ECONOMIC AND FINANCIAL ANALYSIS

A. Introduction

1. The proposed project aims to rehabilitate and upgrade productive rural infrastructure (PRI) in five Central Highlands provinces—Dak Lak, Dak Nong, Gia Lai, Kon Tum, and Lam Dong. It directly supports the implementation of the government's National Target Program for New Rural Development. The project will improve irrigation on about 18,500 hectares (ha) of rice, coffee, and other cash crops and rehabilitate 130 kilometers (km) of rural access roads, aiming to achieve better links between production areas and markets. The project will strengthen capacities of stakeholders in PRI management, from individual beneficiaries to institutional levels. The project will enable farming households and communities to better respond to commercial opportunities through greater agricultural diversity and stronger market links. Specifically, improved irrigation and rural access roads will result in greater productivity of rice and coffee crops, diverse employment opportunities, lower production and marketing costs, fewer post-harvest losses, and better social services.

B. Economic and Financial Analyses

2. The analyses examine the economic and financial viability of the three representative subprojects in Dak Lak, Gia Lai, and Kon Tum selected for a feasibility study. These analyses serve as proxy evaluations of the overall project's economic and financial viability and as guides for the evaluation and selection of subprojects of a similar nature for project financing.

3. **Key assumptions**. To develop a model for the analysis, certain assumptions are made about future practice (both "with" and "without" the subproject) and about the valuation of inputs and outputs. These assumptions include: (i) the subproject's life is counted as 20 years—i.e., assuming adequate maintenance, the irrigation system should be able to continue its expected benefits for 20 years before another major renovation may be required; (ii) without the subproject, current cultivation patterns and technology are expected to continue; (iii) with the subproject, the full command area is expected to be irrigated throughout the life of the subproject, allowing farmers to adopt appropriate cropping patterns and technology; (iv) some agricultural outputs may be consumed within the household but are valued as if sold; (v) some agricultural inputs such as farm labor are provided by farm households but are valued at the market rate as if hired; (vi) values are expressed in constant 2013 prices so as to exclude inflation; (vii) the Vietnamese dong is the unit of account. The exchange rate used is $1 = D21,000; (viii) the analysis uses the domestic price numeraire and for traded goods applies a shadow exchange rate factor of 1.1; (ix) for rural labor, a shadow wage rate factor of 0.8 is applied; (x) transfer payments such as taxes and subsidies are excluded in the calculation of economic values; (xi) to calculate the economic net present value (ENVP) of the subproject a discount rate of 12% is used as representing the opportunity cost of the capital invested. Detailed assumptions and estimations are in supplementary documents 14, 15, and 16.

4. In the analyses, the estimated results of year 10 of the subprojects (i.e., 2024) were used as a snapshot of the annual subproject profile for the with- and without-subproject scenarios and increments. The subprojects were assumed to be completed by December 2014. This means that 2015 would be year 1 of the subproject benefits. The reason for the use of year 10 (2024) as representative is that this is when the subproject benefits are most stable and remain so until the end of year 20 (2034).

1. Ea Kao Irrigation Subproject (Dak Lak Province)

a. Subproject Cost and Benefits

5. The estimated cost of the irrigation system is D93.1 billion in financial prices and

D73.5 billion in economic prices. Annual operation and maintenance (O&M) expenditures are assumed to amount to 3% of construction costs, while the more substantial periodic maintenance (every 8th year) will be about 30%. A snapshot of year 10 in the life of the subproject would indicate that incremental paddy production within the command area can be expected to be more than 9,800 tons per year. Maize, potatoes, and watermelon (which will be displaced by paddy) will decrease by close to 3,000 tons, 1,200 tons, and 306 tons. Coffee production should increase by about 2,200 tons per annum, and fish (from fish ponds) by about 107 tons. This increase in production thanks to the subproject will be worth D56.9 billion (in constant 2013 prices). In effect, production costs will also increase as higher-value crops are grown and more productive inputs are used. Incremental (economic) production costs can be expected to increase by almost D26.7 billion within the command area—producing a net economic increase in crop income of D30.2 billion.

b. Summary Indicators and Sensitivity Analysis

6. The Ea Kao subproject is expected to be economically viable given an economic internal rate of return (EIRR) calculated at 18.9% and an ENPV (at a discount rate of 12%) of D43.6 billion. The reported economic returns of the subproject are based on the assumption that costs and benefits over the life of the subproject will be "as calculated". The future, of course, may not perfectly follow that assumption. A sensitivity analysis has been conducted (Table 1). Overall, the Ea Kao subproject is expected to have economic returns that are quite attractive and fairly robust. None of the risk factors appears to place the subproject's economic viability in immediate jeopardy. Effective maintenance of the canal infrastructure, however, is a basic assumption for this opinion.

