytric Fluvisol	Pc
Dytric Gleysoils	Glc
Ferrlic Acrisols	Xf
Haplic Acrisols	X
Haplic Andosols	Rk
Humic Acrisols	Xh
Humic Ferralsols	Fh
Leptosols	E
Rhodic Ferralsols	Fd
Umbric Gleysoils	Glu
Xanthic Ferralsols	Fx

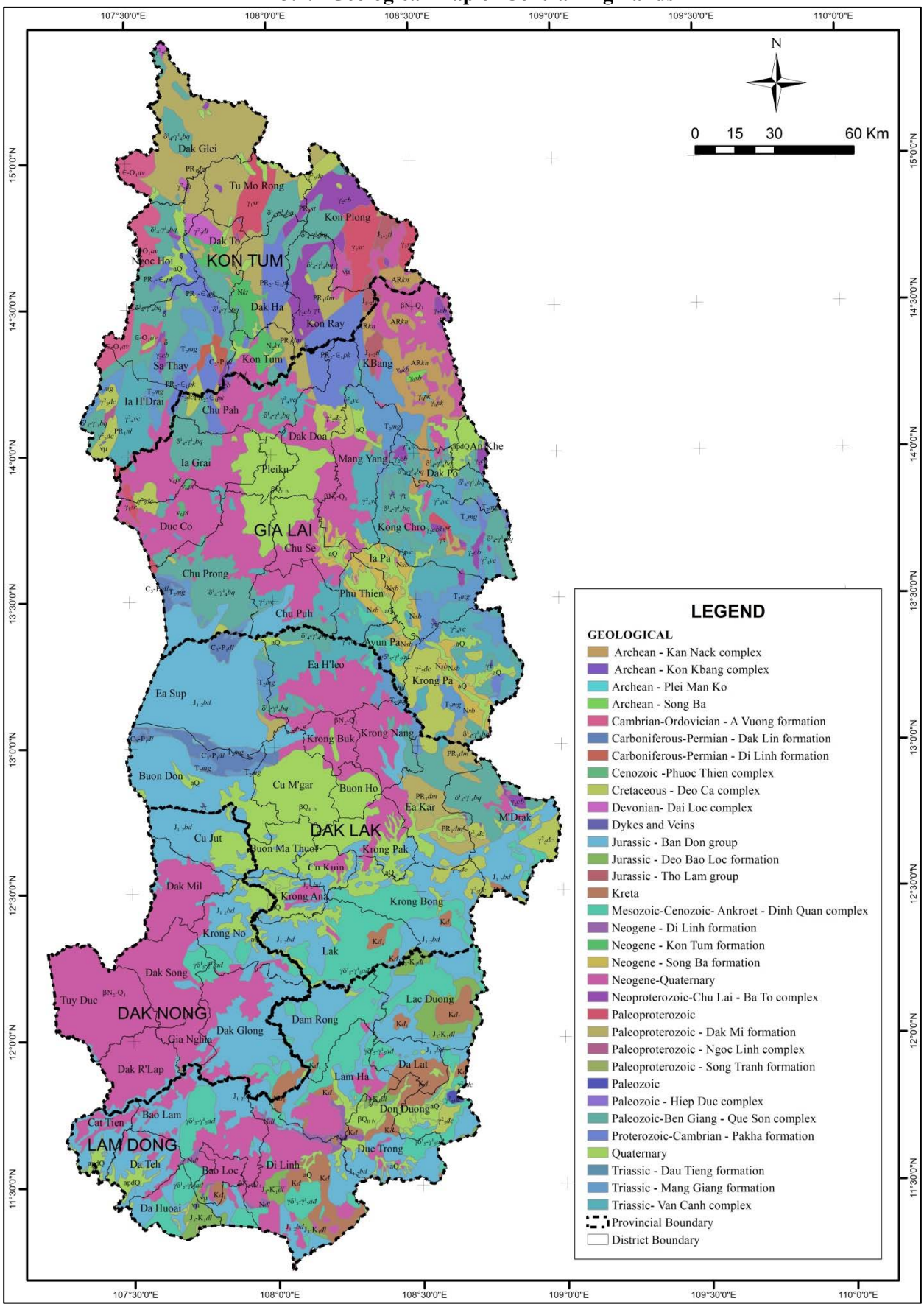
LEGEND

Soil Type

- Alisols
- Leptosols
- Rhodic Ferralsols
- Humic Ferralsols
- Xanthic Ferralsols
- Dytric Gleysoils
- Umbric Gleysoils
- Dytric Fluvisol
- Cambic Fluvisols
- Haplic Andosols
- Chromic Luvisols
- Carisols
- Ferrlic Acrisols
- Humic Acrisols
- ▲ Hydrological Station
- Sub-basin Boundary
- Provincial Boundary

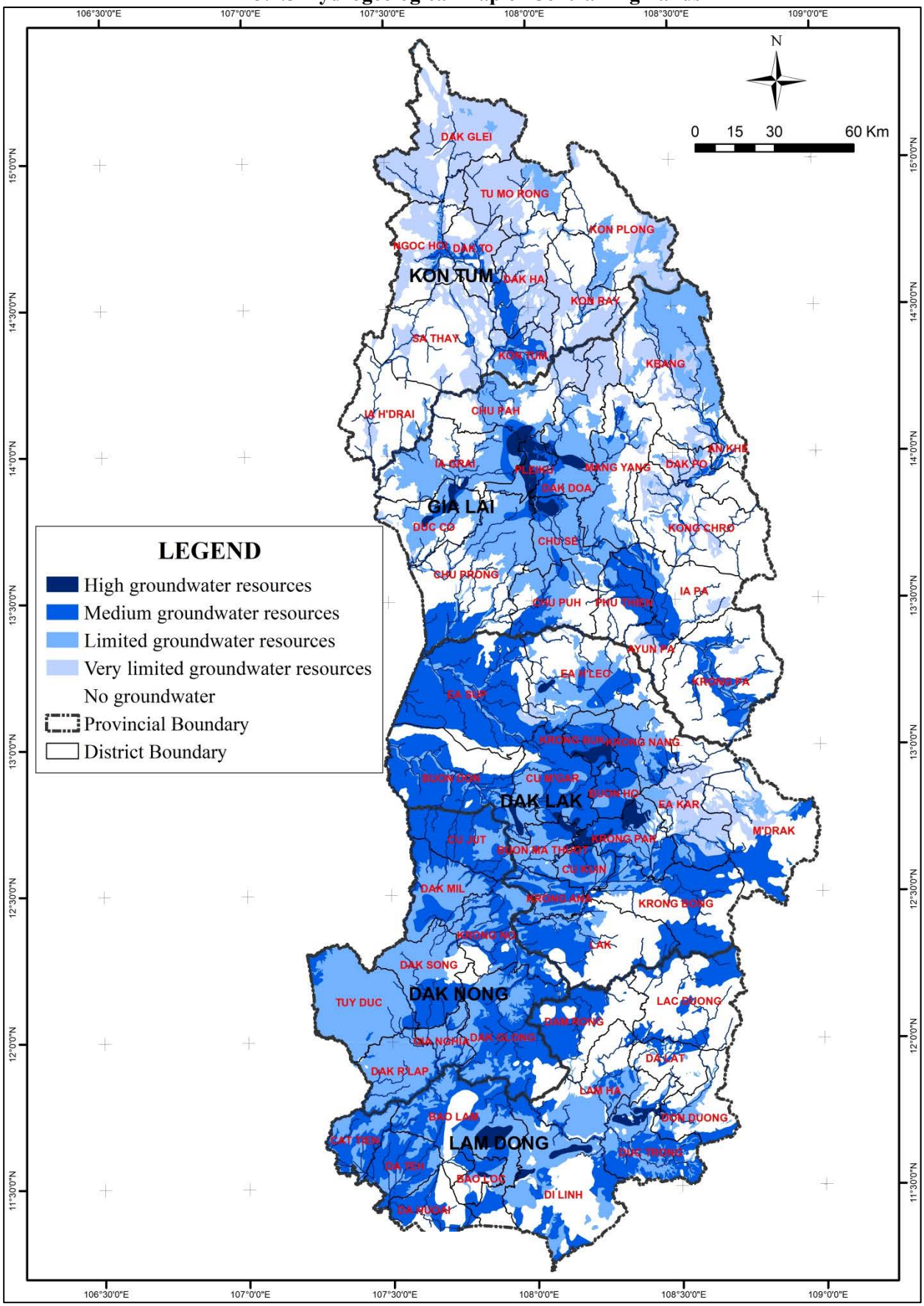
Source: MONRE

AT 3.2.4 Geological Map of Central Highlands



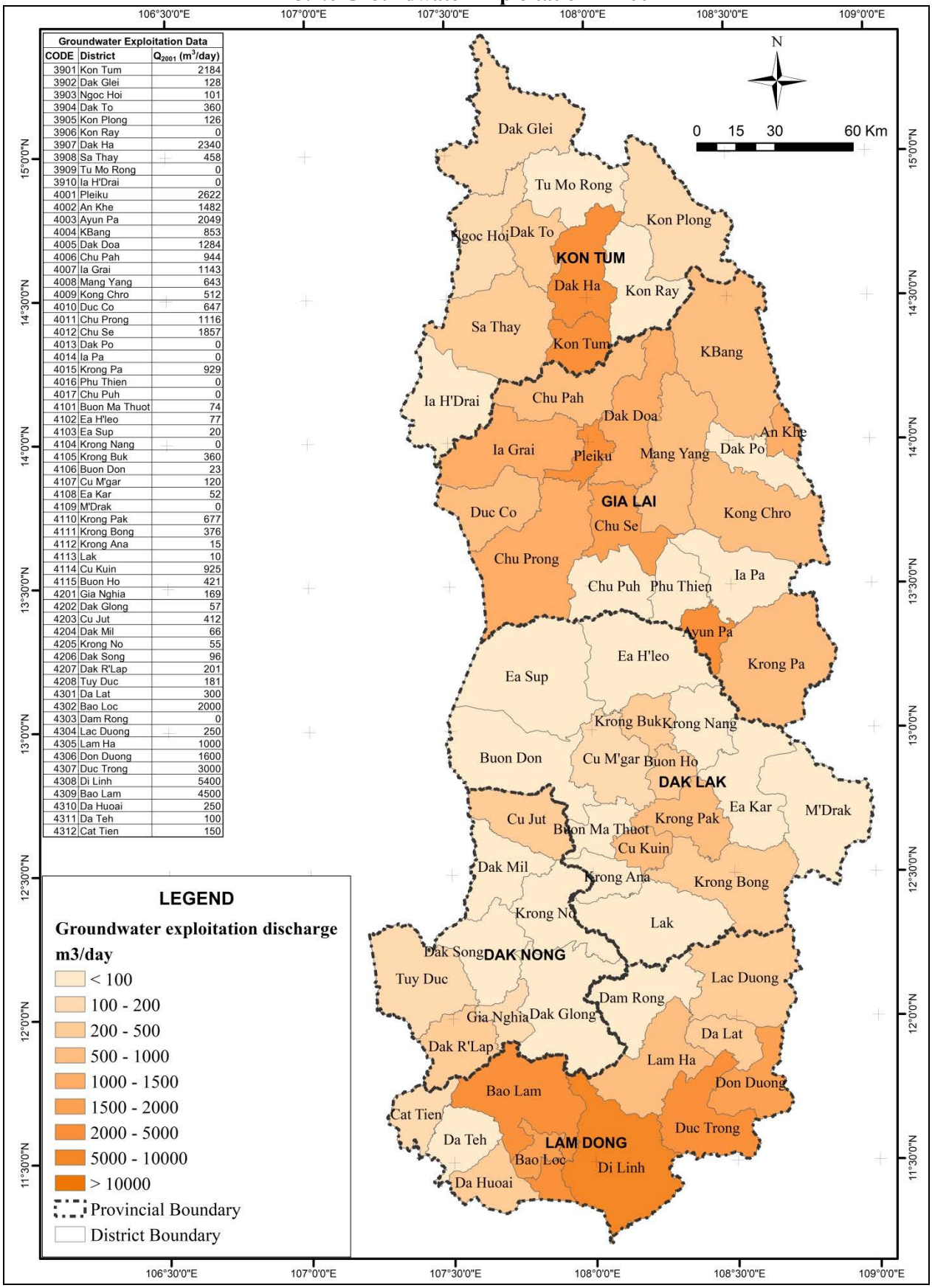
Source: Department of Geology, Ministry of Natural Resources and Environment (MONRE)

