Environmental Assessment and Review Framework

Document Stage: Draft for Staff Review Meeting
Project Number: 41435-054
June 2017

Cambodia: Tonle Sap Poverty Reduction and Smallholder Development Project (Additional Financing)

Prepared on behalf of the Ministry of Agriculture, Forests and Fisheries for the Asian Development Bank (ADB).

CURRENCY EQUIVALENTS
(as of 7 June 2017)

Currency unit	–	Cambodian Riel (KR)
KR1.00	=	$0.000245
$1.00	=	KR4,076

ABBREVIATIONS

ADB	–	Asian Development Bank
AF	–	additional financing
COC	–	Environmental Code of Conduct
DRR	–	disaster risk reduction
DSC	–	Design and Supervision Consultants
EARF	–	Environmental Assessment and Review Framework
EIA	–	environmental impact assessment
ESO	–	Environmental Safeguards Officer (National)
EMP	–	environmental management plan
ESCC	–	Environmental Safeguards and Climate Change Specialist (of PIC)
GRM	–	grievance redress mechanism
ha	–	hectare
IEE	–	Initial Environmental Examination
km	–	kilometer
PIC	–	project implementation consultant
PST	–	provincial support team
TSSD	–	Tonle Sap Poverty Reduction and Smallholder Development

NOTE

In this report, "$" refers to US dollars.

CONTENTS

A. Introduction

1. This environmental assessment and review framework (EARF) is prepared as part of the Asian Development Bank (ADB) transaction technical assistance TA9167-CAM: Tonle Sap Poverty Reduction and Smallholder Development Project (TSSD) - Additional Financing (AF).

2. The overall goal of the project is to enhance agricultural productivity and improve access to markets in 271 target communes through investments in climate-resilient productive infrastructure, building capacity in disaster risk management of the communities and commune councils, and creating an enabled environment for agricultural productivity, diversification and climate resilience. Civil works will focus on the rehabilitation of irrigation systems, and village roads. An initial environmental examination (IEE) including an environmental management plan (EMP) has been prepared for two representative subprojects, an irrigation scheme and a rural road.

1. Project Area and Scope

3. TSSD-AF will modify the ongoing project scope by strengthening activities in the existing 196 communes of the TSSD project and scale up the current project activities in an additional 75 communes. With the additional financing, the overall project impact will be improved livelihoods in target communes in seven provinces in the Tonle Sap Basin. Banteay Meanchey, Kampong Cham, Kampong Thom, Siem Reap, and Tboung Khmum provinces are in the current project. These five provinces, plus Battambang and Prey Veng are proposed to be included in the additional financing project.

4. The impact of the overall project, which is aligned with the Cambodia Country Partnership Strategy 2014-2018, ADB's Assessment, Strategy and Roadmap for the Agriculture, Natural Resources and Rural Development Sector, and the government's Rectangular Strategy for Growth, Employment, Equity, and Efficiency Phase III, will be improved livelihoods and resilience in target communes in seven provinces (Banteay Meanchey, Battambang, Kampong Cham, Kampong Thom, Prey Veng, Siem Reap, and Tboung Khmum provinces) in the Tonle Sap Basin by 2023. The outcome of the overall project will be agricultural productivity increased, climate resilience strengthened, and access to markets improved in 271 communes in seven provinces in the Tonle Sap Basin. This will include improved rural infrastructure, improved agricultural support and rural financial services, increasing diversification of household economic activities, and the creation of on- and off-farm livelihood opportunities.

5. The project will focus on assisting communities establish livelihood improvement strategies for resource-poor farming households with assets that give them the potential to increase their farm based income. Outcomes will be measured on the basis of (i) average rice yields increasing to more than 3.50 t/ha; (ii) average rice yields of ID Poor households in target communes increased to minimum 3 t/ha for wet season rice production; (iii) diversified farming systems reduce share of household income from rice by 20%; (iv) marketed farm and off-farm products increased by 25%; and (v) awareness of climate-smart agriculture and disaster risk reduction (DRR) planning increased.

6. The project has three major Outputs:

7. Output 1: Rural productive infrastructure and livelihood improved with capacity in disaster risk management enhanced.

(i) rural roads, small scale irrigation, and other production related infrastructure;
(ii) support to new and old livelihood improvement groups (LIGs); and
(iii) Capacity building in disaster risk management.

8. Output 2: Improved enabling environment for increased agricultural productivity, diversification and climate resilience created.

(i) Value chain and agribusiness support;
(ii) Support to market improvement groups; and
(iii) ICT/Mobile Commune Access (MCA) program.

9. Output 3: Project management strengthened.

10. Activities for which environmental impact assessment will be required comprise TSSD-AF subproject outputs under Output 1. These are:

1a - Rural Roads: will rehabilitate a total of 175 km of DRR road in commune areas prone to floods and a further 300 km of laterite roads in remote commune areas with low transport volumes.

1b - Small Scale Irrigation: will rehabilitate a total of 6,000 ha of irrigation capable of year round water provision and support tertiary irrigation construction where indicated as viable after a feasibility study.

11. Outputs 1a and 1b will be delivered under similar methodologies. Road and irrigation subprojects will be included in commune development plans, confirming community interest. A candidate list of subprojects which will be covered by this EARF has been identified but will be confirmed during project implementation by the executing agencies assisted by the project design and supervision consultants and project implementation consultants in accordance with the identified subproject selection criteria.

12. The civil works under Output 1 will be complemented by support to communes, water user groups and farmers under Output 2. Under this output, at each irrigation scheme the contracted service provider will ascertain if tertiary canals should be constructed or if pumping remains the better technical option. Should tertiary canals seem the appropriate option they will include the project on the commune development plan and make a request to the national design and construction supervision contractor to undertake a feasibility study. Once the feasibility study is approved by ADB tertiary canal construction can be supported. The environmental assessment of these works is also covered by the requirements of this EARF.

13. Capacity building in support of the civil works to ensure their sustainability will include training of trainers in the national climate smart curriculum being developed between the Ministry of Agriculture Forestry and Fisheries and the Food and Agriculture Organization of the United Nations under the service provision contract, rice and diversified production elements using training methodologies adapted from farmer field schools. The project will also facilitate quarterly meetings in each commune between input suppliers, farmers and processors/traders to develop value chain clusters.

2. Purpose of the environmental assessment and review framework

14. This EARF will guide subproject selection, screening and categorization, environmental

assessment, and preparation and implementation of safeguard plans of subprojects and to facilitate compliance with the requirements specified in the Safeguard Requirements.[1]

15. The framework identifies the broad scope of the project and outlines the policy, procedures and institutional requirements for preparing the environmental safeguards for subsequent subprojects under the loan. The Design and Supervision Consultant will be responsible for screening future subprojects in accordance with the selection criteria (Section C.2 below), determining environmental impact category, preparing appropriate environmental assessments and environmental management plans for subprojects as outlined in this framework and submitting them to ADB for review and approval prior to commencement of work/finalization of contracts.