Table 1: Summary Economic Indicators for Ea Kao Irrigation Subproject

	ENPV (D billion)	BCR	EIRR	SI (ENPV)	SV (ENPV)
Base case	**43.6**	**1.52**	**18.9%**		
1. Capital Costs + 10%	37.4	1.41	17.6%	1.4	70.1%
2. O&M costs + 10%	41.4	1.48	18.6%	0.5	200.5%
3. Benefits decrease - 10%	30.8	1.37	17.2%	2.9	34.2%
4. Benefits decrease - 20%	18.1	1.22	15.2%	2.9	34.2%
5. Benefits decrease - 30%	5.3	1.06	13.0%	2.9	34.2%
6. Benefits delay - 2 years	12.5	1.15	13.9%	2.9	ENPV = 71.2% lower
7. Subproject life is 5 years shorter	28.8	1.36	17.5%	2.3	ENPV = 34.0% lower
8. Subproject life is 7 years shorter	19.2	1.24	16.2%	2.4	ENPV = 55.9% lower

BCR = benefit cost ratio, EIRR = economic internal rate of return, ENPV = economic net present value, O&M = operation and maintenance, SI = sensitivity indicator, SV = switching value.
Source: Asian Development Bank estimates.

c. Households' Financial Returns

7. Since the economic analysis was developed from the financial prices, presentation of the subproject's financial internal rate of return (FIRR) in addition to the EIRR would have limited meaning. In this context, it is more meaningful to discuss how the subproject will impact the financial returns of households. It should be noted that all figures presented hereunder have been converted back to local financial prices.[1]

8. There are 1,597 households that are farming land within the 2,100 ha of the Ea Kao irrigation scheme's with-subproject command area. The average farm size within the command area is 1.31 ha. This land is often on two or more widely separated parcels. If the "average"

[1] This statement also applies to the analyses of the other two subprojects that follow.

farm can be assumed to have representative proportions of irrigated and nonirrigated command area land in the without-subproject scenario, this household land will be able to produce D21.0 million ($1,000) in incremental net crop income in the with-subproject scenario in the year 10 snapshot. (Returns will continue to grow per year over the remaining life of the subproject.) Assuming a household size of 4.5 people, this means that per person incremental net crop income will increase by D4.68 million ($222).

9. The incremental net crop income noted above assumes that all labor inputs are a cost (valued at the going rate for farm labor in the area). In the with-subproject scenario, however, different cropping patterns and higher crop inputs apply than in the without-subproject situation. These differences will call for a greater amount of farm labor. For the part of the incremental labor that is drawn from the farm household itself, these (wages) comprise part of incremental household income (in addition to incremental net crop revenue)—although the additional time commitment to on-farm work may partly have an opportunity cost of work and income off the farm. For the "average" household, the incremental labor requirements in year 10 come to 111 days a year or D8.3 million ($395). The part of this figure that is not hired labor and is not offset by lost employment opportunities off the farm represents an increase in household income. The portion of the figure that goes toward hired labor can be seen as income for other households (which may or may not have land within the command area).

d. Analysis of Poverty Impacts

10. Validated information indicates that 639 households are considered poor. While the actual location of their farms is not known, it is likely that a high proportion of these farms are in the nonirrigated (without-subproject) portion of the 940 ha of the command area. This nonirrigated area produces much less value in the way of crops per ha than does the irrigated area. A way of calculating the amount of incremental crop benefit going to poor households is to assume that all of them farm in the nonirrigated (without-subproject) lower section of the system. A further assumption is that poor households have an average farm size that is 50% of that of the overall average farm size in the area. The 639 poor farm households, then, have farms of an average 0.28 ha. In aggregate, these poor farm households can be expected to have incremental net crop income from the subproject of D6.36 billion (in the year 10 snapshot) or 21% of the overall incremental net crop income from the subproject. This translates into D9.96 million ($474) per poor household.