AT 3.2.5 Hydrogeological Map of Central Highlands



Source: Project KC.08, Hanoi University of Mining and Geology, 2005

AT 3.2.6 Groundwater Exploitation in 2001

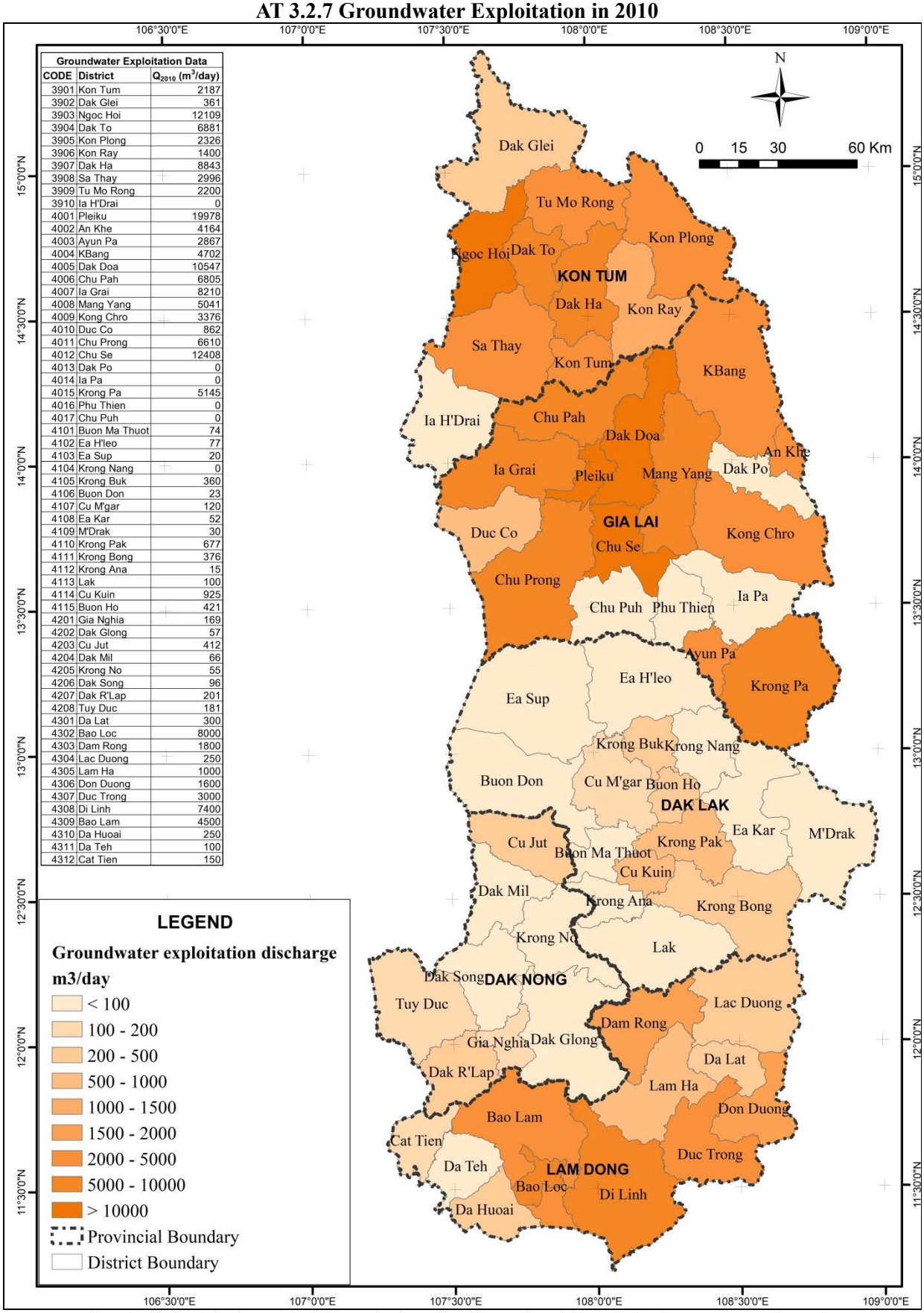


Groundwater Exploitation Data		
CODE	District	Q_{2001} (m^3/day)
3901	Kon Tum	2184
3902	Dak Glei	128
3903	Ngoc Hoi	101
3904	Dak To	360
3905	Kon Plong	126
3906	Kon Ray	0
3907	Dak Ha	2340
3908	Sa Thay	458
3909	Tu Mo Rong	0
3910	Ia H'Drai	0
4001	Pleiku	2622
4002	An Khe	1482
4003	Ayun Pa	2049
4004	KBang	853
4005	Dak Doa	1284
4006	Chu Pah	944
4007	Ia Grai	1143
4008	Mang Yang	643
4009	Kong Chro	512
4010	Duc Co	647
4011	Chu Prong	1116
4012	Chu Se	1857
4013	Dak Po	0
4014	Ia Pa	0
4015	Krong Pa	929
4016	Phu Thien	0
4017	Chu Puh	0
4101	Buon Ma Thuot	74
4102	Ea H'leo	77
4103	Ea Sup	20
4104	Krong Nang	0
4105	Krong Buk	360
4106	Buon Don	23
4107	Cu M'gar	120
4108	Ea Kar	52
4109	M'Drak	0
4110	Krong Pak	677
4111	Krong Bong	376
4112	Krong Ana	15
4113	Lak	10
4114	Cu Kuin	925
4115	Buon Ho	421
4201	Gia Nghia	169
4202	Dak Glong	57
4203	Cu Jut	412
4204	Dak Mil	66
4205	Krong No	55
4206	Dak Song	96
4207	Dak R'Lap	201
4208	Tuy Duc	181
4301	Da Lat	300
4302	Bao Loc	2000
4303	Dam Rong	0
4304	Lac Duong	250
4305	Lam Ha	1000
4306	Don Duong	1600
4307	Duc Trong	3000
4308	Di Linh	5400
4309	Bao Lam	4500
4310	Da Huoai	250
4311	Da Teh	100
4312	Cat Tien	150

Source: "Researching scientific foundation for general solution to solve the conflict of interests in exploiting and using the water resources of Central Highlands"

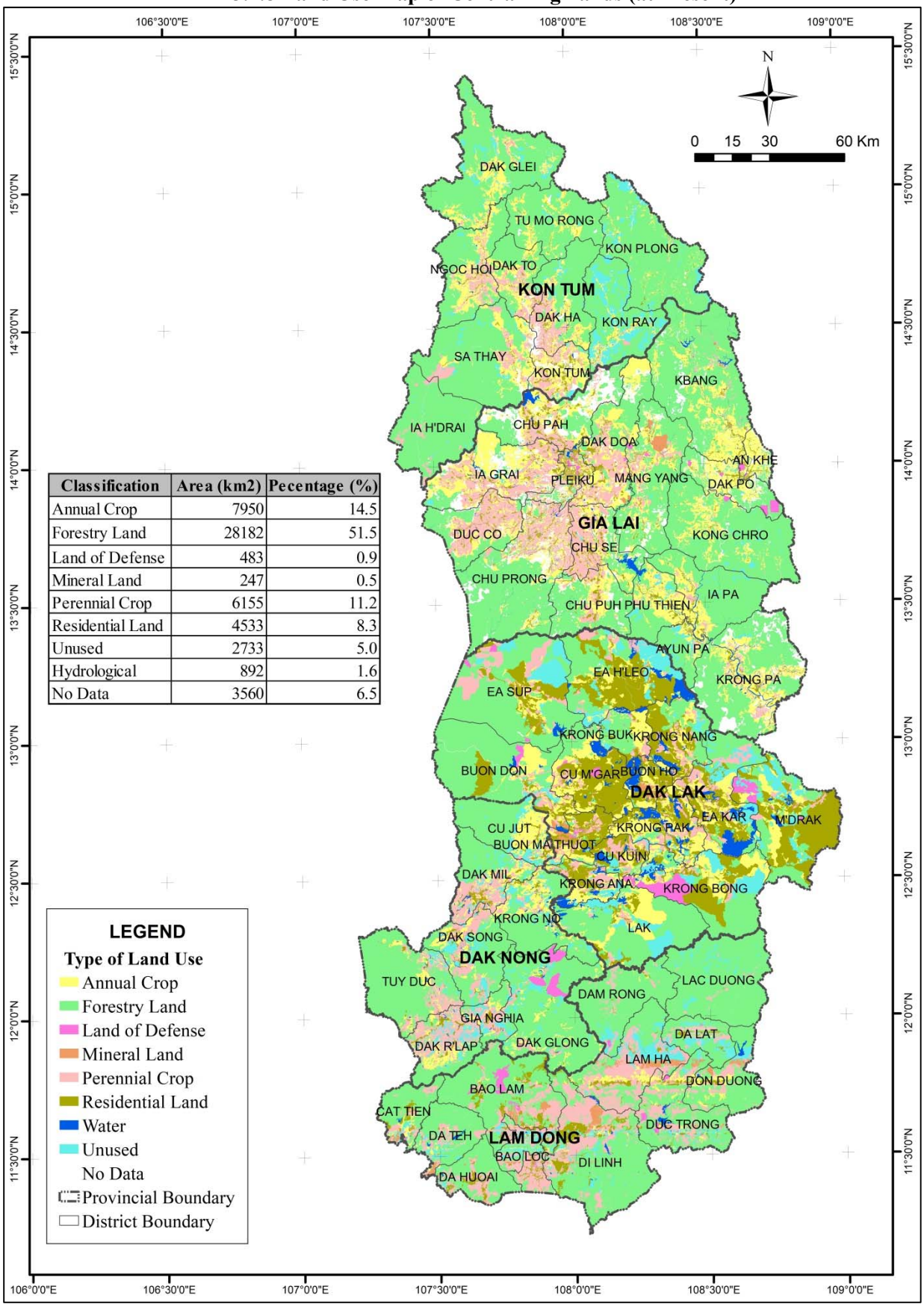
AT 3.2.7 Groundwater Exploitation in 2010

Groundwater Exploitation Data		
CODE	District	Q_{2010} (m^3/day)
3901	Kon Tum	2187
3902	Dak Glei	361
3903	Ngoc Hoi	12109
3904	Dak To	6881
3905	Kon Plong	2326
3906	Kon Ray	1400
3907	Dak Ha	8843
3908	Sa Thay	2996
3909	Tu Mo Rong	2200
3910	Ia H'Drai	0
4001	Pleiku	19978
4002	An Khe	4164
4003	Ayun Pa	2867
4004	KBang	4702
4005	Dak Doa	10547
4006	Chu Pah	6805
4007	Ia Grai	8210
4008	Mang Yang	5041
4009	Kong Chro	3376
4010	Duc Co	862
4011	Chu Prong	6610
4012	Chu Se	12408
4013	Dak Po	0
4014	Ia Pa	0
4015	Krong Pa	5145
4016	Phu Thien	0
4017	Chu Puh	0
4101	Buon Ma Thuot	74
4102	Ea H'leo	77
4103	Ea Sup	20
4104	Krong Nang	0
4105	Krong Buk	360
4106	Buon Don	23
4107	Cu M'gar	120
4108	Ea Kar	52
4109	M'Drak	30
4110	Krong Pak	677
4111	Krong Bong	376
4112	Krong Ana	15
4113	Lak	100
4114	Cu Kuin	925
4115	Buon Ho	421
4201	Gia Nghia	169
4202	Dak Glong	57
4203	Cu Jut	412
4204	Dak Mil	66
4205	Krong No	55
4206	Dak Song	96
4207	Dak R'Lap	201
4208	Tuy Duc	181
4301	Da Lat	300
4302	Bao Loc	8000
4303	Dam Rong	1800
4304	Lac Duong	250
4305	Lam Ha	1000
4306	Don Duong	1600
4307	Duc Trong	3000
4308	Di Linh	7400
4309	Bao Lam	4500
4310	Da Huoai	250
4311	Da Teh	100
4312	Cat Tien	150