16. This framework shall apply to all subprojects under the loan additional funding so as to ensure that the environmental issues are properly addressed and mitigated to acceptable levels. Candidate subprojects will be confirmed annually in a workplan, environmental assessments of subprojects may be grouped, subject to confirmation by ADB during review of the workplan.

B. Legal and Policy Framework

1. Cambodian Legal Framework

17. The government law covering environmental impact assessment is sub-decree No. 72 ANRK.BK in the Law on Environmental Impact Assessment Process dated 11 August 1999. The main objectives of this sub-decree are:

(i) to determine an environmental impact assessment (EIA) upon every private and public project or activity, it must be reviewed by the Ministry of Environment, prior to the submission for a decision from the government;
(ii) to determine the type and size of the proposed project(s) and activities, including existing and ongoing activities in both private and public sector prior to undertaking the process of EIA; and
(iii) to encourage public participation in the implementation of the EIA process and take into account their conceptual input and suggestions for re-consideration prior to the implementation of any project.

18. An annex of the sub-decree lists the activities and the scale of activity which require an environmental assessment. An excerpt from this annex, covering agricultural activities is included below.

Table 1: List of Projects Required an Environmental Impact Assessment

No.	Type and activities of the projects	Size / Capacity
B.	**AGRICULTURE**	
1.	Concession forest	10,000 ha
2.	Logging	500 ha

[1] Safeguard Requirements cited in the ADB's Safeguard Policy Statement (SPS, 2009) for (i) Environment; (ii) Involuntary Resettlement; and (iii) Indigenous Peoples.

No.	Type and activities of the projects	Size / Capacity
3.	Land covered by forest	□ 500 ha
4.	Agriculture and agro-industrial land	□ 10,000 ha
5.	Flooded and coastal forests	All sizes
6.	Irrigation systems	□ 5,000 ha
7.	Drainage systems	□ 5,000 ha
D	**INFRASTRUCTURE**	
1.	Urbanization development	All sizes
2.	Industrial zones	All sizes
3.	Construction of bridge-roads	≥ 30 Tones weight
4.	Buildings Height	≥ 12 m or floor ≥ 8,000 m2
5.	Restaurants	≥ 500 Seats
6.	Hotels	≥ 60 Rooms
7.	Hotel adjacent to coastal area	≥ 40 Rooms
8.	National road construction	≥ 100 km

Source: Sub-Decree No. 72 ANRK.BK on Environment Impact Assessment Process. 1999.

19. **Irrigation Subprojects.** Since all subprojects which comply with the selection criteria will involve the refurbishment of existing irrigation schemes, most will not require EIA under sub-decree No. 72 ANRK.BK. Additionally, few or none will exceed 1,000 hectares (ha) and will therefore be below the scale threshold of sub-decree No. 72 ANRK.BK.

20. **Village road subprojects.** The kind of rural village road rehabilitations of realignments to be funded by the AF do not qualify as national road construction and individual projects will be in the range 5 km - 10 km. Drainage structures and culverts will be designed for farm vehicles, farm machinery and small haulage, with maximum loads of 10 tons - 15 tons. They will therefore not require EIA under government regulations.

2. ADB Environmental Classification

21. Under ADB procedures, there are a number of categories of projects and subprojects depending on the significance of environmental impacts and risks. The main ones are:

Category A: A proposed project is classified as Category A if it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works.

Category B: A proposed project is classified as Category B if its potential adverse environmental impacts are less adverse than those of Category A projects. These impacts are site-specific, few if any of them are irreversible, and in most cases mitigation measures can be designed more readily than for Category A projects.

Category C: A proposed project is classified as Category C if it is likely to have minimal or no adverse environmental impacts. An EIA or IEE is not required, although environmental implications need to be reviewed.

22. It is expected that most subprojects implemented under the loan will be classified as Category B or C. The project will not fund Category A subprojects. Category B subprojects require an IEE and EMP. Category C subprojects require consideration of potential environmental implications of proposed activities. An Environmental Code of Conduct that covers generic construction impacts and mitigation measures associated with the types of subprojects proposed has been developed and is included in Annex 5. This code of conduct could be adopted for all Category C subprojects. The IEE and EMP (for Category B subprojects) or environmental code of conduct (for Category C subprojects) will be prepared according to ADB SPS requirements.

3. Capacity to Implement EARF

23. Subproject implementation units and owners will be commune councils. Commune councils were not developed nor equipped to undertake the environmental due diligence responsibilities of an ADB funded infrastructure construction subproject. This was recognized from project inception and the project was designed with extensive capacity building outputs and consultant support to address this. Project implementation arrangements will include design and supervision consultants who will (in conjunction with the implementing agency, commune councils and National Environmental Safeguards Officer) implement the EARF, prepare the IEEs and Environmental Codes of Conduct (CoCs) and supervise construction. The project will also include project implementation consultants who will closely monitor the implementation of the EMP or environmental measures in the CoC and ensure the project's environmental performance.

C. Anticipated Environmental Impacts

24. The two core subproject IEEs prepared in April 2017 as representative candidate subprojects in Kampong Cham and Prey Veng provinces have provided guidance on the common types of impacts to be expected for both the construction and operation phases of irrigation and road subprojects and have also flagged some significant issues for special attention. Further guidance on potential impacts relevant to candidate subprojects can also be sourced from the World Bank/IFC Environmental Health and Safety guidelines.[2] These cover impacts to the main environmental media as well as different sectoral considerations, and should be referenced in the environmental impact assessments.

1. Pre-construction Screening and Classification

25. Candidate subprojects will be selected on the basis of the selection criteria described below, they will then be subject to screening procedures. These will exclude any subprojects likely to be Category A from further consideration. Specific environmental criteria for subproject screening are:

a. Irrigation

[2] Available at: http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/ifc+sustainability/learning+and+adapting/knowledge+products/publications/publications_policy_ehs-general.

(i) The proposed subprojects will have sustainable water supply; Primary water source should be demonstrably capable of sustaining water extraction to suit the intended cropping calendar.
(ii) The proposed subprojects will not be subject to water use conflict (ecological needs or human users) or other water security conflict.
(iii) The proposed subprojects will not encroach on or impact legally protected area including nature reserves or wildlife sanctuaries or sites that meet ADB's criteria for critical habitat or otherwise support any critically endangered or endangered species.
(iv) The proposed subprojects will not be undertaken where soil contamination requiring remediation[3] occurs.
(v) Power demand for the operation of a subproject (pumps) will not result in net CO_2 equivalent emissions in excess of 100,000 tons/year in electricity generation.
(vi) The proposed subprojects will avoid monuments of cultural or historical importance.
(vii) Primary water source (main canal, waterbody) should be functional and operational and not in imminent need of repairs.
(viii) No groundwater should be used as primary water source.
(ix) Additions to irrigation command areas should not involve extensive land conversion (natural habitats must not be converted) or land levelling.
(x) Additions to irrigation command areas should not be upstream of ecologically sensitive areas (ensure protection of ecologically sensitive areas from elevated nutrients and agricultural chemicals in downstream runoff from irrigation).

b. Roads

(i) New or upgraded roads should not encroach on:
  a. natural areas;
  b. wetlands;
  c. flooded forest; and
  d. wildlife breeding areas.
(ii) New or upgraded roads should not encroach on heritage sites or sites of religious ceremony or community value.
(iii) New or upgraded roads should not encroach on wildlife reserves or protected areas or sites that meet ADB's criteria for critical habitat or otherwise support any critically endangered or endangered species.
(iv) New or upgraded roads should not open up new natural resource areas for exploitation (e.g., forests and wetlands).
(v) New or upgraded roads should not divide or isolate communities. Should not create safety hazards near schools and populated areas.