2. Tan Son Irrigation–Road Subproject (Gia Lai Province)

a. Subproject Cost and Benefits

11. **Subproject cost**. The estimated cost of rehabilitating the access road and irrigation system is D53.5 billion in financial prices and D42.5 billion in economic prices. The access road by itself will cost D22.8 billion and the irrigation system D30.7 billion (both in financial prices). Annual O&M expenditures are assumed to amount to 3% of construction costs, while the more substantial periodic maintenance (every 8th year) will be about 30%.

12. **Benefits from irrigation rehabilitation**. A snapshot of year 10 in the life of the subproject would indicate that incremental paddy production within the command area can be expected to be more than 4,390 tons per year. Maize, watermelon, and potatoes (which will be displaced by paddy) will decrease by close to 1,200 tons, 670 tons, and 1,000 tons. Coffee production should increase by about 930 tons per annum, and fish (from fish ponds) by about 44 tons. This increase in production thanks to the subproject will be worth D22.8 billion (in constant 2013 prices). In effect, production costs will also increase as higher-value crops are grown and more productive inputs are used. Incremental (economic) production costs can be

expected to increase by almost D9.8 billion within the command area—producing a net economic increase in crop income of D13.0 billion.

13. **Benefits from access road rehabilitation**. Traffic benefits calculated on a km basis are applied to the full length of the road from year 4 of the subproject. Traffic is assumed to grow at a rate of 4%[2] a year after that time, reflected in a similar growth in value of the economic annual vehicle operating cost (VOC) savings. Taking year 10 of subproject life as an example, the economic VOC saving for local-area traffic is expected to be D3.8 billion. Diverted traffic from the district road will save 15 km en route to the main road compared with its present, longer route. This traffic (which also will be expected to grow at 4% a year) will save its full VOC per km on these 15 km. Again using the year 10 example, diverted traffic economic annual VOC savings are expected to be D6.9 billion. The aggregate VOC savings are expected to be D10.7 billion for this snapshot year.

b. Summary Indicators and Sensitivity Analysis

14. The Tan Son Irrigation–Road subproject is expected to be economically viable given an EIRR calculated at 20.0% and an ENPV (using a 12% discount rate) of D40.0 billion. The reported economic returns of the subproject are based on the assumption that costs and benefits over the life of the subproject will be "as calculated". The future, of course, may not perfectly follow that assumption. A sensitivity analysis has been conducted (Table 2). Overall, the Tan Son Irrigation–Road subproject is expected to have economic returns that are quite attractive and fairly robust. None of the risk factors appears to place the subproject's economic viability in immediate jeopardy. Effective maintenance of the canal and road infrastructure, however, is a basic assumption to support this assessment.

Table 2: Summary Economic Indicators for Tan Son Irrigation–Road Subproject

	ENPV (Bil. VND)	BCR	EIRR	SI (ENPV)	SV(ENPV)
Base case	**40.0**	**1.52**	**20.0%**		
1. Capital Costs + 10%	34.3	1.42	18.5%	1.4	70.8%
2. O&M costs + 10%	38.0	1.49	19.7%	0.5	202.5%
3. Benefits decrease - 10%	28.4	1.37	17.9%	2.9	34.4%
4. Benefits decrease - 20%	16.7	1.22	15.7%	2.9	34.4%
5. Benefits decrease - 30%	5.1	1.07	13.2%	2.9	34.4%
6. Benefits delay - 2 years	11.4	1.15	14.1%	2.9	ENPV = 71.4% lower
7. Subproject life is 5 years shorter	25.9	1.36	18.5%	2.3	ENPV = 35.1% lower
8. Subproject life is 7 years shorter	17.3	1.24	17.0%	2.4	ENPV = 56.7% lower

BCR = benefit cost ratio, EIRR = economic internal rate of return, ENPV = economic net present value, O&M = operation and maintenance, SI = sensitivity indicator, SV = switching value.
Source: Asian Development Bank estimates.

c. Households' Financial Returns

15. There are 1,200 households that are farming land within the 900 ha of the Tan Son irrigation scheme's with-subproject command area. The average farm size within the command area is 0.75 ha. This land is often on two or more widely separated parcels. If the "average" farm can be assumed to have representative proportions of irrigated and nonirrigated command area land in the without-subproject scenario, this household land will be able to produce D12.0 million ($573) in incremental net crop income in the with-subproject scenario in the year 10 snapshot. (Returns will continue to grow per year over the remaining life of the

[2] The traffic growth rate is the average rate for rural transport in the Central Highlands region as indicated in various past and ongoing rural transport initiatives.

subproject.) Assuming a household size of 4.5 people, this means that per person incremental net crop income will increase by D2.68 million ($127).