Source: "Researching scientific foundation for general solution to solve the conflict of interests in exploiting and using the water resources of Central Highlands"

AT 3.2.8 Land Use Map of Central Highlands (at Present)



Classification	Area (km2)	Pecentage (%)
Annual Crop	7950	14.5
Forestry Land	28182	51.5
Land of Defense	483	0.9
Mineral Land	247	0.5
Perennial Crop	6155	11.2
Residential Land	4533	8.3
Unused	2733	5.0
Hydrological	892	1.6
No Data	3560	6.5

LEGEND

Type of Land Use

- Annual Crop
- Forestry Land
- Land of Defense
- Mineral Land
- Perennial Crop
- Residential Land
- Water
- Unused
- No Data
- Provincial Boundary
- District Boundary

Source: MONRE

AT 3.3.1 Administration, Area and Population of the Five Provinces in 2016

Code	Districts	Number of commune	Area (km^2)	Share of agricultural area (%)	Population (person)	Share of rural population (%)	Population density (persons/km^2)
39	**Kon Tum Province**	**102**	**9,674.19**	**27.36**	**507,818**	**64.4**	**52**
3901	Kon Tum City	21	432.90	71.81	164,794	36.7	381
3902	Dak Glei	12	1,493.65	21.86	44,502	84.7	30
3903	Ngoc Hoi	8	839.36	46.36	53,005	67.9	63
3904	Dak To	9	508.70	57.25	44,648	66.7	88
3905	Kon Plong	9	1,371.25	8.21	24,966	100.0	18
3906	Kon Ray	7	913.90	21.73	25,216	77.2	28
3907	Dak Ha	11	845.04	41.20	69,740	71.3	83
3908	Sa Thay	11	1,431.73	27.75	48,717	75.5	34
3909	Tu Mo Rong	11	857.44	30.85	25,241	100.0	29
3910	Ia H'Drai	3	980.22	0.77	6,989	100.0	7
40	**Gia Lai Province**	**222**	**15,510.99**	**51.68**	**1,417,259**	**70.0**	**91**
4001	Pleiku City	23	260.77	63.71	231,387	21.9	887
4002	An Khe Town	11	200.07	61.70	66,840	34.8	334
4003	Ayun Pa Town	8	287.18	42.37	37,752	38.7	131
4004	Kbang	14	1,840.92	27.27	65,932	74.5	36
4005	Dak Doa	17	985.30	66.06	110,345	85.9	112
4006	Chu Pah	15	974.58	56.99	72,434	83.6	74
4007	Ia Grai	13	1,119.60	66.84	96,382	88.6	86
4008	Mang Yang	12	1,127.18	43.84	64,607	84.6	57
4009	Kong Chro	14	1,439.71	38.06	48,438	79.5	34
4010	Duc Co	10	721.86	83.76	70,651	81.2	98
4011	Chu Prong	20	1,693.91	62.25	109,134	91.3	64
4012	Chu Se	15	641.04	71.16	117,021	74.0	183
4013	Dak Po	8	502.53	47.89	41,953	88.5	83
4014	Ia Pa	9	868.59	36.07	54,624	100.0	63
4015	Krong Pa	14	1,623.66	37.75	81,014	85.4	50
4016	Phu Thien	10	505.17	60.85	77,667	73.2	154
4017	Chu Puh	9	718.92	71.96	71,078	83.3	99
41	**Dak Lak Province**	**184**	**13,030.45**	**48.13**	**1,874,459**	**75.6**	**144**
4101	Buon Ma Thuot City	21	377.07	74.43	360,018	34.6	955
4102	Ea H'leo	12	1,334.09	57.07	129,651	84.3	97
4103	Ea Sup	10	1,765.31	32.89	65,531	81.4	37
4104	Krong Nang	12	614.60	75.18	125,699	89.8	205
4105	Krong Buk	7	357.67	91.29	63,702	100.0	178
4106	Buon Don	7	1,410.15	19.23	64,496	100.0	46
4107	Cu M'Gar	17	824.49	80.48	174,693	81.8	212
4108	Ea Kar	16	1,037.00	54.12	152,684	83.8	147
4109	M'Drak	13	1,244.48	37.30	72,153	92.0	58
4110	Krong Pac	16	625.77	80.49	208,846	91.1	334
4111	Krong Bong	14	1,256.95	32.65	95,837	92.6	76
4112	Krong Ana	8	355.90	77.70	87,034	71.1	245
4113	Lak	11	1,256.07	17.32	65,452	90.5	52
4114	Cu Kuin	8	288.30	83.61	105,016	100.0	364
4115	Buon Ho Town	12	282.60	88.90	103,647	45.2	367
42	**Dak Nong Province**	**71**	**6,509.27**	**55.33**	**609,595**	**84.8**	**94**
4201	Gia Nghia Town	8	284.11	75.01	58,644	31.2	206
4202	Dak G'Long	7	1,447.76	39.73	58,701	100.0	41
4203	Cu Jut	8	720.70	42.73	99,983	82.6	139
4204	Dak Mil	10	681.58	64.92	104,308	89.0	153
4205	Krong No	12	813.74	64.66	74,812	90.7	92
4206	Dak Song	9	806.46	65.24	76,481	92.7	95
4207	Dak R'Lap	11	635.67	69.05	86,385	87.2	136
4208	Tuy Duc	6	1,119.25	51.08	50,281	100.0	45
43	**Lam Dong Province**	**147**	**9,783.34**	**37.64**	**1,285,943**	**60.8**	**131**
4301	Da Lat City	16	394.46	34.63	223,935	10.3	568
4302	Bao Loc City	11	233.15	79.61	160,979	38.5	690
4303	Dam Rong	8	872.10	27.69	47,705	100.0	55
4304	Lac Duong	6	1,311.36	9.44	25,097	60.5	19
4305	Lam Ha	16	930.23	66.66	141,349	78.2	152
4306	Don Duong	10	611.35	33.24	102,851	73.9	168
4307	Duc Trong	15	903.62	53.80	180,459	74.2	200
4308	Di Linh	19	1,614.18	41.64	159,051	82.6	99
4309	Bao Lam	14	1,463.43	39.63	118,976	83.9	81
4310	Da Huoai	10	495.56	32.16	36,425	60.1	74
4311	Da Teh	11	526.96	27.29	48,365	64.7	92
4312	Cat Tien	11	426.94	30.25	40,751	72.1	95

Source: Provincial Statistical Yearbooks 2016

AT 3.3.2 Features of Living and Livelihoods of Main Ethnicities in Central Highlands

Ethnic Minority Groups	House Style	Living Location	Language Group	Main Livelihood Means	Agriculture Patterns
Jarai	Long house on the stilts	Reside mainly in Gia Lai (90%), Kon Tum (5%) and North of Dak Lak (4%)	Jarai language is a subgroup of Cham language, belongs to the Malay-Polynesian language of the Austronesian language family	Agriculture	Cultivate on upland field
Ba Na	House on the stilts	Reside mainly in Gia Lai (66%), Kon Tum (24%) and living scattered in other 49 provinces	Bahnar language belongs to the Mon-Khmer language of the Austronesian language family	Agriculture, raising cattle, pig, goat and poultry; brocade	Cultivate on upland field
Xo Dang		Reside mainly in Kon Tum (62%), Quang Nam (22%), Quang Ngai (10%), Dak Lak (5%) and living scattered in other 45 provinces	Xo Dang language belongs to the Mon-Khmer language of the Austronesian language family	Agriculture, raising cattle, pig, goat and poultry; fishery; forge, brocade, textile	Mainly cultivate on upland field
Co Ho	Long house on the stilts	Reside mainly in Lam Dong (88%), Binh Thuan (7%) and living scattered in other 44 provinces	Co Ho language is a subgroup of Bahnar language, belongs to the Mon-Khmer language of the Austronesian language family	Agriculture, forge, brocade, textile	Cultivate and forestry
E De	Long and lowly house on the stilts	Reside mainly in Dak Lak (90%), Phu Yen (6%), Dak Nong (2%) and living scattered in other 43 provinces	E De language is a subgroup of Cham language, belongs to the Malay-Polynesian language of the Austronesian language family	Cultivate annual and industry crops; raising cattle, pig, goat and poultry; fishery, brocade, textile	Mainly cultivate on upland field (maize, gourd) plant paddy rice
Ma	Long house on the stilts	Reside mainly in Lam Dong (77%), Dak Nong (2%) and living scattered in other 32 provinces	Ma language is a subgroup of Bahnar language, belongs to the Mon-Khmer language of the Austronesian language family	Agriculture, raising cattle, and poultry; forge, brocade, textile	Cultivate on upland field (rice, gourd, tobacco, cotton)
Ra Glai	Low house on the stilts	Reside mainly in Ninh Thuan (48%), Khanh Hoa (38%), Binh Thuan (13%), Lam Dong (2%) and living scattered in other 39 provinces	Ra Glai language belongs to the Malay-Polynesian language of the Austronesian language family	Agriculture, forge, brocade, textile	Cultivate on upland field (rice, maize)
Gie Trieng	Long house on the stilts	Reside mainly in Kon Tum (62%), Quang Nam (37%) and living scattered in other 39 provinces	Gie Trieng is two languages (Jeh and Tariang) Both language are subgroups of Bahnar language, belongs to the Mon-Khmer language of the Austronesian language family	Agriculture, raising cattle, pig, goat and poultry	Cultivate on upland field

Source: Committee for Ethnic Minorities Affairs

AT 3.4.1 Value of Agricultural Products traded at Local Markets and Outside in Central Highlands