[3] Indicated for screening purposes by review of past land use and by assessment against Soil Guideline Values of the UK Department for Environment Food & Rural Affairs (https://www.gov.uk/government/publications/contaminated-soil-assessing-risks-on-human-health).

(vi) New roads should not cross a major waterway, requiring a bridge structure; alignment should be sought where drainage structures under road are culverts.

26. Further screening of projects to determine whether they are Category B or C requires a preliminary assessment of the likely impacts, whether they can be avoided or minimized and whether there are areas of the receiving environment (including human communities) at risk of suffering the effects of these impacts. In summary, if there are likely impacts to the natural, agricultural or community environment, but these are either temporary or can be reduced by design and mitigation measures, then the subproject is likely to be Category B. If there are no identifiable impacts to the natural, agricultural or community environment, or the impacts are minimal and can mostly be avoided through good design and construction site management, then the subproject is likely to be Category C. In cases where a subproject requires extensive civil works in close proximity to the community or other livelihood or natural asset, Category B should be considered to ensure that procedures for environmental management of construction will be implemented via the EMP.

27. A screening worksheet to assist in this classification determination is at Annex 1.

2. Construction Impacts

28. **Irrigation subprojects.** It is anticipated that irrigation subprojects will focus on secondary and tertiary canal construction or rehabilitation, along with water management structures. During construction activities at sluices, canals and local regulators (including canal bank access ways), the main impacts will be (i) dust from earthworks in canal excavation; (ii) noise from excavation; (iii) safety hazards and disruption from the operation of machinery and haulage vehicles; (iv) loss of canal bank trees; and (v) surplus spoil disposal.

29. **Water impoundment**. The long list of candidate subprojects includes some subprojects with construction or rehabilitation of earthen dams or storage ponds as part of irrigation infrastructure. They have environmental issues relating to the potential for water conflicts with downstream users and flooding safety, as well as possible impact on the ecology or productivity of waterways.

30. **Rural road subprojects.** Rural road projects will be narrow village and farm access roads complying with the Ministry of Rural Development's rural road specifications. They will have surfaces, side batters and drainage/culverts per local needs. For road construction or rehabilitation, the main potential impacts will be (i) dust from earthworks; (ii) noise from excavation; roadmaking and haulage machinery use; (iii) safety hazards and disruption from the operation of machinery and haulage vehicles; (iv) loss of roadside trees and vegetation; and (v) sourcing of roadmaking materials at borrow pits and quarries.

31. **Mitigation measures.** Mitigation of construction-phase impacts for both types of subprojects will rely heavily on the responsibility of works contractors to follow specification clauses designed to minimize pollution of air and water and soil erosion. Additional localized traffic congestion should also be anticipated and this must be minimized by responsible transport planning. Health and safety of the community and construction workers is also, as always, a primary concern. The success of impact mitigation will rely on enforcement of the mitigation measures by commune councils and oversight by an Environmental Safeguards Officer (ESO) in the implementing agency and by the Design and Supervision Contractor and Project Implementation Consultant (PIC) team.

3. Operation Phase Impacts

32. **Irrigation subprojects.** Post-construction, a fundamental concern will be that the irrigation schemes must be sustainable and responsibly managed, to ensure that agreed irrigation and base flows in the primary canals are maintained and water users downstream are not disadvantaged. The subproject EMP or environmental code of conduct should set, as a prerequisite for project commencement, a clear water extraction plan for the growing seasons to be prepared and submitted before construction. The extraction plan will set out the volumes of seasonal releases to the new command area. Corresponding inflow data will be provided to confirm the sustainability of that level of supply. The possibility of reduced supply and increased crop water demands due to future climate change should also be considered. Guidelines for these considerations are in the project climate risk and vulnerability assessment.

33. Operation and protection of water source. Water sources for some long-list subprojects are from existing upland reservoirs. The management of these sources should be included as part of the operational environmental protection measures. This will include: watershed protection; pollution control; protection of local fisheries; and maintenance of local beneficiary users (direct irrigators, subsistence gardens, etc.).

34. Loss of terrestrial vegetation and habitat. New areas not previously farmed or long abandoned, which come into the command area with the renovated irrigation scheme may have regrowth shrubland or forest and provide habitat for local wildlife populations. Subproject selection criteria have ensured that no critical or important natural habitats will be involved, however local biodiversity may need to be considered and the retention of linked refuge vegetation and corridors should be included where local biodiversity is recorded. Additionally, the retention, replacement and establishment of trees and shrubs along canal banks, paddy dykes, creeks and drainage lines is recommended as an ecological and climate-smart agricultural practice.

35. Attention should also focus on any increases in the level of un-recycled agricultural waste, and fertilizer and pesticide residues. Mitigation of these impacts will involve the establishment of linkages to the national integrated pest management program and training/agricultural extension services for farmer groups.

36. **Rural road subprojects.** During operation of the roads, the main potential impacts will be from increases in traffic on the new road and hydrological changes in the locality resulting from the new road anti-flood embankments and culverts.

37. Increased traffic will potentially cause noise and dust impacts on people where the road passes through villages. Some estimate of future traffic will be needed to assess the magnitude of this impact. Increased traffic will also increase the need for road safety and community management of traffic speed.

38. Hydrological changes include drainage through the road and changes to the distribution of local flood waters. The road embankment can also affect cross road water movement for agricultural irrigation and field drainage. In general, multiple culverts in the road alignment will allow free passage of surplus water, ensuring that the road embankment does not act as a flood barrier which would increase local flooding. This and other design features for flood resilience will need to take account of the design for water management of adjacent paddies and the need to retain field banks and drains.

4. Climate Change Adaptation

39. Assessing possible climate change impacts on subprojects and identifying and applying climate change adaptation measures to subproject design and operation is an important impact assessment function. A Climate Risk and Vulnerability Assessment (CRVA) has been prepared for the project. It considers a range of future scenarios for temperature, rainfall, floods droughts and extreme weather events and provides a set of adaptation measures relating to the different kinds of subprojects which must be incorporated, to the extent possible, into subproject planning and design. This is set as a requirement in the model EMP at Annex 3 and model Environmental Code of Conduct at Annex 5. The CRVA is included at Annex 9.