16. The incremental net crop income noted above assumes that all labor inputs are a cost (valued at the going rate for farm labor in the area). In the with-subproject scenario, however, different cropping patterns and higher crop inputs apply than in the without-subproject situation. These differences will call for a greater amount of farm labor. For the part of the incremental labor that is drawn from the farm household itself, these (wages) are part of incremental household income (in addition to incremental net crop revenue)—although the additional time commitment to on-farm work may partly have an opportunity cost of work and income off the farm. For the "average" household, the incremental labor requirements in year 10 come to 49 days a year or D3.6 million ($171). The part of this figure that is not hired labor and is not offset by lost employment opportunities off the farm represents an increase in household income. The portion of the figure that goes toward hired labor can be seen as income for other households (which may or may not have land within the command area).

17. In addition to the quantified benefits associated with crop production, VOC savings have been quantified. In order to estimate per-household road benefits, a more detailed analysis is needed after completion of the access road rehabilitation. However, it is certain that the majority of the 1,200 households will benefit from the improved road, since the access road is in the production areas.

d. Analysis of Poverty Impacts

18. Validated information indicates that 480 households are considered poor. While the actual location of their farms is not known, it is likely that a high proportion of these farms are in the nonirrigated (without-subproject) portion of the 440 ha of the command area. This nonirrigated area produces much less value in the way of crops per ha than does the irrigated area. A way of calculating the amount of incremental crop benefit going to poor households is to assume that all of them farm in the nonirrigated (without-subproject) lower section of the system. A further assumption is that poor households have an average farm size that is 50% of that of the overall average farm size in the area. The 480 poor farm households, then, have farms of an average 0.33 ha. In aggregate, these poor farm households can be expected to have incremental net crop income from the subproject of D2.77 billion (in the year 10 snapshot) or 21% of the overall incremental net crop income from the subproject. This translates into D5.77 million ($274) per poor household.

3. Kon Trang Kla and Dak Trit Irrigation–Road Subproject (Kon Tum Province)

a. Subproject Cost and Benefits

19. **Subproject cost**. The estimated cost of rehabilitating the access road and irrigation system is D86.1 billion in financial prices and D68.9 billion in economic prices. The access road will cost D47.9 billion and the irrigation system D38.2 billion (both in financial prices). Annual O&M expenditures are assumed to amount to 3% of construction costs, while the more substantial periodic maintenance (every 8th year) will be about 30%.

20. **Benefits from irrigation rehabilitation**. A snapshot of year 10 in the life of the subproject would indicate that incremental paddy production within the command area can be expected to increase by more than 4,990 tons per year. Annual incremental production increases in other crops includes: coffee 927 tons, potatoes 379 tons, watermelon 25 tons per year, and fish (from fish ponds) by about 47 tons. Maize (which will be displaced by paddy and other crops) will decrease by 1,300 tons. The increase in production thanks to the subproject

will be worth D31.7 billion (in constant 2013 prices). In effect, production costs will also increase as higher-value crops are grown and more productive inputs are used. Incremental (economic) production costs can be expected to increase by almost D13.9 billion within the command area—producing a net economic increase in crop income of D17.7 billion.

21. **Benefits from access road rehabilitation**. Taking year 10 of subproject life as an example, the economic VOC saving for local-area traffic is expected to be D5.9 billion. Diverted traffic from the district road will save 17 km en route to the main road compared with its present, longer route. This traffic (which also will be expected to grow at 4% a year) will save its full VOC per km on these 17 km. Using the year 10 example, diverted traffic economic annual VOC savings are expected to be D7.2 billion. The aggregate VOC savings are expected to be D13.1 billion in year 10.

b. Summary Indicators and Sensitivity Analysis

22. To calculate the economic returns of the subproject, the net incremental value benefits (both VOC savings as well as producer surplus in terms of crop production) is determined for each year of project life and arranged as a stream of cash flow. Costs are similarly arrayed - with construction costs falling in the first two years followed by annual maintenance costs in each subsequent year and a somewhat more major periodic maintenance expenditure every eighth year after construction. To calculate the cash flow of net project economic benefits the cost cash flow is subtracted from the benefit cash flow.