District Code	Province / District	Total Value of Agr. Products (VND Mil.)	Value of Agr. Products for People and livestock Consumption (VND Mil.)			Value of Agr. Products (Food and Foodstuff) selling at local Markets (VND Mil.)			Value of Agr. Products sold at Outside (VND Mil.)
			People	Livestock	Total	Food	Foodstuff	Total	
		A	B	C	D=B+C	E	F	G=E+F	H=A-[D+G]
I					39-Kon Tum				
3901	Kon Tum	2,663,894	727,417	194,066	921,482	257,033	753,705	1,010,737	731,675
3902	Dak Glei	721,899	197,125	68,641	265,766	69,654	204,249	273,903	182,229
3903	Ngoc Hoi	840,977	229,642	67,890	297,531	81,144	237,941	319,084	224,362
3904	Dak To	719,699	196,525	65,257	261,781	69,442	203,627	273,069	184,849
3905	Kon Plong	404,063	110,336	86,881	197,217	38,987	114,323	153,310	53,536
3906	Kon Ray	409,985	111,953	60,092	172,045	39,558	115,998	155,557	82,384
3907	Dak Ha	1,131,321	308,924	90,697	399,621	109,158	320,089	429,247	302,453
3908	Sa Thay	786,028	214,637	73,874	288,511	75,842	222,394	298,236	199,281
3909	Tu Mo Rong	411,110	112,260	73,581	185,841	39,667	116,317	155,984	69,285
3910	Ia H'Drai	113,306	30,940	12,188	43,128	10,933	32,058	42,991	27,187
Sub-Total		8,202,282	2,239,757	793,167	3,032,924	791,418	2,320,700	3,112,118	2,057,240
II					40-Gia Lai				
4001	Pleiku	1,474,929	1,177,286	233,810	1,411,096	363,473	1,065,823	1,429,296	-1,365,464
4002	An Khe	1,021,831	343,343	104,700	448,043	106,003	310,836	416,839	156,948
4003	Ayun Pa	574,858	193,740	59,920	253,660	59,815	175,397	235,212	85,986
4004	KBang	2,039,608	338,804	138,754	477,559	104,602	306,727	411,329	1,150,720
4005	Dak Doa	3,643,059	560,227	169,808	730,035	172,963	507,186	680,149	2,232,875
4006	Chu Pah	1,952,182	371,000	127,172	498,172	114,542	335,874	450,416	1,003,594
4007	Ia Grai	4,137,002	492,590	123,244	615,834	152,081	445,953	598,034	2,923,134
4008	Mang Yang	1,908,987	324,495	102,591	427,086	100,184	293,773	393,957	1,087,944
4009	Kong Chro	1,862,619	247,414	139,256	386,670	76,386	223,989	300,376	1,175,574
4010	Duc Co	2,713,033	354,949	48,185	403,134	109,586	321,343	430,929	1,878,970
4011	Chu Prong	5,776,445	556,887	127,921	684,808	171,932	504,162	676,095	4,415,542
4012	Chu Se	3,140,146	595,725	158,572	754,297	183,923	539,323	723,246	1,662,602
4013	Dak Po	1,600,468	215,488	80,393	295,881	66,529	195,086	261,615	1,042,972
4014	Ia Pa	1,617,617	280,038	172,242	452,281	86,459	253,525	339,983	825,353
4015	Krong Pa	1,862,012	411,693	250,402	662,096	127,105	372,715	499,821	700,095
4016	Phu Thien	1,459,720	397,989	153,940	551,929	122,874	360,309	483,183	424,608
4017	Chu Puh	2,035,758	362,093	114,718	476,811	111,792	327,811	439,602	1,119,345
Sub-Total		38,820,273	7,223,762	2,305,629	9,529,391	2,230,250	6,539,832	8,770,082	20,520,799
III					41-Dak Lak				
4101	Buon Ma Thuot	4,327,497	2,050,112	383,688	2,433,800	567,656	1,664,554	2,232,210	-338,513
4102	Ea H'leo	5,364,405	739,795	128,371	868,166	204,842	600,664	805,506	3,690,734
4103	Ea Sup	1,896,640	372,148	132,240	504,389	103,044	302,160	405,204	987,048
4104	Krong Nang	5,554,577	718,064	146,997	865,062	198,825	583,020	781,845	3,907,670
4105	Krong Buk	2,888,969	361,104	64,889	425,993	99,986	293,193	393,179	2,069,797
4106	Buon Don	1,712,821	367,837	140,877	508,714	101,850	298,659	400,509	803,598
4107	Cu M'gar	6,475,228	997,314	216,073	1,213,387	276,146	809,752	1,085,899	4,175,942
4108	Ea Kar	6,164,245	869,762	524,065	1,393,827	240,828	706,189	947,017	3,823,402
4109	M'Drak	2,162,456	409,983	157,485	567,468	113,520	332,879	446,399	1,148,589
4110	Krong Pak	5,066,128	1,194,455	612,243	1,806,698	330,733	969,818	1,300,550	1,958,879
4111	Krong Bong	2,097,174	545,046	207,266	752,312	150,918	442,541	593,459	751,404
4112	Krong Ana	2,470,082	496,438	123,813	620,251	137,459	403,074	540,533	1,309,298
4113	Lak	1,597,359	372,609	179,501	552,111	103,172	302,534	405,706	639,543
4114	Cu Kuin	2,883,288	598,547	179,824	778,371	165,732	485,981	651,712	1,453,204
4115	Buon Ho	3,142,894	591,538	65,338	656,877	163,791	480,290	644,081	1,841,937
Sub-Total		53,803,765	10,684,754	3,262,670	13,947,425	2,958,502	8,675,307	11,633,809	28,222,532
IV					42-Dak Nong				
4201	Gia Nghia	1,190,713	527,583	31,961	559,544	90,820	266,315	357,136	274,033
4202	Dak Glong	1,503,120	496,181	67,000	563,180	85,415	250,464	335,879	604,061
4203	Cu Jut	2,627,074	920,787	161,412	1,082,200	158,508	464,799	623,307	921,567
4204	Dak Mil	4,305,796	937,791	62,824	1,000,614	161,435	473,382	634,817	2,670,365
4205	Krong No	3,629,334	673,160	180,267	853,427	115,881	339,801	455,682	2,320,226
4206	Dak Song	4,342,021	639,849	155,836	795,685	110,146	322,986	433,132	3,113,205
4207	Dak R'Lap	3,670,130	781,875	86,055	867,930	134,595	394,678	529,274	2,272,926
4208	Tuy Duc	2,158,528	436,390	43,250	479,640	75,122	220,283	295,405	1,383,482
Sub-Total		23,426,717	5,413,615	788,605	6,202,220	931,924	2,732,708	3,664,632	13,559,865
V					43-Lam Dong				
4301	Da Lat	5,913,780	1,770,425	71,057	1,841,482	351,361	1,030,307	1,381,668	2,690,631
4302	Bao Loc	2,490,494	1,270,945	496,501	1,767,446	252,233	739,632	991,865	-268,817
4303	Dam Rong	1,072,492	366,082	82,523	448,605	72,653	213,043	285,696	338,191
4304	Lac Duong	1,644,675	172,112	40,799	212,911	34,158	100,161	134,319	1,297,445
4305	Lam Ha	6,155,751	1,178,150	340,239	1,518,388	233,817	685,629	919,447	3,717,916
4306	Don Duong	8,953,388	814,657	225,392	1,040,049	161,678	474,093	635,771	7,277,567
4307	Duc Trong	7,796,956	1,432,852	512,643	1,945,495	284,366	833,854	1,118,220	4,733,241
4308	Di Linh	5,126,087	1,324,648	213,418	1,538,066	262,892	770,885	1,033,776	2,554,244
4309	Bao Lam	5,201,412	944,107	188,485	1,132,592	187,369	549,427	736,796	3,332,024
4310	Da Huoai	614,442	289,531	103,225	392,756	57,461	168,494	225,955	-4,269
4311	Da Teh	1,099,020	378,088	149,230	527,319	75,036	220,030	295,066	276,635
4312	Cat Tien	1,037,712	317,155	139,838	456,993	62,943	184,570	247,513	333,206
Sub-Total		47,106,208	10,258,753	2,563,350	12,822,102	2,035,966	5,970,126	8,006,092	26,278,013

Notes: - Consumption for people is estimated basing on the "average monthly expenditure of per capita main agricultural products and their average retail price in the local area;
- Value of food and foodstuffs (sold at local Markets) are based on "monthly per capita consumption expenditure by region"
- The consumption for Livestock is based on guidance for calculation the diet food for chicken, cow and pig

Sources: Statistic Books, DOITs in Central Highlands and result of the Vietnam Household Living Standards Survey 2014

AT 3.4.2 Value of Sale at Local Markets in Central Highlands

District Code	Province/ District	Value of Sales for for Food at local Market (VND Mil.)	Value of Sales for for Foodstuffs at local Market (VND Mil.)	Value of Sales for Drinking and Smoking at Local Market (VND Mil.)	Value of Sales for Clothing, hat, shoes (VND Mil.)	Annual Consumption Sales for Furniture (VND Mil.)	Value of Sale at Local Markets (VND Mil.)
		A	B	C	D	E	F=sum(A:E)
I	39-Kon Tum						
3901	Kon Tum	257,033	753,705	92,764	115,955	166,202	1,128,624
3902	Dak Glei	69,654	204,249	25,138	31,423	45,040	305,850
3903	Ngoc Hoi	81,144	237,941	29,285	36,606	52,469	356,301
3904	Dak To	69,442	203,627	25,062	31,327	44,902	304,918
3905	Kon Plong	38,987	114,323	14,071	17,588	25,210	171,191
3906	Kon Ray	39,558	115,998	14,277	17,846	25,579	173,700
3907	Dak Ha	109,158	320,089	39,396	49,244	70,584	479,312
3908	Sa Thay	75,842	222,394	27,372	34,214	49,041	333,020
3909	Tu Mo Rong	39,667	116,317	14,316	17,895	25,649	174,177
3910	Ia H'Drai	10,933	32,058	3,946	4,932	7,069	48,005
Sub-Total		791,418	2,320,700	285,625	357,031	511,744	3,475,099
II	40-Gia Lai						
4001	Pleiku	363,473	1,065,823	131,178	163,973	235,028	1,596,002
4002	An Khe	106,003	310,836	38,257	47,821	68,543	465,457
4003	Ayun Pa	59,815	175,397	21,587	26,984	38,677	262,646
4004	KBang	104,602	306,727	37,751	47,189	67,637	459,304
4005	Dak Doa	172,963	507,186	62,423	78,029	111,841	759,478
4006	Chu Pah	114,542	335,874	41,338	51,673	74,065	502,950
4007	Ia Grai	152,081	445,953	54,886	68,608	98,338	667,785
4008	Mang Yang	100,184	293,773	36,157	45,196	64,781	439,906
4009	Kong Chro	76,386	223,989	27,568	34,460	49,393	335,410
4010	Duc Co	109,586	321,343	39,550	49,437	70,860	481,190
4011	Chu Prong	171,932	504,162	62,051	77,563	111,174	754,951
4012	Chu Se	183,923	539,323	66,378	82,973	118,928	807,602
4013	Dak Po	66,529	195,086	24,011	30,013	43,019	292,128
4014	Ia Pa	86,459	253,525	31,203	39,004	55,906	379,637
4015	Krong Pa	127,105	372,715	45,873	57,341	82,188	558,117
4016	Phu Thien	122,874	360,309	44,346	55,432	79,453	539,539
4017	Chu Puh	111,792	327,811	40,346	50,432	72,286	490,875
Sub-Total		2,230,250	6,539,832	804,902	1,006,128	1,442,117	9,792,979
III	41-Dak Lak						
4101	Buon Ma Thuot	567,656	1,664,554	204,868	256,085	367,056	2,492,563
4102	Ea H'leo	204,842	600,664	73,928	92,410	132,454	899,456
4103	Ea Sup	103,044	302,160	37,189	46,486	66,630	452,465
4104	Krong Nang	198,825	583,020	71,756	89,695	128,563	873,036
4105	Krong Buk	99,986	293,193	36,085	45,107	64,653	439,037
4106	Buon Don	101,850	298,659	36,758	45,948	65,858	447,223
4107	Cu M'gar	276,146	809,752	99,662	124,577	178,561	1,212,552
4108	Ea Kar	240,828	706,189	86,916	108,644	155,724	1,057,472
4109	M'Drak	113,520	332,879	40,970	51,212	73,404	498,465
4110	Krong Pak	330,733	969,818	119,362	149,203	213,857	1,452,240
4111	Krong Bong	150,918	442,541	54,467	68,083	97,586	662,676
4112	Krong Ana	137,459	403,074	49,609	62,011	88,883	603,578
4113	Lak	103,172	302,534	37,235	46,544	66,713	453,025
4114	Cu Kuin	165,732	485,981	59,813	74,766	107,165	727,725
4115	Buon Ho	163,791	480,290	59,113	73,891	105,910	719,203
Sub-Total		2,958,502	8,675,307	1,067,730	1,334,663	1,913,016	12,990,716
IV	42-Dak Nong						
4201	Gia Nghia	90,820	266,315	32,777	40,972	58,726	398,790
4202	Dak Glong	85,415	250,464	30,826	38,533	55,231	375,054
4203	Cu Jut	158,508	464,799	57,206	71,508	102,494	696,007
4204	Dak Mil	161,435	473,382	58,262	72,828	104,387	708,859
4205	Krong No	115,881	339,801	41,822	52,277	74,930	508,830
4206	Dak Song	110,146	322,986	39,752	49,690	71,222	483,650
4207	Dak R'Lap	134,595	394,678	48,576	60,720	87,032	591,006
4208	Tuy Duc	75,122	220,283	27,112	33,890	48,575	329,860
Sub-Total		931,924	2,732,708	336,333	420,417	602,597	4,092,055
V	43-Lam Dong						
4301	Da Lat	351,361	1,030,307	126,807	158,509	227,196	1,542,818
4302	Bao Loc	252,233	739,632	91,032	113,790	163,098	1,107,551
4303	Dam Rong	72,653	213,043	26,221	32,776	46,979	319,018
4304	Lac Duong	34,158	100,161	12,328	15,409	22,087	149,985
4305	Lam Ha	233,817	685,629	84,385	105,481	151,190	1,026,686
4306	Don Duong	161,678	474,093	58,350	72,937	104,544	709,924
4307	Duc Trong	284,366	833,854	102,628	128,285	183,876	1,248,643
4308	Di Linh	262,892	770,885	94,878	118,598	169,990	1,154,351
4309	Bao Lam	187,369	549,427	67,622	84,527	121,156	822,732
4310	Da Huoai	57,461	168,494	20,738	25,922	37,155	252,309
4311	Da Teh	75,036	220,030	27,081	33,851	48,519	329,481
4312	Cat Tien	62,943	184,570	22,716	28,395	40,700	276,382
	Sub-Total	2,035,966	5,970,126	734,785	918,481	1,316,489	8,939,881

Notes: - The name of markets and number of shops inside are collected from DOITs;
- Value of food and foodstuffs (sold at local markets) are based on "monthly per capita consumption expenditure by region.