D. Environmental Assessment for Subprojects

1. Procedures for Environmental Assessment of Subprojects

40. The environmental assessment of the subprojects will be conducted by the International and National Environment and Climate Change Consultants recruited as part of the Design and Supervision Consultant services. The terms of reference (TORs) for these positions are at Annex 6.

41. Environmental assessments will be undertaken according to the ADB's SPS (2009), the government's environmental assessment regulations and guidelines, and this EARF for each subproject. Subprojects will be classified for their level of potential environmental impact using a screening worksheet (see Annex 1). This worksheet combines the identification of potential impacts with a consideration of their magnitude. The environment category of a proposed project is determined on the basis of the project's most environmentally sensitive component. For subprojects determined to be Category B, an IEE and EMP is required. For subprojects determined to be Category C, an Environmental Code of Conduct is required.

2. Category B: Process to Prepare Initial Environmental Examination

42. The IEE process shall initially involve the scoping and preparation of a plan for the study. Scoping is a planning exercise to determine the content and emphasis (level of detail) for the study. Scoping quickly assesses the existing environmental status of the project area, identifies potential environmental impacts, and methodology of assessment. The plan also indicates the team of experts for the assessment and refines the study schedule. The format and contents for the write-up of an IEE, taken from ADB SPS (2009) is at Annex 2. The IEE for the representative subprojects can also be used as a guide.

43. **Impact assessment.** The activities for conducting the IEE study has the following steps:

(i) Desk Study: Review of information such as maps, reports, and EARF for the project. Checklist for collecting site information is also finalized. This will include review of Cambodian environmental standards, laws and regulations, and reference to the ADB's SPS and Environmental Safeguards Sourcebook,[4] and World Bank/IFC EHS Guidelines.

(ii) Consultations: communities and local stakeholders shall be consulted by means of focus group discussions. If required, discussion with concerned government offices will also be undertaken.

[4] ADB. 2012. *Environment Safeguards: A Good Practice Sourcebook—Draft Working Document.*

(iii) Field Assessment: Assessment of the potential and significant environmental concerns shall be done to collect data and analyze any potential impacts.
(iv) Consultation with subproject affected persons and relevant stakeholders as described in Section F below.
(v) Preparation of an environmental constraints map showing the project area and identifying and plotting areas, structures and other environmentally important life support systems/features that may be adversely and/or positively affected by the development.
(vi) Sampling and Testing: Special tests may be necessary in certain cases where water pollution issues need to be investigated (water quality for enterococci organisms, arsenic or fluoride content, iron, salinity, etc.), soil and canal sediment for contamination and noise levels, particulate matter in air.
(vii) Identification of Environmental Impacts and Mitigation Measures: The impacts will be identified in terms of their significance and duration. Direct, indirect, cumulative and induced impacts on the physical, biological, socioeconomic environments should be considered. This should include impacts on livelihoods (e.g., canal or paddy fisheries). Impacts should be quantified to extent possible,

44. **Environmental Management Plan (EMP).** The Category B IEE will be supported by an EMP. The purpose of the EMP is to present the impact mitigation measures identified in the IEE or environmental review as an action plan, with responsibilities, timing, and estimated costs. The EMP action plan should show the following:

(i) nature of the impact;
(ii) how the impact will be mitigated;
(iii) approximate cost of the mitigation measure to ensure availability of funds;
(iv) responsible entity for mitigating the identified impact, i.e., commune, service provider, construction company, etc.

45. The EMP should include mitigation actions during construction or implementation of a subproject and also during operation of the subproject, if necessary. A model EMP matrix of mitigation measures is at Annex 3. This model covers all potential impacts and in adapting it to individual subprojects will require selection of those measures which are relevant to the particular circumstances.

46. Based on the measures in the final EMP, specific environmental clauses will be included in the civil works contracts.

47. The EMP will also include the requirement to establish the subproject grievance redress mechanism (GRM) and link it to the project GRM (see Section F.3 below);

48. **Environmental Monitoring Plan.** The EMP will include a monitoring plan which checks that the mitigation measures are working and are successfully protecting the environment. In most cases, the monitoring will be undertaken by the commune council and contractor, assisted by the project implementation consultants (PIC) and national environmental safeguards officer (ESO). The monitoring plan should include the following:

(i) what needs to be monitored;
(ii) where will the monitoring be undertaken;
(iii) how the monitoring will be done;
(iv) when will the monitoring be done;

(v) who will be responsible for monitoring.

49. A model monitoring plan is at Annex 4. As with the EMP mitigation matrix, this model covers all potential impacts and in adapting it to individual subprojects will require selection of those monitoring parameters which are relevant to the particular circumstances. The results of monitoring will be evaluated against environmental performance standards which will be from Cambodian environmental standards, laws and regulations and Word Bank/IFC EHS Guidelines or performance targets for individual environmental measures set by the EMP. The results of monitoring will become part of the reporting of the progress of the project implementation by the executing and implementing agencies to the ADB.

50. **Management and Monitoring Costs.** The costs of implementing the environmental management and impact mitigation measures listed in the EMP matrix are included in the design costs, construction contracts, and operational budgets. Detailed budget allocations against each of the items in the EMP will be developed by the Design and Supervision Consultants.

51. The continuing activities of the commune councils' monitoring during construction and the initial operational period will be funded from the construction budget. The operational monitoring costs will be covered by the operational budget.

3. Category C: Process to Prepare an Environmental Code of Conduct

52. The Environmental Code of Conduct for low impact subprojects shall be undertaken by the commune council assisted by the project implementation consultants and should follow the following process outlined below:

Step 1 – Identify potential impacts for (i) siting and design of works; (ii) construction; and (iii) operation.
Step 2 – Identify how each potential impact will affect the land, air, water, living environment, or people.
Step 3 – Rank each potential impact for significance and duration.
Step 3 – Identify mitigation or avoidance measures which can be implemented, their costs and who will be responsible.

53. A model Environmental Code of Conduct is presented at Annex 5. This lists common impacts and their mitigation measures and can be added to or reduced according to the circumstances of each subproject and site. The mitigation measures will be incorporated into subproject design and operation practice, as appropriate.

E. Environmental Training and Capacity Building

54. Training of commune councils and contractors on the preparation of construction environmental management plans to guide site preparation and construction will be undertaken by the Environmental safeguards and Climate Change specialist (ESCC) of the Design and Supervision Consultant team and the implementing agency's ESO (see Section G. Institutional Arrangements and Responsibilities).

55. Development of specialized impact mitigation and the environmental management practices required for subprojects will be supported by the project's capacity building funding and outputs. These have been designed to be delivered by special service providers (SSP) contracted by the implementing agency and funded by the project loan. They include (i) water allocation

planning and management; (ii) canal fisheries; (iii) integrated pest management; (iv) road safety awareness; and (v) DRR and disaster management.