23. The Kon Trang Kla and Dak Trit subproject is expected to be economically viable given an EIRR calculated to be 20.2% and an ENPV (at a discount rate of 12%) of D51.5 billion.

24. The reported economic returns of the subproject are based on the assumption that costs and benefits over the life of the subproject will be “as calculated”. The future, of course, may not perfectly follow that assumption. A sensitivity analysis has been conducted (Table 3). Overall, the subproject is expected to have economic returns that are quite attractive and fairly robust. None of the risk factors appear to place the subproject’s economic viability in immediate jeopardy. Effective maintenance of the canal and road infrastructure, however, is a basic assumption to support this assessment.

Table 3: Summary Economic Indicators for Trang Kla and Dak Trit Irrigation –Road Subproject

	ENPV (D billion)	BCR	EIRR	SI (ENPV)	SV(ENPV)
Base case	**51.5**	**1.45**	**20.2%**		
1. Capital Costs + 10%	43.1	1.35	18.4%	1.6	61.3%
2. O&M costs + 10%	48.6	1.42	19.8%	0.6	175.2%
3. Benefits decrease - 10%	35.0	1.31	17.8%	3.2	31.2%
4. Benefits decrease - 20%	18.5	1.16	15.2%	3.2	31.2%
5. Benefits decrease - 30%	2.0	1.02	12.4%	3.2	31.2%
6. Benefits delay - 2 years	11.9	1.10	13.6%	3.2	ENPV = 76.9% lower
7. Subproject life is 5 years shorter	34.8	1.32	18.8%	2.4	ENPV = 32.5% lower
8. Subproject life is 7 years shorter	23.9	1.22	17.3%	2.6	ENPV = 53.7% lower

BCR = benefit cost ratio, EIRR = economic internal rate of return, ENPV = economic net present value, O&M = operation and maintenance, SI = sensitivity indicator, SV = switching value.
Source: Asian Development Bank estimates

c. Households' Financial Returns

25. There are 900 households that are farming land within the 890 ha of the irrigation scheme's with-subproject command area. The average farm size within the command area is 0.99 ha. This land is often on two or more widely separated parcels. If the "average" farm can be assumed to have representative proportions of irrigated and nonirrigated command area land without the subproject, this household land will be able to produce D21.9 million ($1,042) in incremental net crop income in the with-subproject scenario in the year 10 snapshot. (Returns will continue to grow per year over the remaining life of the subproject.) Assuming a household size of 4.5 people, this means that per person incremental net crop income will increase by D4.86 million ($231).

26. The incremental net crop income noted above assumes that all labor inputs are a cost (valued at the going rate for farm labor in the area). In the with-subproject scenario, however, different cropping patterns and higher crop inputs apply than in the without-subproject situation. These differences will call for a greater amount of farm labor. For the part of the incremental labor that is drawn from the farm household itself, these (wages) form part of incremental household income (in addition to incremental net crop revenue)—although the additional time commitment to on-farm work may partly have an opportunity cost of work and income off the farm. For the "average" household, the incremental labor requirements in year 10 come to 99 days a year or D7.4 million ($353). The part of this figure that is not hired labor and is not offset by lost employment opportunities off the farm represents an increase in household income. The portion of the figure that goes toward hired labor can be seen as income for other households (which may or may not have land within the command area).

27. In addition to the quantified benefits associated with crop production, VOC savings have been quantified. In order to estimate per-household road benefits, a more detailed analysis is needed after completion of the access road rehabilitation. However, it is certain that the majority of the 900 households will benefit from the improved road, since the access road is in the production areas.

d. Analysis of Poverty Impacts

28. Validated information indicates that 318 households are considered poor. While the actual location of their farms is not known, it is likely that a high proportion of these farms are in the nonirrigated (without-subproject) portion of the 360 ha of the command area. This nonirrigated area produces much less value in the way of crops per ha than does the irrigated area. A way of calculating the amount of incremental crop benefit going to poor households is to assume that all of them farm in the nonirrigated (without-subproject) lower section of the system. A further assumption is that poor households have an average farm size that is 50% of that of the overall average farm size in the area. The 318 poor farm households, then, have farms of an average 0.49 ha. In aggregate, these poor farm households can be expected to have incremental net crop income from the subproject of D3.36 billion (in the year 10 snapshot) or 19% of the overall incremental net crop income from the subproject. This translates into D10.56 million ($502) per poor household.