Source: Statistic Books, DOITs in Central Highlands and Result of the Vietnam household living standards survey 2014.

AT 3.6.1 Organization and Recent Activities of Steering Committees for Natural Disaster Prevention and Control at Central Highlands (as of 2017)

		Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
Provincial level	Number	25	16	25	29	27
	Members	• PPC Chairperson • PPC Vice Chairperson • DARD Director • Vice Director of relevant departments (DONRE, DPI, DOF, DOT, DOC, DOH, DOLISA, etc.) • Chairperson of mass organization (Women Union, Red Cross Association, Youth Union, etc.)				
District level	Number	220	388	342	202	263
	Members	• DPC Chairperson • DPC Vice Chairperson • Head of relevant divisions (Agricultural, Natural resources and environment, etc.) • Chairperson of mass organizations (Women Union, Red Cross Association, Youth Union, etc.)				
Activities in General		• Prepare and implement the disaster prevention and recovery programs (drought, floods, etc.). • Raise community awareness for community-based disaster management and implement staff training on natural disaster prevention. • Formulate evacuation and stable livelihood plan for people in flood-prone area.				
Specific Activities		• Distribute rescue equipment (500 life-floats, 400 life-jackets and 30 canvas) to flood area. • Organize emergency drill (in commune level).	• Provide water and tanks to poor people in the drought season (conducted by mass organizations) • Encourage farmers for crop diversification to vegetables, fruit trees or to raise cattle	• Canal dredging, pond construction, provide electricity and fuel fee for pumping water, repair irrigation and water supply works. • Adjust the crop calendar to plant earlier. • Reduce the amount of water release from reservoir, change water-release schedule. • Inform the flood discharge plan of reservoir to local people	• Canal dredging, pond construction, provide electricity and fuel fee for pumping water. • Provide water tanks for farmer to store drinking water. • Apply water-saving facility (drip tube, sprinkler system). • Give warnings in dry season to store water (based on analysis of Agri. Division and water assessment of IMC).	• Reservoir and canal dredging, construct of pond and small reservoir, provide electricity and fuel fee for pumping water, repair irrigation and water supply systems. • Distribute rescue equipment (300 life-floats, 300 life-jackets and 30 canvas) to flood area. • Provide water tanks to store drinking water. • Construction 552 ponds and small reservoirs (total capacity of 1.648 million m^3, irrigated 1,400 ha at drought area).
Budget	Provincial budget (Regular budget)	• Annual amount: VND 4.0 billion to repair irrigation and flood prevention works, storage materials and fuel, recover disaster damages, management.	• Annual amount: VND 4.5 billion to recover disaster damages, storage materials and fuel, repair irrigation and flood prevention works, canal dredging.	• Annual amount: VND 5.0 billion to management, repair irrigation works, canal dredging, storage materials and fuel, recover disaster damages.	• Annual amount: VND 4.0 billion to management, repair irrigation and flood prevention works, storage materials and fuel, recover disaster damages.	• Annual amount: VND 5 billion to management, repair irrigation works, canal dredging, storage materials and fuel, recover disaster damages. • Year 2016: VND 9.2 billion (contingency budget) to recover drought damages.
	Central budget (recover drought damages 2015-16)	• Year 2016, allocated VND 17.6 billion to pay electricity and fuel fee for pumping water, repair irrigation and water supply, canal dredging. • Year 2017, allocated VND 19.8 billion for pond construction and repair domestic water pipeline.	• Year 2016, allocated VND 17.9 billion to recover drought damage.	• Year 2016, allocated VND 57 billion to recover drought damage.	• Year 2016, allocated VND 18.6 billion to recover drought damage.	• Year 2016, allocated VND 53.2 billion to recover the drought damages. • Year 2017, allocated VND 18.1 billion to recover the drought damages. • VND 0.138 billion donate by private enterprises to recover the drought damages.
Issues		• Limited budget for preparation of rescue activities.	• Irrigation systems degraded. • Lack of drought prevention works.	• Limited budget for upgrading and repairing irrigation systems.	• Shortage of reservoirs capacity for irrigation demand.	• Limited budget for construction and rehabilitation irrigation systems.

	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
	• Irrigation systems degraded. • Lack of equipment for early warning system.			• Limited budget to construction irrigation systems.	
Evaluation	• Awareness raising activities to the people affected by the natural disasters are limited. • Activities for water saving are a few against rehabilitation and new construction of irrigation facilities. • Available budget for prevention activities of the natural disasters is limited except investment for irrigation facilities. • No programs for improving hydrological and meteorological monitoring and evaluation for alarming drought and flood damages.				

Source: Steering Committees for Natural Disaster Prevention and Control of Five Provinces

AT 3.7.1 Infrastructure Development Plans and Achievements in SEDP 2011-2015 of Central Highlands

Item		Plans in 2011-2015	Achievements in 2011-2015
I. Kon Tum Province			
1.Overall development concept, strategies and target	Overall	Exploit and utilize resources for pushing industrialization, modernization, and ensuring high and stable economic growth speed with reasonable structure	
	Target	Complete socio-economic infrastructure, especially transportation, and urban infrastructure Enhance technological scientific capability and human resource quality Innovate administration, enhance and improve investment environment and competitive capability Concentrate development of three focal economic zones Boost up implementation of New Rural Development Program Develop specialty products and comparative advantages of each region and sector of the province Maintain political stability, and ensure national defense in all situations	
2. Sector Development			
Road	1	Complete construction of National Highway No. 14 - Ho Chi Minh Road (155km), National Highway. 14C (106,3km); Eastern Truong Son road and South Quang Nam Road (Tắc Pỏ - Đăk Tô) - 16,5km, border patrol road, Sa Thay-Ya Ly-Tam An Village Road (Sa Son Commune), Ya Mo- Lang Re (Mo Rai) Road; Upgrade NH No. 40, section Km13 -:- Km21, NH No. 24 (99,2km); Invest PR No. 667 section from NH No. 24 to Đăk Côi Commune (28km); Complete construction of road from Đăk Ruồng - Đăk Koi - Đăk Psi, inter-commune road from Đăk Long - Đăk Nhoong - Đăk Blo; Complete the internal road of Mang Den tourist area and Bờ Y economical border gate;	Upgrade and new construct Ho Chi Minh Road crossing Kon Tum (155km), National Highways 24 (26km), 14C (106,8km), 40 (61km), 40B, Provincial Road lộ 671, 672, 673, 674, 675, 676, 677, 678, Ngọc Hoàng - Măng Bút - Tu Mơ Rông - Ngọc Linh Road (13,56km), Ya Tăng - Sê San - NH. 14C;
	2	Construct rural transportation road system, inter-village roads, inter-commune road within region;	86/86 communes and 568/671 villages with road accessing to center communes
Irrigation	1	Invest in construction of irrigation works such as Đăk Krong, Đăk Hà, Đăk Long - Đăk Trui, Đăk Glei, Ya Mô - Ya Tri, Kon Rẫy;	Upgrade Đăk Toa irrigation works, Đăk Uy reservoir
	2	There are 537 irrigation systems (69 reservoirs, 460 wiers, 8 pumping stations, of which, 86 systems for repairing. There are 122 newly-constructed irrigation systems; Irrigated area total: 18315 ha; Paddy area: 13915 ha; Industry crop: 4409 ha; other crop: 28 ha;	523 existing irrigation works with total of designed irrigating area by 16,742 ha (paddy: 11, 153 ha, industrial crops and perennial crops: 5,589.8 ha)
	3	Priority project: 20 repairing works, 15 irrigation systems.	
Water Supply	1	90% rural population accessed to clean water.	85.1% rural population accessed to clean water.
	2	Upgrade water supply system for Kon Tum City, economic zone in Bo Y international border gate.	Kon Tum water plant, capacity 12,000 m3/day night and completed pile-line system is constructed.
	3	Upgrade drainage and intake in towns.	Invest water supply system in Dak Ha Town, and Mang Den Urban; Deploy water supply in Kon Ray District; Formulate investment project of water supply system in Plei Kan Town, Dak Glei, and Sa Thay for mobilizing ODA investment
Item		Plans in 2011-2015	Achievements in 2011-2015
Electrification	1	Upgrading and maintenance the medium and low voltage network; Construct electric grid 110KV Đăk Tô-Bờ Y-Đăk Glei-Phước Sơn, closed circut 110kv grid between Kon Tum and Quang Nam; Newly construct three transformers 110kV: Kon Tum 2, Đăk Glei, 110kV Bờ Y (Ngọc Hồi); Investment on upgrading capacity of transformer 110/2kV Kon Tum from (16+25) MVA to 2x25 MVA;	Deploy project on providing electricity to rural area from national electricity grid in period 2014-2020 with total budget of VND 500 billion; Remain 41 small and medium-scale hydropower plants with total capacity of 433 MW; Invest and upgrade 109.78 km medium voltage, 37.02 km low voltage, 85 machines/ 17,860kVA transformer with total investment fund of VND 264 billion;
	2		86/86 communes and 660/671 villages accessed to electric grid (98.4%); Rate of rural households accessed to electricity: 97.78%
Agriculture	1	Develop agriculture towards commodity production, focusing on major crops such as rubber, coffee, sugarcane, cassava powder, Ngoc Linh ginseng, flower planted in cold region, and products from cattle. Expand rubber area as planned, new plantation by 5,500 ha/year, and 70,000 ha by 2015. Trial plantation of rubber in slope land of Dak Glei, Tu Mo Rong, and Kon Plong. Paddy: 114,650 ha; maize: 50,700 ha; cassava: 142,000 ha, sugarcane: 13,200 ha, coffee: 59,002 ha, rubber: 294,947 ha.	By 2015: Area of flower planted in cold region by 15 ha, Ngoc Linh ginseng by 180.24 ha, paddy: 24,399 ha; maize: 6,361 ha; coffee: 15,265 ha, rubber: 74,776 ha, cassava 39,486 ha.
	2	Expand aquaculture area 4,400 ha by 2015	Aquaculture area: 1,660 ha by 2015
	3	Buffalo: 133,000 heads, cow: 471,000 heads, pig: 890,500 heads	
Industry	1	Invest to construction of three industrial zones with area of 360 ha (Hoa Binh: 60 ha, Sao Mai: 150 ha, Dak To: 150 ha);	Establish and develop 3 industrial zones: + Expand more 70 ha of Hoa Binh Industrial zone (phase 2): 30 units have registered for doing business and production with register capital by VND 488 billion, employed 1,500 labors + Compensate and site-clear 88,885/150 ha in Sao Mai Industrial Zone + Complete site clearance and leveling for Đăk Tô Industry (150 ha)
	2	Invest to construction of 3 industrial clusters and small handicraft clusters with area of 136 ha, 3 concentrated production points with area of 140ha; construct new urban regions along South Dak Bla, National Highway 14 and 24;	Economic zone at Bo Y border gate has 27 operating investment projects with register capital by VND 499.6 billion, implementing capital by VND 478.9 billion. Invest infrastructure for 10 industrial clusters and put them into operation, including Đăk La industrial cluster in Đăk Hà District, Plei Kần craft village industrial cluster in Ngọc Hồi District, service 24/24 industrial cluster in Đắk Tô District, industrial and small-handicraft industrial cluster of Hoa Binh, Vinh Quang, Hno, Đăk Hà Town, and Đăk Ruông in Kon Rẫy District, Đăk Mar industrial cluster in Đăk Hà District, Kon Plong industrial cluster;
Gia Lai Province			
1.Overall development concept, strategies and target	Overall objective	Develop socio-economy rapidly and sustainably; Create basic change on growth quality and competition of economy Contract modern and synchronous infrastructure Improve physical and spirit living of people Become center of North Central Highlands region, and motivating zone in development triangle of three countries of Viet Nam - Laos – Cambodia	
2. Sector Development			
Road	1	Upgrade highway route linking Gia lai to other provinces of Central Highlands, Central Coastal Region. Upgrading and repairing pavement, embankment and other works of NH. 14C (112km) to meet the Class IV standard requirement;	Invest, upgrade and expand 459km parts of National Highways, 108.3 km of provincial roads, 230.3 km of district roads, 200km main commune roads, and more than 630 km rural road;
	2	Upgrade road as planning in urban areas of Pleiku City, An Khe Town, Ayun Pa Town. Upgrading and rehabilitating the urban roads synchronously and modernly;	Upgrading and new construction 313km district road. Repairing 1.213,2km rural roads (in which: Asphalt pavement 152,8km, BPM pavement: 369,5km, Concrete Pavement: 672,8km, Macadam Pavement: 96,7km, Gravel Pavement: 236,4km);
	3	District Road: Upgrading and new building the district road system upto 1,523 km, roads with surface structure reaching over 90%, in which asphalt and cement concrete reaching over 60%, pavement surface over 30%;	New construction 34 bridges/1.475,6m, 1.510 culverts;
	4	Develop rural road system for rearranging residents, socio-economic development and adjust transportation density. Rural Roads with asphalt and cement concrete pavement reaches 40%	