F. Consultation, Information Disclosure, and Grievance Redress Mechanism

1. Public Consultation

56. The public consultation and participation process during the project preparation stage should involve: (i) reconnaissance surveys of the subproject sites; and (ii) participatory meetings with affected persons and local stakeholders.

57. Reconnaissance surveys of the subproject sites will comprise on-site discussions with district and town commune officials to provide information on the physical and biological resources, social-economic environment, opportunities and constraints relevant to the proposed subproject.

58. Participatory meetings will be held with government stakeholders and representatives from affected villages, communes, water user groups and farmers to collect data, to present the project (designs and locations), and to ascertain social and environmental issues and concerns. For Category B infrastructure subprojects, consultation will be carried out during subproject preparation and following completion of detailed engineering design.

59. Feedback from the participants on subproject implementation and consensus on how to deal with environmental issues in the area will be important goals of the consultation process. Subproject design and management will respond to community concerns and the consideration of environmental issues raised in public consultation sessions will be incorporated in the IEE (and CoC as appropriate).

60. The respective IEEs, EMPs and Environmental Codes of Conduct developed for subprojects will set out ongoing public consultation requirements during implementation.

2. Public Disclosure

61. The details of the proposed subprojects will be discussed and disclosed during public and stakeholder consultations during subproject preparation and following completion of detailed engineering design.

62. IEEs and semi-annual environmental monitoring reports will be submitted to ADB and disclosed on the project website. IEEs and the monitoring reports will also be disclosed on the executing agencies' website and be made available at the commune level. At the commune level, the executive summary will be translated into Khmer.

3. Grievance Redress Mechanism

63. A grievance redress mechanism (GRM) for environmental complaints will be established for the project in compliance with ADB's SPS (2009) requirement to prevent and address community concerns and assist the project to maximize environmental benefits. The setting up of the GRM in the implementing agency and its implementation will be supported by the

environmental consultant of the loan implementation consultancy services.[5]

64. The GRM will be accessible to diverse members of the community, including more vulnerable groups such as women and youth. Multiple points of entry, including face-to-face meetings, written complaints, telephone conversations, or e-mail, will be available. Opportunities for confidentiality and privacy for complainants will be honoured where this is seen as important.

65. The implementing agency will establish a complaints unit which will act as a central recording and coordinating unit for each subproject under the project. Each subproject commune council will ensure that the GRM is publicized locally so that the community is fully aware of the mechanism and the local points of entry to it. In most cases these will be complaints directed to contractors or grievances communicated to the commune administration or farmer groups. The preferred action sequence for complaints handling is that the complaint should be investigated and resolved by the unit receiving the complaint.

66. During construction, the implementing agency's complaints unit will be informed by contractors and construction supervisors, or commune leaders if people complain about the project.

67. To ensure that complaints are dealt with in a timely fashion, time limits should be set for referral of complaints and resolution.

68. The complaints unit will maintain records of complaints and actions taken to correct them. This data will be included in the project management office's project progress reports to the ADB.

G. Institutional Arrangement and Responsibilities

69. The arrangements and key responsibilities for the implementation of the project are set out in Table 2 below.

Table 2: Institutional Arrangements

Aspects	Arrangements and Key Responsibilities
Management	
(i) Oversight body	The Council for Agriculture and Rural Development (CARD) will be responsible for overseeing overall implementation of the project in compliance with ADB and RGC requirements.
(ii) Executing agencies	There are two executing agencies. Ministry of Agriculture Forestry and Fisheries (MAFF) and National Committee for Democratic Development Secretariat (NCDDS). The executing agencies are responsible for overseeing the implementation of and compliance with ADB safeguard requirements and for submitting due diligence reports for non-infrastructure activities, the preliminary short reports, feasibility studies and related safeguard assessment reports (where applicable) for infrastructure subprojects to ADB for review and approval. NCDDS will be responsible for disclosure of safeguard assessment reports on the government project website.
(iii) Key implementing agencies	NCDDS: responsible for Output 1, MAFF: responsible for Output 2. Ministry of Posts and Telecommunications (MPTC) will be the implementing agency for the specialized telecommunications tasks in Output 2.

[5] The project GRM will have been established in support of the implementation of the two core subprojects (for which an IEE has already been prepared). Subsequent subproject implementation should use the same GRM arrangements.

Aspects	Arrangements and Key Responsibilities
	NCDDS will be responsible for ensuring preparation of the due diligence reports for non-infrastructure activities, and the preliminary short reports, feasibility studies and safeguard assessment reports (where applicable) for infrastructure subprojects for submission to ADB for review and approval. NCDDS will designate a staff member to be the project Environmental Safeguards Officer (ESO). The ESO will coordinate with subnational government counterparts to monitor implementation of project environment and climate change requirements. They will also support the Consultant teams with public and stakeholder consultations during subproject preparation and ensure disclosure of safeguard assessment reports at a commune level.
(iv) Provincial Support Team (PST)	A PST will be established for each province incorporating provincial staff of the executing and implementing agencies' ministries. The PST will ensure that all subproject designs are technically cleared by relevant provincial technical departments and that road designs are approved at provincial level by the provincial department of rural development, and that irrigation designs are approved by the provincial departments of water resources and meteorology.
(v) Commune Implementation units	Commune councils will be the implementation units for infrastructure subprojects – contracting and supervising construction contractors, owning, operating, monitoring and maintaining the finished facilities.
(vi) Design and Supervision Consultants (DSC)	Support commune councils with design, bidding and supervision of infrastructure subprojects. The DSC will assist commune councils to monitor construction standards and facilitate monthly coordination at provincial level. This team includes two Environment and Climate Change Specialists (international for 8 person months and national for 16 person months). These Consultants will support the ESO with environment and climate risk screening of subprojects and preparation of environmental assessment reports, management plans, environmental training, environmental supervision and monitoring and preparation of quarterly project progress reports and semi-annual environmental monitoring reports in accordance with the EARF and Climate Risk Management Report.
(vii) Project Implementation Consultants (PIC)	The PIC will support the implementing agencies, ESO and commune council with non-infrastructure components of the project. This team includes a National Environmental Safeguards Specialist (8 person-months). This Consultant will review the environmental implications of non-infrastructure activities and prepare an environmental due diligence report in relation to proposed activities in the annual work plan. They will also provide training, undertake supervision and monitoring and prepare inputs for quarterly project progress reports and semi-annual monitoring reports on non-infrastructure subproject components.

70. The subproject civil works for irrigation and village road will be included in commune development plans, confirming community interest and funds to contractors will be paid by relevant commune councils. Final design for subprojects, support in bid preparation, and construction supervision will be undertaken by a Design and Supervision Consultants (DSC), and selected by a procurement review committee composed of representatives from the implementing agencies. The DSC will support commune councils and PST to prepare tender documents and contracts for construction.