C. Fiscal Affordability and Sustainability

29. Based on the above analyses, sustainability of all subprojects proposed by all five project provinces (including the subprojects under examination in this document) hinges on effective O&M of the system. Since the government is currently waiving the irrigation fee and water user groups can only take care of on-farm facilities, the responsibility of O&M for the whole system rests with the irrigation and drainage companies in each province. To ensure adequate O&M of all proposed subprojects during 2018–2034, each of the five provincial

people's committees (PPCs) will need to set aside an annual budget of at least D8.8 billion (in 2013 constant price) for O&M of the newly constructed or rehabilitated systems (irrigation and access road).

30. The affordability analysis (Table 4) indicates that (i) based on the past 5 years' figures, all PPCs actually will be able to allocate significant budget amounts to infrastructure investment and O&M; (ii) the required level of D8.8 billion is in the range of 2.0%–3.4% of these projected allocations. Therefore, the required O&M budget level is assessed as highly affordable for all PPCs. Reviews of past and present projects suggest that if the O&M budget required of PPCs is below 5% of these annual allocations, PPCs will be able to finance it. This analysis suggests that the project loan agreement must include (i) a covenant to bind all five PPCs to allocate a budget for O&M of the newly constructed or rehabilitated systems (irrigation and access road; and (ii) a covenant to ensure that the provincial irrigation and drainage companies receive adequate allocations for the O&M work under their responsibility.

Table 4: Provincial Contributions Required and Affordability (for all five Project PPCs)

Provincial Peoples Committees (PPCs)	Provincial Contribution Required and Affordability					
	2013 (Project Start)	**2014**	**2015**	**2016**	**2017**	**2018 - onwards**
0. Budget Required for Each Province						
Counterpart contribution Required during Project implementation	1,949	1,949	1,949	1,949	1,949	0
Budget Required for Annual Operation and Maintenance	0	2,940	2,940	2,940	4,410	8,820
Total Annual Budget Required for Each Province (VND million)	**1,949**	**4,889**	**4,889**	**4,889**	**6,359**	**8,820**
Total Annual Budget Required for Each Province (USD thousand)	**93**	**233**	**233**	**233**	**303**	**420**
1. Dak Nong Province Affordability Profile						
Annual Allocation for Infrastructure Investment and O&M In-province *	432,024	373,632	370,100	371,966	359,349	430,356
Total Budget Required as % of the In-province Annual Allocation	0.5%	1.3%	1.3%	1.3%	1.8%	2.0%
2. Kon Tum Affordability Profile						
Annual Allocation for Infrastructure Investment and O&M In-province *	140,900	190,860	250,000	260,000	260,000	260,000
Total Budget Required as % of the In-province Annual Allocation	1.4%	2.6%	2.0%	1.9%	2.4%	3.4%
3. Dak Lak Affordability Profile						
Annual Allocation for Infrastructure Investment and O&M In-province *	472,445	404,632	410,000	415,000	425,000	435,000
Total Budget Required as % of the In-province Annual Allocation	0.4%	1.2%	1.2%	1.2%	1.5%	2.0%
4. Gia Lai Affordability Profile						
Annual Allocation for Infrastructure Investment and O&M In-province *	319,944	335,941	352,738	370,375	388,894	408,339
Total Budget Required as % of the In-province Annual Allocation	0.6%	1.5%	1.4%	1.3%	1.6%	2.2%
5. Lam Dong Affordability Profile						
Annual Allocation for Infrastructure Investment and O&M In-province *	303,898	275,640	291,420	306,000	321,300	337,000
Total Budget Required as % of the In-province Annual Allocation	0.6%	1.8%	1.7%	1.6%	2.0%	2.6%

*Annual allocation required for infrastructure investment and O&M in each province was estimated based on actual allocations for this item over the 2009–2012 period.
Source: Asian Development Bank estimates.