Item		Plans in 2011-2015	Achievements in 2011-2015
Irrigation	1	Ensure stable irrigation and drainage for over 52,000 ha of cultivation area up to 2020;	Construct 19 irrigation works, serving for irrigation of 8,000 ha
	2	Irrigated area total: increase 37.859 ha (paddy area: 14.898 ha; other area: 22.961 ha);	
	3	355 Irrigation systems: 242 reservoirs, 82 wells, 15 pumping stations, 16 canals;	
	4	Priority project: 99 works (65 reservoirs, 29 dams, 7 pumping stations);	
Water Supply	1	100% urban population accessed to clean water;	Over 99% urban population accessed to clean water;
	2	90% rural population accessed to clean water;	85% rural population accessed to clean water
Electrification	1	100% household accessed to electricity system;	Put into operation: 15 hydropower plants with total capacity of 345kw. 86 projects with total cost over 370 VND billion were implemented;
	2	Concentrate to construct small-scale hydropower works and electric-providing network for remote and mountainous area;	Develop high-voltage electric network: 220Kv network: new construction 20km and upgrading 146km line;
	3	Develop high-voltage electric network:	362 km medium and low voltage line and 746 transformer stations were built and upgraded;
		+ 220Kv network: new construction 20km and upgrading 286km line;	
		+ 110 Kv network: new construction 6 transformer stations, capacity 190 MVA and 205,5km line;	
	4	Develop medium and low-voltage network:	
		+ New construction 693,2km and upgrading 116,3 km medium-voltage line;	
		+ New construction 1330km low voltage line and replacing 31955 electricity meters;	
Agriculture	1	By 2015: Double paddy: 28,000 ha, maize: 60,000 ha, sugarcane: 25,000 ha, cotton: 3,500 ha, rubber: 70,000 ha, coffee: 77,000 ha	Paddy area: 75,226 ha; maize: 51,591 ha; coffee: 79,732 ha, rubber: 102,640 ha, pepper: 14,000 ha, cashew: 25,000 ha, sugar cane: 38,000 ha;
Industry	1		Invest and upgrade Tra Da industrial zone from 109.3 ha to 197.83 ha (33 operating projects, 11 approved industrial zones, of which 4 industrial zones (Dien Phu-Pleiku: 9 projects, Ia Khuoi-Chu Pah: 5 projects, Dak Djrang-Mang Yang: 4 projects, Chu Se: 5 projects) are operating);
III. Dak Lak Province			
1.Overall development concept, strategies and target	Overall objective	Promote provincial potentials (human resource, capital, land resource, forest, hydropower, minerals) to push up movement of economic structure and labor structure; Try to become the centre of economy, culture, society of Central Highlands;	
2. Sector Development			
Road	1	Rate of Bituminous or cement concreted surface of National Highway is 100%, provincial road is 100%; district road is 80% and commune road is 50%, 100% number of communes have bituminous road accessing to the center.	Rate of asphalt concreted or cement concreted road at provincial level: 95.54% (364/381 km), 81% (1,137/1,403.82 km) at district level, 42% (1,352/3,220 km) at commune level, and 98.7% of road accessing to commune center.
	2	Upgrading 4 National Highways, including NH. No14 (HCM road), 14C, 26, 27;	NH. No 14, 14C were upgraded;
	3	New construction National Road, namely: Truong Son Dong and Daklak - Phu Yen - Dak Rue border gate;	Finish construction Truong Son Dong Road and Daklak - Phu Yen - Dak Rue border gate;
	4	Upgrade 77km from provincial road to national road	
Irrigation	1	75% crop area with irrigating demand irrigated; Irrigated area total: 235.280 ha (paddy area: 58.335 ha; coffee area: 120.941 ha, other area: 56.004 ha	Irrigated area: 224, 169/320,000 ha (76.3% crop area with irrigating demand);
	2	115 new Irrigation systems: 81 reservoirs, 6 dams, 19 pumping stations; 9 hydraulic works system;	Invested and constructed 219 irrigation works, of which: + Upgraded and repaired works: 91; + Newly-constructed works: 128;
	3		Permanent construction of channel: 554km;
Water Supply	1	90% urban population accessed to clean water;	72% urban population accessed to clean water;
	2	85% rural population used hygienic water;	85.5% rural population used hygienic water; Total province has 129 water supply works for rural area
Electrification	1	Number of hamlet/village accessed to electricity system: 100%; Number of ethnic household accessed to electricity: 99%;	315 hamlet/village accessed to electricity system (95%); 39,755 ethnic households accessed to electricity (96.8%); Rate of commune accessed to national network: 100%;
	2	Upgrading transformer station 220kV at Buôn Kuốp, new construction 156,9 km line 220kV;	
	3	New construction 6 transformer stations and 134,2 110kV line and Upgrading 10km 110kV line;	
	4	Medium voltage system:	
		+ New construction 716km line and 956 transformer station;	
		+ Upgrading 173 km line and 438 transformer station;	
	5	Low voltage system: + New construction 1,047 km line; + Locate 60,842 electricity meters;	
Agriculture	1	Paddy area: 360,000 ha; maize area: 630,000 ha; coffee: 847,300 ha, rubber: 181,500 ha, pepper: 24,300 ha, cashew: 220,250 ha;	By 2015: Paddy area: 449,768 ha; maize area: 599,308 ha; coffee: 1,011,755 ha, rubber: 192,432 ha, pepper: 59,968 ha, cashew: 125,336 ha;
Item		Plans in 2011-2015	Achievements in 2011-2015
	2	Buffalo: 186,250 heads, cow: 1,619,500 heads, pig: 4,385,000 heads, poultry: 39,520,000 heads	Buffalo: 168,935 heads, cow: 876,091 heads, pig: 3,607,556 heads, poultry: 42,970,216 heads
	3	Aquaculture area: 57,100 ha	Aquaculture area: 41,493 ha
IV. Dak Nong Province			
1.Overall development concept, strategies and target	Overall objective	Concentrate human resource development, construction of main infrastructure serving for socio-economic development, mineral industry; create economic pace in mining and processing industry and high technology agriculture Improve living standard for people in combination with poverty reduction.	
2. Sector Development			
Road	1	Coordinate with Ministry of Transportation to upgrade National Highway 14, 14C, 28, and Ho Chi Minh Road;	Complete upgrading 310km national road (NH. No 14; 28; 14C); Start construction NH. No 14, section by-pass Gia Nghia town;
	2	Provincial road: 100% asphalt-concreted road no. 3 (Krông Nô - Đắk Mil); upgrade road no. 4 (from km 94 to km 111), road no. 1 (Đắk Rấp - Tuy Đức), road no. 5 (from km 0 - km 14), no. 6 (Quảng Sơn - Đồn 9) and some inter-district such as newly construct Đắk Song - Đắk Năng road, road to Bu Prăng border gate, Đạo Nghĩa - Quảng Khê Road, Đắk Lao - Ea Tlinh Town Road;	Rate of asphalt concreted provincial road: 99%; Complete construction and upgrading PR. No 3, 4, 6 and part of PR. No 5, 100% bituminous surface; Preparing to construct projects: Đắk Song - Đắk Nang road, Đạo Nghĩa - Quảng Khê road, road to Bu Prăng border gate;
	3	District road: 100% asphalt concreted, upgrade district road with grade IV mountainous scale and two lanes;	Rate of asphalt concreted district road: 80%;
	4	All communes have road accessing to commune center. Asphalt concreted inter-commune roads: Trường Xuân-Nâm N'Giang in Đắk Song, Kiến Thành - Đắk Wer in Đắk R'Lấp, Quảng Tâm - Đắk Ngo in Tuy Đức District, Đắk Lao - Đắk ND'Rót in Đắk Mil;	
	5	100% number of hamlet/village with 1-2 km asphalt concreted road;	100% number of hamlet/village with 1-2 km asphalt concreted road; Upgrading 245km road to village (bituminous and cement concrete surface). 139/139 villages have car accessed road to center;