71. For the environmental aspects of the project, the safeguard unit within the National Committee for Democratic Development Secretariat (NCDDS) will assign a suitably qualified staff member to be the project Environmental Safeguards Officer (ESO). The major responsibilities of the ESO will be to ensure that the mitigation measures and monitoring of these activities are carried out in accordance with the EMP or Environmental Code of Conduct; the environmental

monitoring program, including taking samples and analysis are being carried out; and reporting is performed in compliance with ADB and government requirements.

72. The DSC will include international and national Environmental Safeguards and Climate Change specialists (DSC ESSCs). The DSC ESCCs will be responsible for the development of infrastructure subprojects. These consultants will work with the implementing agencies, ESO, PSTs and commune councils to fulfil their environmental responsibilities in implementing the EARF, preparing subproject IEEs and EMPs and Environmental Code of Conducts. They will prepare subprojects in line with the EARF and Climate and Disaster Risk Assessment Report and monitor and report on implementation of subprojects.

73. The project implementation consultants (PIC) will include a National Environment and Climate Change Specialist (PIC ESSC). The PIC ESCC will be responsible for implementing the EMPs and CoCs. The PIC ESCC will prepare inputs for the quarterly project progress report and semi-annual environmental monitoring reports for ADB. The PIC ESCC will supervise the proper implementation of all EMP requirements. For this, the PIC ESCC will develop a checklist or other format for ranking the environmental performance on a case-by-case basis and include the results in the EMP compliance monitoring report. They will also develop procedures for unanticipated impacts and appropriate corrective actions, should they occur. The PIC ESCC will be contracted for the duration of the loan implementation period. Terms of reference for the DSC and PIC ESCC positions are at Annex 8.

H. Reporting

74. For non-infrastructure activities, a due diligence report will be prepared based on activities in the annual workplan and submitted to ADB for review.

75. For infrastructure subprojects, the DSC will prepare preliminary short studies of all proposed subprojects, including categorization of safeguards. The preliminary short studies will be submitted to ADB for review and confirmation of safeguards classifications. Any subproject classified as Category “B” for environmental safeguards will require an IEE and EMP and will be subject to review by ADB and disclosure as per SPS and the EARF.

76. The implementing agency will submit semi-annual progress reports to the ADB covering each subproject until project completion report stage. These progress reports will include environmental progress which will cover:

(i) implementation of the EMP or code of conduct provisions;
(ii) results of monitoring of environmental parameters by the contractors or commune councils;
(iii) complaints dealt with through the GRM; and
(iv) environmental training and capacity building undertaken.

CATEGORIZATION CHECKLIST

The following Impacts Questions Table has been derived from the ADB's Rapid Environmental Assessment checklist for roads and agriculture – and has been adapted for the Tonle Sap Poverty Reduction and Smallholder Development Project - Additional Financing.

Impact Questions Table:

1. Answer the first question ("Will it happen?") assuming that no mitigation measures will be conducted. The purpose is to identify potential impacts. If the answer is "No" then place a "C" in the final column.

2. If the answer is "Yes" then fill out the next two columns, "is it irreversible?" and "can it be minimized?"

3. The final column refers to the ADB categories "B" and "C" for environmental impacts. They are defined below.

Category B. Potential adverse environmental impacts are site-specific, few if any are irreversible. In most cases mitigation measures can be readily designed. Initial environmental examination (IEE) including environmental management plan is required.

Category C. Sub-project likely to have minimal or no adverse environmental impacts. Environmental review required.

4. A notation of Category B for any Impact Question indicates that the subproject as a whole is Category B and an IEE is required. Where no Category B is given to any question, the subproject is Category C, requiring only an environmental code of conduct.

5. To assist in this determination, the following scoring matrix can be used as a guide:

Will it happen? Y/N	If YES		ADB Category
	Is it irreversible? Y/N	Can it be minimized?	
N	-	-	C
Y	N	Y	C
Y	Y	N	B
Y	Y	Y	Depends on scale*
Y	N	N	Depends on scale*

**** See the Magnitude/Scale Questions below. If "Yes" to any Magnitude/Scale question, the ADB Category is B***

Impact Questions	Will it happen? Y/N	If YES		ADB Category
		Is it irreversible? Y/N	Can it be minimized?	
Sub-project Siting				
Will the siting of the subproject cause the removal of native trees and shrubs				
Is siting of the subproject likely to be affected by climate conditions including extreme weather related events such as floods, droughts, storms, landslides?				
Potential Environmental Impacts				
Will the subproject cause…				
• alteration of surface water hydrology of waterways resulting in increased sediment in streams affected by increased soil erosion at construction site?				
• deterioration of surface water quality due to silt runoff and wastes from construction?				
• increased air pollution due to subproject construction and operation?				
• noise and vibration due to subproject construction or operation?				
• generation of solid waste and/or hazardous waste?				
• use of chemicals?				
• generation of wastewater during construction or operation?				
From earthworks will there be:				
• construction dust and erosion				
• loss of micro-habitat for local biodiversity				
• changes to local drainage				
In the upgrade or establishment of an irrigation system, will there be:				
• Unsustainable use of local water resources				
• Water use conflicts				
• Cumulative impacts on limited water resource				
For road construction will there be problems with:				
• location (too close to residences / waterways)				
• construction impacts - dust, noise				

Impact Questions	Will it happen? Y/N	If YES		ADB Category
		Is it irreversible? Y/N	Can it be minimized?	
• operational impacts – dust, noise				
For use, handling, transport, and storage of materials and inputs of seeds, seedlings, fertilizers and chemicals will there be:				
• application of chemicals and fertilizer not carefully managed - increased volumes enter soil and water				
• noise, dust, pollution from haulage, handling and storage of materials				
• extensive residue of plastic mulch material in soil and water.				

The following considerations are NOT determinants of Categorization, but to be used as modifiers only for candidate subprojects for which the categorization on the basis of the Impact Questions is not conclusive (see point 4 above).

Magnitude/Scale Questions	Yes	No
Irrigation Subproject		
Does the irrigation subproject involve construction or rehabilitation of canals with a total length greater than 4 km?		
Will the irrigation subproject increase the irrigated area by more than 500 ha?		
Road Subproject		
Is the road rehabilitation or realignment subproject longer than 5 km?		
Will the proper drainage design of the road subproject require 10 or more culverts?		

CONTENTS OF AN INITIAL ENVIRONMENTAL EXAMINATION FOR CATEGORY B SUBPROJECTS

A. Executive Summary
This section describes concisely the critical facts, significant findings, and recommended actions.

B. Policy, Legal, and Administrative Arrangement
This section discusses the national and local legal and institutional arrangement within which the environmental assessment is carried out. It also identifies project-relevant international environmental agreements to which the country is a party.

C. Description of the Project
This section describes the proposed project; its major components; and its geographic, ecological, social, and temporal context, including any associated facility required by and for the project (for example, access roads, power plants, water supply, quarries and borrow pits, and spoil disposal). It normally includes drawings and maps showing the project's layout and components, the project site, and the project's area of influence.