Item		Plans in 2011-2015	Achievements in 2011-2015
	6	Urban road: Invest in South-North main road (phase 2), ringroad no. 2 in Gia Nghĩa Town (from Ho Chi Minh roundabout to National Highway 28 in Nghĩa Trung Ward, ringroad no. 3 in Gia Nghĩa Town (from Cầu Gãy to Nghĩa Thắng Village, Đắk Nia Commune); Upgrade and expand Quang Trung Road in Gia Nghĩa Town, road from ringroad to ecological tourist area of Đắk RTih hydropower, Võ Thị Sáu Road, road accessing to Nghĩa Phú Ward, Nơ Trang Long Road, and district center road.	Upgrading and new construction 17km urban road, rate of bituminous is 85% in 2015; Newly construct special-use roads accessing to industrial zones, tourist areas, roads serving for agro-forestry exploitation, about 300km with rural transportation road scale.
Irrigation	1	80% crop area with irrigating demand irrigated; Irrigated area total: 49.180 ha; Paddy area: 6.626 ha; Industry crop: 37.097 ha; Vegetables: 5.457 ha;	Rate of irrigated area: 68%
	2	There are 230 Irrigation systems (181 reservoirs, 44 wells, 5 pumping stations; In which, 55 systems for repairing. There are 50 new Irrigation systems; Complete construction of irrigation works such as Đăk Rồ, Đắk Riêr, Gia Nghĩa, Đắk Song and small-scale irrigation works by Governmental bonds;	Invested and constructed 219 irrigation works, of which: + Upgraded and repaired works: 91 + Newly-constructed works: 128
	3	Priority project: Đăk Rồ (Krông Nô), Đăk Diêr (Cư Jút), Gia Nghĩa irrigation system, Buôn Choáh pumping station etc…	Permanent construction of cannel: 554km
Water Supply	1	90% population accessed to hygienic water.	90% urban population accessed to clean water;
	2	100% district center with concentrated water supply system with water supply standards by 120-150 littles/person/day and night;	99% rural population accessed to sanitary water (wells, filled surface water);
	3	Complete construction of project on water supple for Gia Nghia urban area with capacity by 12,000m3/day and night;	Complete construction of project on water supple for Gia Nghia urban area with capacity by 12,000m3/day and night. Complete construction WS system at Đắk R'Lấp, Đắk Glong, Cư Jut, Krông Nô town;
Electrification	1	Rate of hamlet/village accessed to electricity system: 100%;	Rate of households accessed to electricity: 95%;
	2	Rate of ethnic household accessed to electricity: 95%;	Rate of hamlet/village accessed to electricity system: 99%;
	3	Invest 220Kv line from Buôn Kuốp – Bình Long - 500kV transformer station at Đăk Nông; Connected line from Đồng Nai 5 to Đồng Nai 6 hydraulic plant;	
	4	Construct 110kV line and transformer station at Gia Nghĩa (2x25)MVA, Nhân Cơ (2x25) MVA, Đăk Song (1x25) MVA, Tuy Đức (1x25)MVA, Krông Nô (1x25) MVA, Quảng Sơn (1x25) MVA;	
	5	Upgrade 110kV transformer station at Đăk R'lấp and Cư Jút;	
Agriculture	1	Paddy area: 19,500 ha; maize area: 35,000 ha; coffee: 66,000 ha, rubber: 32,000 ha, pepper: 6,500 ha, cashew: 35,000 ha;	Paddy area: 12,570 ha; maize area: 51,000 ha; coffee: 137,910 ha, rubber: 42,260 ha, pepper: 28,870 ha, cashew: 25,220 ha;
Industry	1	Construct infrastructure for two industrial zones of Tâm Thắng and Nhân Cơ, and others such as Đăk Hà, Thuận An, Quảng Tâm, Krông Nô, Đắk Song.	Continue completion of infrastructure for industrial zones. Until now the province has 7 industrial clusters with total planned area of 484.6 ha
	2	Planning industrial zones of Quảng Đức, Đắk R'La, Trúc Sơn, Quảng Khê;	
V. Lam Dong Province			
1.Overall development concept, strategies and target	Overall objective	Become province whose has high service proportion in their economy, synchronous infrastructure system towards modernization, develop educational system to meet requirement on human resource for development; Improve physical and spirit living for people;	
2. Sector Development			
Road	1	Construction the first section of Day Giay - Lien Khuong Expressway (Lien Khuong - Prenn, L=19,2km); Upgrade PR. 721 to meet class IV, RP. 723 to meet class III with asphalt pavement; PR. 724 to meet class IV, asphalt pavement;	Complete construction of Lien Khuong airport, Lien Khuong - Prenn Express-way, provincial road 723, 721, 725, national road 27C; Implement the second stage to upgrade PR. No 721, 725;
	2	Complete and put into operation some sections of HN. 20 (Di Linh town, L=5km, Duc Trong town, L=6km, Trai Mat, L=5km, Mada Gouil town, L=3,1km, Bao Loc hill and Phu Hiep hill, L=12,5km, section from Km20 - Km62 and Km79 - Km98, L= 61km); Complete roads avoid flood Dongnai 3, 4, L=15,37km, class IV; PR. 726, 727, 728, 729: Upgrade the embankment to meet class IV with Bituminous pavement; Regular maintenance NH. 55 to meet class III;	
	3	PR. 725: Concentrate on rehabilitation bridges and culverts and regular maintenance whole road;	Invest and newly construct 72 bridges 0n district and rural roads with more than 1200m and total cost of VND 2,163 billion;
	4	Construct ringroad and avoidance road to urban areas (Da Lat, Bao Loc, Di Linh, Duc Trong and Lien Nghia);	
	5	Asphalt and concrete commune main roads, inter-commune roads in 2015; 30% surface of rural road is bituminous and cement concrete;	Newly construct: 705 km of rural road; upgrading and repairing: 1,065km rural road;
Irrigation	1	Ensure water supply for 90% area of rice, vegetable, flower; and 60% area of long-term industrial crops; Irrigated area total: 133942 ha;	Continue construction of irrigation works of Da Lay; Irrigated area total: 56779 ha;
	2	There are 29 forwarding systems and 609 Irrigation systems (503 reservoirs, 76 wells, 30 pumping stations; In which, 80 systems for repairing and 529 new Irrigation systems. 18 works for flood prevention;	There are 426 Irrigation systems (217 reservoirs, 86 wells, 19 pumping stations)
Water Supply	1	90% urban population accessed to clean water;	65% urban population accessed to clean water;
	2	85% rural population used hygienic water	86% rural population used hygienic water;
Electrification	1	Improve and contract synchronous electric system;	Complete construction of Dong Nai 2,3,4 ,5 Hydropower;
	2	Deploy and construct small and medium hydropower plants as planned;	
	3	220kV system: New construction 01 transformer station and 2 lines with total length 16km; Upgrading existing line, total length 119.6km;	
	4	110kV system: New construction 01 transformer station, capacity: 105MVA; Upgrading and widening 01 existing transformer and new construction 06 line, 110kV with total length 103,3km;	
	5	Low voltage system: new construction 1026 22/0,4kV transformer stations, capacity 93.816kVA; Upgrading 291 22/0.,4kV transformer station with total capacity 26.132 kVA; Total investment for new construction and Upgrading electricity system is 2,374 VND billion;	
Agriculture	1	Paddy area: 35.126 ha; coffee: 152.000 ha, rubber: 11.800 ha, tea: 24.000 ha, cashew: 14.000 ha;	Paddy area: 31.988 ha; coffee: 158.944.000 ha, rubber: 10.358 ha, tea: 21.354 ha, cashew: 15.907 ha
Industry	1	Continue construction (phase 2) of industrial zones of Loc Son and Phu Hoi;	

Source: SEDPs of Central Highlands

AT 3.7.2 Budget Revenue and Expenditure of Central Highlands in 2013-2015

(Unit: VND bil.)

	Kon Tum Province	2013		2014		2015	
		Plan	Actual	Plan	Actual	Plan	Actual
I	Local Budget Revenues	4,486	6,296	4,664	6,198	4,883	6,356
Out of local budget revenues							
1	Decentralized Revenues	1,536	1,437	1,576	1,718	1,730	1,625
	Revenues with 100% entitlement	1,536	557	1,576	800	1,730	863
	Shared revenue in percentage		880	0	919	0	762
2	Transfers from central budget	2,415	2,996	2,354	3,122	2,455	3,268
	Balancing transfers	1,326	1,705	1,326	1,928	1,326	1,911
	Target transfers	1,089	1,291	1,028	1,195	1,129	1,357
3	Revenues from grants	76	76	12	12	0	0
4	Investment mobilizations under Article 8. Clause 3 - State Budget Law	50		60	0	60	0
5	Budget remainder revenues	37	37	37	37	26	23
6	Brought forward revenues	1,295	1,440	968	1,075	1,126	1,230
II	Local Budget Expenditures	4,486	6,259	4,664	6,172	4,883	6,310
Out of local budget revenues							
1	Development investment expenditures	450	1,493	456	1,171	427	1,349
2	Recurrent expenditures	2,702	3,658	2,968	3,676	3,108	3,857
3	Payment for participants and its interest of mobilization under Article 8. Clause 3 - State Budget Law			0	0	0	0
4	Brought forward expenditures	968	1,075	1,126	1,230	1,193	995
5	Target programs expenditure and others	1,089	1,010	1,028	816	1,129	800
6	Transfer to financial reserve fund	1	1	1	1	1	1

1/ "Revenues with 100% entitlement" includes land & house tax, natural resource tax (except those from oil and gas), license tax, land use right transfer tax, agricultural land use tax, the land use levy, land rent.
2/ "Share revenues in percentage" refers those shared between central budget and local budget under the provisions in Clause 2, Article 30 of the State Budget Law. It includes VAT and enterprise income tax.
3/ "Transfers from central budget" is comprised of "balancing transfers" and "target transfers".
Source: Kon Tum DOF

(Unit: VND bil.)

	Gia Lai Province	2013		2014		2015	
		Plan	Actual	Plan	Actual	Plan	Actual
I	Local Budget Revenues	7,511	10,188	7,818	10,361	8,235	11,164
Out of local budget revenues							
1	Decentralized Revenues	3,350	3,159	2,865	2,961	2,463	2,941
	Revenues with 100% entitlement	663	751	671	1,091	791	962
	Shared revenue in percentage	2,687	2,408	2,194	1,870	1,672	1,980
2	Transfers from the central budget	3,446	4,517	3,575	5,147	4,002	6,244
	Balancing transfers	2,217	2,217	2,217	3,384	2,217	3,772
	Target transfers	1,229	2,301	1,358	1,763	1,785	2,473
3	Revenues from grants	-	-	0	0	0	0
4	Investment mobilizations under Article 8. Clause 3 - State Budget Law	-	82	0	60	0	55
5	Budget remainder revenues	-	649	0	387	72	372
6	Brought forward revenues	8	1,353	11	1,311	0	1,310
II	Local Budget Expenditures	7,511	9,729	7,818	9,987	8,235	10,640
Out of local budget revenues							
1	Development investment expenditures	593	959	568	1,147	633	962
2	Recurrent expenditures	5,296	5,511	5,621	5,716	5,749	5,839
3	Payment for participants and its interest of mobilization under Article 8. Clause 3 - State Budget Law	-	-	0	0	0	0
4	Brought forward expenditures	-	1,311	0	1,310	0	1,948
5	Target programs expenditure and others	1,229	1,393	1,165	1,314	1,574	1,594
6	Transfer to financial reserve fund	1	1	1	1	1	1

1/ "Revenues with 100% entitlement" includes land & house tax, natural resource tax (except those from oil and gas), license tax, land use right transfer tax, agricultural land use tax, the land use levy, land rent.
2/ "Share revenues in percentage" refers those shared between central budget and local budget under the provisions in Clause 2, Article 30 of the State Budget Law. It includes VAT and enterprise income tax.
3/ "Transfers from central budget" is comprised of "balancing transfers" and "target transfers".
Source: Gia Lai DOF

(Unit: VND bil.)

	Dak Lak Province	2013		2014		2015	
		Plan	Actual	Plan	Actual	Plan	Actual
I	Local Budget Revenues	9,724	12,195	10,805	11,642	11,261	13,054
Out of local budget revenues							
1	Decentralized Revenues	4,041	3,326	3,770	3,169	3,333	3,246
	Revenues with 100% entitlement	142	348	160	446	138	229
	Shared revenue in percentage	3,899	2,978	3,610	2,723	3,195	3,018
2	Transfers from the central budget	4,897	6,261	6,146	6,817	6,920	8,227
	Balancing transfers	3,612	3,612	4,646	4,646	5,096	5,096
	Target transfers	1,284	2,648	1,501	2,172	1,824	3,131
3	Revenues from grants	-	21	0	34	0	16
4	Investment mobilizations under Article 8. Clause 3 - State Budget Law	-	213	0	37	0	160
5	Budget remainder revenues	-	233	0	225	0	160
6	Brought forward revenues	-	1,282	0	1,113	0	992
II	Local Budget Expenditures	9,724	11,970	10,805	11,481	11,261	12,823
Out of local budget revenues							
1	Development investment expenditures	654	1,161	659	947	658	1,155
2	Recurrent expenditures	6,691	7,298	7,328	7,699	7,361	8,002
3	Payment for participants and its interest of mobilization under Article 8. Clause 3 - State Budget Law	100	128	263	241	240	237
4	Brought forward expenditures	-	1,113	0	992	0	1,461
5	Target programs expenditure and others	1,284	1,404	1,501	1,370	1,824	1,715
6	Transfer to financial reserve fund	2		1	3	1	1

1/ "Revenues with 100% entitlement" includes land & house tax, natural resource tax (except those from oil and gas), license tax, land use right transfer tax, agricultural land use tax, the land use levy, land rent.
2/ "Share revenues in percentage" refers those shared between central budget and local budget under the provisions in Clause 2, Article 30 of the State Budget Law. It includes VAT and enterprise income tax.
3/ "Transfers from central budget" is comprised of "balancing transfers" and "target transfers".
Source: Dak Lak DOF

(Unit: VND bil.)

Dak Nong Province		2013		2014		2015	
		Plan	Actual	Plan	Actual	Plan	Actual
I	Local Budget Revenues	4,087	5,704	4,305	5,815	4,445	5,990
Out of local budget revenues							
1	Decentralized Revenues	1,377	1,151	1,265	1,294	1,143	1,364
	Revenues with 100% entitlement	377	384	441	501	439	593
	Shared revenue in percentage	1,000	767	824	793	704	771
2	Transfers from the central budget	2,416	2,903	2,265	3,271	2,492	3,423
	Balancing transfers	1,298	1,298	1,298	1,962	1,298	1,895
	Target transfers	1,118	1,605	967	1,309	1,193	1,528
3	Revenues from grants	-	-	0	0	0	2
4	Investment mobilizations under Article 8. Clause 3 - State Budget Law	50	231	0	116	0	99
5	Budget remainder revenues	-	166	0	144	0	146
6	Brought forward revenues	143	1,108	11	857	90	780
II	Local Budget Expenditures	4,087	5,539	4,305	5,668	4,445	5,860
Out of local budget revenues							
1	Development investment expenditures	899	1,314	792	1,108	808	1,023
2	Recurrent expenditures	2,741	3,126	3,064	3,436	3,180	3,630
3	Payment for participants and its interest of mobilization under Article 8. Clause 3 - State Budget Law	104	102	160	252	132	102
4	Brought forward expenditures	-	857	-	780	-	952
5	Target programs expenditure and others	178	0	124	129	137	148
6	Transfer to financial reserve fund	1	1	1	1	1	1

1/ "Revenues with 100% entitlement" includes land & house tax, natural resource tax (except those from oil and gas), license tax, land use right transfer tax, agricultural land use tax, the land use levy, land rent.
2/ "Share revenues in percentage" refers those shared between central budget and local budget under the provisions in Clause 2, Article 30 of the State Budget Law. It includes VAT and enterprise income tax.
3/ "Transfers from central budget" is comprised of "balancing transfers" and "target transfers".
Source: Dak Nong DOF

(Unit: VND bil.)

Lam Dong Province		2013		2014		2015	
		Plan	Actual	Plan	Actual	Plan	Actual
I	Local Budget Revenues	7,879	10,212	9,608	10,664	10,560	11,267
Out of local budget revenues							
1	Decentralized Revenues	3,778	3,249	4,065	3,569	4,934	6,508
	Revenues with 100% entitlement	3,778	3,249	4,065	3,569	4,934	3,968
	Shared revenue in percentage	0	0	0	0	0	2,540
2	Transfers from the central budget	2,814	3,941	3,761	3,952	3,726	1,930
	Balancing transfers	2,395	2,226	1,674	2,838	1,674	1,930
	Target transfers	419	1,716	2,087	1,114	2,052	0
3	Revenues from grants	-	-	-	-	-	55
4	Investment mobilizations under Article 8. Clause 3 - State Budget Law	-	-	-	119	-	478
5	Budget remainder revenues	-	665	-	713	-	486
6	Brought forward revenues	-	737	-	528	-	-
II	Local Budget Expenditures	7,897	9,508	9,608	10,185	10,560	10,521
Out of local budget revenues							
1	Development investment expenditures	1,146	2,009	1,135	2,101	1,119	1,513
2	Recurrent expenditures	4,805	5,664	5,651	5,828	6,045	5,889
3	Payment for participants and its interest of mobilization under Article 8. Clause 3 - State Budget Law	-	-	-	-	-	-
4	Brought forward expenditures	-	528	-	486	-	620
5	Target programs expenditure and others	419	0	768	0	863	710
6	Transfer to financial reserve fund	1	1	1	1	3	3

1/ "Revenues with 100% entitlement" includes land & house tax, natural resource tax (except those from oil and gas), license tax, land use right transfer tax, agricultural land use tax, the land use levy, land rent.
2/ "Share revenues in percentage" refers those shared between central budget and local budget under the provisions in Clause 2, Article 30 of the State Budget Law. It includes VAT and enterprise income tax.
3/ "Transfers from central budget" is comprised of "balancing transfers" and "target transfers".
Source: Lam Dong DOF

AT 3.7.3 Recurrent Expenditures of Central Highlands in 2015

Description	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
1. Recurrent Expenditures					
Total local recurrent expenditures in 2015 (VND bil.)	3,857	5,839	8,002	3,630	5,889
Recurrent expenditures of major provincial departments (VND bil)					
Planning and Investment	16	6	7	9	6
Finance	9	7	11	8	11
Justice	8	5	11	9	6
Construction	13	5	11	40	6
Transportation	25	3	6	8	6
Agriculture and Rural Development	124	5	22	65	24
Natural Resource and Environment	25	4	19	42	6
Industry and Trade	11	5	9	10	5
Health	285	5	31	283	6
Education and Training	252	25	50	258	7
Information and Education	9	14	5	7	5
Culture, Sport, and Tourism	40	9	17	33	6
Science and Technology	15	12	19	15	6
Sub-total	832	106	216	787	99

Source: DOF of Central Highlands

AT 3.7.4 Infrastructure Development Plans in SEDP 2016-2020 of Five Provinces

Item	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong
1.Overall development concept, strategies and target	- Pushing industrialization, modernization, and ensuring high and stable economic growth speed and combination with growth model conversion towards improvement quality and effectiveness. - Enhance environmental protection, and adapt to climate change actively.	- Formulate strategy on economic development for border gate regions - Implement growth model renovation, and economic structure conversion towards industry-trade-service sectors, give priority to industrial development serving for agricultural production. - Focus on poverty reduction.	- Try to develop economy towards green growth upto 2020, exploit development advantages, international integration - Create chance for Buon Ma Thuot City become central urban of Central Highlands - Ensure social welfare, stable poverty reduction, ecological environment protection	- Utilize provincial potentials and advantages, and outside resource - Develop agricultural sector towards high quality merchandise, applying advanced techniques for high and stable effectiveness - Improve living standard for people in combination with poverty reduction;	- Maintain growth speed and movement of reasonable economic structure. - Develop comprehensively all socio-cultural sectors, ensure security and defense. - Continue stable and rapid development.
2. Sector Development					
Road	- Upgrade and newly construct 312 km provincial road to meet Class IV - mountain area. - Newly construct 148 km district road. - Maintain and upgrade existing rural road, roads with surface structure reaching over 60%.	- Upgrade Provincial Road No. 12, No. 7 to meet the Class IV, V (930km). - Construct 1,670km District Road to meet Class V; - Upgrade 6,732 km of commune and villages to meet class A. - Rural roads with asphalt and concrete pavement reaches 60% by 2020.	- Rate of bituminous/concreted surface road: 100% at provincial and district road, 70% at inter-commune road. - Number of commune with asphalt concreted road accessing to commune center: 100%; - Up to 2020, 100% (2020km) district road and 900km commune road surface is bituminous and cement concrete	- Rate of provincial road with two lanes: 59%. - 100% asphalt concreted district road.	- Upgrade 9 provincial roads (05 new roads). - 100% surface of district roads is bituminous or cement concrete. - Newly construct and upgrade commune roads and main roads to 100% communes
Irrigation	- Invest in construction of irrigation works for Ia H'Drai district. - Upgrade and repair Dak Cam reservoir.	- Develop irrigation system and dike in combination with water supply for aquaculture and ecological environmental protection. - Irrigated area total: 81,560 ha.	- Ensure to supply 82% irrigating water for crop. - Irrigated area total: 235.280 ha (paddy area: 58.335 ha; coffee area: 120.941 ha, other area: 56.004 ha).	- Rate of irrigated area: 80% (101,082 ha). - Newly construct 150-165 small and medium works (150 reservoirs, 10 weirs, 4 pumping stations) - Upgrade: 24 systems; construct: 207 new irrigation systems.	- Ensure water supply enough for the whole area of rice, vegetable and flower; and 80% area of long-term industrial crops Irrigated area total: 131785 ha
Water Supply	- Near 100% rural population accessed to clean water:	- 100% urban and 95% rural population accessed to clean water:	- 90% urban and 95% rural population accessed to clean water:.	- 100% urban and 90% rural population accessed to clean water.	- 99% rural, 90% urban population accessed to clean water:
Electrification	- 99% households accessed to electricity grid.	- 100% household accessed to national electric grid.	- 100% Hamlet /village accessed to electricity; - 100% households accessed to electricity	- 100% hamlet/village accessed to electricity; - 99% households accessed to electricity	- 100% hamlet/village accessed to electricity; - 99% households accessed to electricity
Industry	- Invest infrastructures of industrial parks and Bo Y border-gate economical zone and new industrial parks with favorable conditions to attract investors. - Develop urban, tourist areas and functional zones.	- Improve operating effectiveness of Tra Da Industrial Zone and new invest to industrial cluster	- Widen existing industrial park and industrial clusters and new investment 07 industrial clusters (551.4 ha). Up to 2020, industry will contribute about 20-25% of the total industrial production value.	- Construct infrastructure for industrial zones of Tâm Thắng, Nhân Cơ, Đăk Hà, Thuận An, Quảng Tâm, Krông Nô, Đắk Song. - Planning industrial zones of Quảng Đức, Đắk R'La, Trúc Sơn, Quảng Khê.	

Source: Provincial SEDPs in 2016-2020

AT 3.7.5 Project's Feature of Mid-term Investment Projects in 2016-2020 in Central Highlands

Sector/Feature	Unit	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong	Total
Irrigation							
No. of Project	No.	3	3	15	17	38	76
Total Service Area	ha	2,519	5,220	10,007	19,324	10,021	47,091
Reservoir intake/well	mil.m^3	22.2	51.2	99.8	44.0	75.4	292.6
Water Supply							
No. of Project	No.	3	6	5	7	5	26
Total Design Capacity	m^3	4,000	35,097	6,525	1,972	62,850	110,444
Total Beneficiaries	person	32,000	35,097	51,592	8,975	238,470	366,134
Road							
No. of Project	No.	16	24	37	62	126	265
Length of National Highway	km	0	0	14.6	0	28.9	43.5
Length of Provincial Road	km	47.4	113.7	83.1	139.9	91.9	476.0
Length of District Road	km	91.1	143.6	164.9	308.6	282.7	990.8
Length of Urban Road	km	27.0	36.2	44.4	56.3	154.9	318.9
Length of Rural Road	km	11.4	0.0	20.5	81.1	108.9	222.0
Sub-total	km	192.9	317.5	364.5	647.9	793.4	2316.2
Electricity							
No. of Project	No.	0	0	4	1	0	5
Length of Line	km	0	0	714	103	0	817
Total Capacity	kVA	0	0	16,210	1,050	0	17,260
No. of Connections	No.	0	0	22,408	2,040	0	24,448
Flood							
No. of Project	No.	3	2	3	4	0	12
No. of strengthened Dam	No.	0	0	0	9	0	9
Length of protected Embankment	km	5.3	13.4	5.9	2.5	0.0	27.1

Note: kVA: Kilo Volt-Ampere
Source: Mid-term Plans and DARDs, DOCs, DOTs in Central Highlands

AT 3.7.6 Features of ODA Projects in Central Highlands (2006-2016)

Sector	Unit	Kon Tum	Gia Lai	Dak Lak	Dak Nong	Lam Dong	Total
Road projects							
No. of project	No.	2	6	8	5	5	26
Total length	km	23.3	82.5	100.2	67.0	39.5	312.5
Project cost	VND mil.	101,919	203,428	331,515	287,263	163,548	1,087,673
Counterpart fund	VND mil.	29,399	29,975	232,924	134,440	58,532	485,270
ODA fund	VND mil.	72,520	68,453	98,591	152,823	105,016	497,403
Electricity projects							
No. of project	No.	2	2	2	1	2	9
Total length	km	33.3	95.5	56.6	29.2	5.2	219.8
Beneficiary	household	1,100	8,300	2,990	1,500		13,890
Project cost	VND mil.	31,663	36,897	25,539	20,638	2,350	117,087
Counterpart fund	VND mil.	11,789	0	13,710	7,257	1,026	33,782
ODA fund	VND mil.	19,874	0	11,829	13,381	1,324	46,408
Water supply projects							
No. of project	No.	3	4	3	1	4	15
Total capacity	m3/day	10,200	3,200			2,600	16,000
Beneficiary	person	51,250	27,100			2,600	80,950
Project cost	VND mil.	131,887	73,582	1,272,075	166,942	954,973	2,599,459
Counterpart fund	VND mil.	52,167	4,328	1,023,894	93,133	246,931	1,420,453
ODA fund	VND mil.	79,720	9,750	248,181	73,809	708,042	1,119,502
Irrigation projects							
No. of project	No.	1	3	4	0	2	10
Total capacity	m3/day	90	95	700		366	1,251
Beneficiary	household	876	151			444	1,471
Project cost	VND mil.	25,323	551,636	856,241		53,600	1,486,800
Counterpart fund	VND mil.	7,792	6,528	500,233		34,658	549,211
ODA fund	VND mil.	17,531	121,103	356,008		18,942	513,584
Multi-components projects							
No. of project	No.	4	10	14	5	6	39
Project cost	VND mil.	1,371,536	2,055,281	3,114,609	1,875,902	1,385,911	9,803,239
Counterpart fund	VND mil.	201,241	268,854	2,499,089	526,601	254,312	3,750,096
ODA fund	VND mil.	1,170,295	1,543,879	615,520	1,349,301	1,131,599	5,810,595

Source: DPIs of Central Highland Provinces