D. Description of the Environment (Baseline Data)
This section describes relevant physical, biological, and socioeconomic conditions within the study area. It also looks at current and proposed development activities within the project's area of influence, including those not directly connected to the project. It indicates the accuracy, reliability, and sources of the data.

E. Anticipated Environmental Impacts and Mitigation Measures
This section predicts and assesses the project's likely positive and negative direct and indirect impacts to physical, biological, socioeconomic (including occupational health and safety, community health and safety, vulnerable groups and gender issues, and impacts on livelihoods through environmental media, and physical cultural resources in the project's area of influence, in quantitative terms to the extent possible; identifies mitigation measures and any residual negative impacts that cannot be mitigated; explores opportunities for enhancement; identifies and estimates the extent and quality of available data, key data gaps, and uncertainties associated with predictions and specifies topics that do not require further attention; and examines global, transboundary, and cumulative impacts as appropriate.

F. Analysis of Alternatives
This section examines alternatives to the proposed project site, technology, design, and operation, including the no project alternative in terms of their potential environmental impacts; the feasibility of mitigating these impacts; their capital and recurrent costs; their suitability under local conditions; and their institutional, training, and monitoring requirements. It also states the basis for selecting the particular project design proposed and, justifies recommended emission levels and approaches to pollution prevention and abatement.

G. Environmental Management Plan
This section deals with the set of mitigation and management measures to be taken during project implementation to avoid, reduce, mitigate, or compensate for adverse environmental impacts (in that order of priority).

H. Conclusion and Recommendation

This section provides the conclusions drawn from the assessment and provides recommendations.

MODEL ENVIRONMENTAL MANAGEMENT PLAN FOR CATEGORY B SUBPROJECTS

The matrix below summarizes the typical potential impacts of subprojects developed as part of the Tonle Sap Poverty Reduction and Smallholder Development Project - Additional Financing. It also outlines corresponding mitigation measures designated to minimize those impacts.

The mitigation measures, suitably adapted to particular subprojects and locations, will be incorporated into tender documents, construction contracts, and operational management procedures. Contractors, project implementation units and the project management office will implement these measures, depending upon subproject phases. The effectiveness of these measures will be carefully watched via environmental monitoring to determine whether to continue them or to make improvements.

Ticks (√) show where the cost of an environmental measure should be allowed for in construction contracts.

Typical Potential Impacts and Mitigation Measures

Item	Environmental Impacts and issues	Mitigation Measures and/or Safeguards	Who Implements	Who Supervises	Costs	
					Irrig.[a]	Road[b]
Pre-construction						
1.1 Design stage	Final site designs	Final designs of embankments, siting of control structures and canal alignments will be completed after taking into account all the provisions of the EMP (below). Final alignment of road, embankments and drainage structures will be completed after taking into account all the provisions of the EMP (below). At all sites, trees to be retained will be clearly marked.	CC and ESCC	IA	Design costs	
	Subproject must be designed to be resilient to future climate change.	Final design of subproject(s) will incorporate all relevant recommendations of the CRVA appropriate to the type of subproject.	CC and ESCC	IA, ADB	Design costs	
	Irrigation extraction planning and command area management	Water allocations and drainage will be documented and approved by the CC, IA, and ADB before procurement and construction commences.	CC and ESCC	IA, ADB	Design costs and supported by SSPs	
		Where new irrigation areas not previously farmed or long abandoned, have regrowth shrubland or forest and provide habitat for local wildlife, key linked refuge vegetation, corridors and windbreaks should be reserved and retained by the plan. Where natural regrowth vegetation is removed from a	CC and ESCC	IA	Design costs	

Item	Environmental Impacts and issues	Mitigation Measures and/or Safeguards	Who Implements	Who Supervises	Costs	
					Irrig.[a]	Road[b]
		locality during construction, replacement planting will be undertaken.				
	Baseline water quality	Establish baseline water quality for surface water and groundwater (see monitoring plan).	CC and ESCC	IA	Included in monitoring costs	
1.2 Construction Preparation Stage	Environmental management budget	Confirm budgets for the implementation of environmental management measures and environmental supervisory responsibilities. Assign final budget allocations against each of the items in the EMP.	CC and ESCC	IA	Design costs	
	Incorporate environmental management into contract documents	Contract documents: Preparation of the environment section in the Terms of Reference for bidders for construction contracts, and environmental contract clauses for contractors, namely the special conditions for the protection of the water, soil and air environments (referencing the EMP and monitoring plan).	CC and ESCC	IA	Design costs	
1.3 Construction support preparation	Environmental education and awareness	Environmental Protection Training: Environmental specialists (including ESCC) and/or officials from local MOE offices will provide training on implementation and supervision of environmental mitigation measures to CC and contractors. This will include training in the preparation of a Construction Site Environmental Management Plan.	ESCC and MOE officers as required	IA	EMP training budget √	√
	Site planning	Prepare a Construction Site Environmental Management Plan which incorporates the relevant provisions of this EMP for each subproject construction site. The plan will also include an emergency preparedness and response plan for construction emergencies, site environmental health and safety plan, identification of sensitive receptors and vegetation to be retained.	Contractors	CC	Part of construction costs √	√
Construction						

Item	Environmental Impacts and issues	Mitigation Measures and/or Safeguards	Who Implements	Who Supervises	Costs	
					Irrig.[a]	Road[b]
2.1 Water	Construction wastewater	Construction wastewater will not be discharged directly onto the surrounding soil or into surface water systems. All wastewater to be passed through silt traps or temporary sedimentation screens. Oil-containing wastewater will be intercepted, collected and transported to vehicle servicing area for treatment and disposal.	Contractors	CC, ESO	√	√
	Polluting materials	To prevent pollution of soil and surface water/groundwater: (i) storage facilities for fuels, oil, cement, and chemicals will be within secured areas on impermeable surfaces, provided with bunds and cleanup installations; (ii) vehicle, machinery, and equipment maintenance and re-fueling will be carried out in such a way that spilled materials do not seep into the soil; (iii) oil traps will be provided for service areas and parking areas; (iv) fuel storage and refilling areas will be located at least 50 m from canals and channels and will be protected by temporary drainage bunds to contain spills.	Contractors	CC, ESO	Construction costs √	√
2.2 Air	Air quality	Equipment will be maintained to a high standard to ensure efficient running and fuel-burning. High-horsepower equipment will be provided with tail gas purifiers. All vehicle emissions will be in compliance with relevant Cambodian emission standards.	Contractors	CC, ESO	Construction costs √	√
	Dust	Material stockpiles and concrete mixing equipment will be equipped with dust shrouds. For both construction sites and construction roads, water spraying for the suppression of dust and maintenance of driving surfaces will be standard site management practice. Vehicles carrying soil, sand, or other fine materials to and from the construction sites will be covered.	Contractors	CC, ESO	Construction costs √	√

Item	Environmental Impacts and issues	Mitigation Measures and/or Safeguards	Who Implements	Who Supervises	Costs	
					Irrig.[a]	Road[b]
2.3 Noise and Vibration	Noise impacts on sensitive receivers	Construction at night within 300 m of residences shall be strictly prohibited. During daytime construction, the contractor will ensure that: (i) sites for concrete-mixing plants and similar activities will be located at least 500 m away from residences and schools; and (ii) temporary anti-noise barriers will be installed to shield sensitive receptors within 50 m of the construction site.	Contractors	CC, ESO	Construction costs	
					√	√
2.4 Solid wastes	Demolition waste	Any waste from the demolition of structures will be either sold to building material recyclers or collected and transported to official landfill sites. Metal parts will be broken up and sold to scrap metal merchants. Any excess spoil will be made available to nearby communities for use as building pads and bunds.	Contractors	CC, ESO	Construction costs	
					√	√
	Excavated channel spoil	The sediment quality of spoil from old channel clearing or deepening will need to be tested and assessed for contamination before reuse in levee banks or disposal. The sediment testing results will determine the requirements to ensure safe disposal or reuse.	Contactor and CC	IA	Monitoring costs included in the monitoring plan	
					Construction contingency costs (if disposal is required)	
					√	
	Waste from workers	Contractors will provide sufficient garbage bins at strategic locations and ensure that they are (i) protected from birds and vermin; (ii) emptied regularly (using the nearest township licensed solid waste system and landfill); and (iii) are not left to overflow.	Contractors	CC, ESO	Construction costs	
					√	√
2.5 Soil erosion and ecology	Erosion impacts	Erosion control will include: (i) limiting construction and material handling during periods of rains and high winds; and (ii) stabilizing all cut slopes, embankments, and other erosion-prone working areas while works are going on. All earthwork disturbance	Contractors	CC, ESO	Construction costs	
					√	√

Item	Environmental Impacts and issues	Mitigation Measures and/or Safeguards	Who Implements	Who Supervises	Costs	
					Irrig.[a]	Road[b]
		areas shall be stabilized within 30 days after earthworks have ceased at the sites.				
	Flora and fauna	Clearing of vegetation along canal embankments, levees and road verges will be minimized to assist in stabilization and retention of habitat values. Trees marked for retention will be protected and any removed native trees will be replaced.	Contractor	CC, ESO	Construction costs √	
2.6 Social and Cultural	Impacts to local cultural sites	The baseline survey reported no physical cultural sites in the subproject areas. There may still be sites or item which are important at a local or household level contractors will ensure that all local cultural sites (including small shrines and graves) will be kept clear of construction material and protected from dust and other disturbance. Access to these sites will not be impeded. After construction is finished any disturbed surroundings will be restored to pre-construction standards.	Contractors	CC, ESO	Construction contingency costs √	√
2.7 EHS	Community health and safety	Community health and safety will be safeguarded by: (i) Planning construction activities so as to minimize disturbances to residents, utilities and services. Temporary land occupation will be planned well ahead of construction to minimize its impact and after consultation with the affected community. Land will be reinstated to its original condition after construction. (ii) Implementing safety measures around the construction sites to protect the public, including warning signs to alert the public to potential safety hazards, barriers to prevent public access to construction sites and a watch person, where necessary.	Contractors	CC, ESO	Construction costs √	√

Item	Environmental Impacts and issues	Mitigation Measures and/or Safeguards	Who Implements	Who Supervises	Costs	
					Irrig.[a]	Road[b]
	Occupational health and safety	Measures to ensure occupational health and safety will include: (i) Contractors shall be required by the CC to ensure that their workers and other staff engaged in the proposed constructions are in a safe environment; (ii) Following the award of construction contracts, the successful contractors will prepare site environmental health and safety plan, for approval by the CC and PST; (iii) Contractors shall ensure that: (a) all reasonable steps are taken to protect any person on the site from health and safety risks; (b) the construction site is a safe and healthy workplace; (c) machineries and equipment are safe; (d) adequate training or instruction for occupational health and safety is provided; (e) adequate supervision of safe work systems is implemented; and (f) means of access to and egress from the site are without risk to health and safety.	Contractors	ESO	Construction costs	
					√	√
2.8 Unexpected environmental impacts		If unexpected environmental impacts occur during project construction phase, the CC and PST (supported by the ESCC) will update the EMP, and environmental protection measures will be designed and resources will be utilized to cope with these impacts.	CC, ESCC	IA	Construction contingency costs	
					√	√
Operation						
3.1 Management of Irrigation	Implementation of extraction and drainage plans	Irrigation schemes to be operated strictly in concurrence with agreed extraction and irrigation plans which ensure sustainability of supply.	IA and CCs	IA, ESCC	Operations cost and capacity building outputs supported by SSPs	
					√	
	Canal fisheries	Informal canal fisheries rights safeguarded for local farmers	CCs	IA	Costs under project capacity building output	

Item	Environmental Impacts and issues	Mitigation Measures and/or Safeguards	Who Implements	Who Supervises	Costs	
					Irrig.[a]	Road[b]
					and supported by SSPs	
	Pesticide use	Farmers will be trained in IPM to reduce chemical use. Training will include safe handling, application and disposal of pesticides.	SSP and CCs	IA, ESCC	Costs under project capacity building output and supported by SSPs	
3.2 Management of road	Increased road safety hazards	Implement community road safety awareness training and traffic-calming resources.	IA and Communes	IA, ESCC	Costs under project capacity building output and supported by SSPs	
	Road maintenance	Surfacing - Regularly inspect surface and fill potholes and ruts early before they enlarge. Commune to have a stockpile of suitable gravel and fill material and sections of the road should be under the care and supervision of adjacent landholders or user groups. Embankments and side batters of road across flood-liable land need to be checked regularly for stability and cracks. Embankments should be well vegetated to increase stability. All culverts and pipes must be regularly cleared to allow free passage of water. Any debris and silt must be totally removed from site to ensure it is not back into drainage structures by the next runoff event.	IA and Communes	IA, ESCC	An O&M fund established under the project will assist with subproject maintenance costs (up to 10% of the subproject cost) during the life of the project.	
3.3 Emergency response Planning	Floods and extreme weather events	The project will promote the enhancement of community based disaster risk reduction and disaster management programs at the irrigation and drainage communes with particular reference to flooding and other natural disasters.	Project output	ADB	Directly funded under project output and supported by SSPs	

ADB = Asian Development Bank; CC = commune council; CRVA = climate risk and vulnerability assessment; EHS = World Bank Group's Environmental, Health and Safety Guidelines; EMP = environmental management plan; ESCC = Environmental Safeguards and Climate Change Specialist (of PIC); ESO = Environmental Safeguards Officer; IA = implementing agency; IPM = Integrated Pest Management; MOE = Ministry of Environment; O&M = operation and maintenance; PST = provincial support team; SSP = special service provider.

[a] Irrigation subproject.

[b] Village road subproject.

Source: PPTA team.

MODEL ENVIRONMENTAL MONITORING PLAN FOR CATEGORY B SUBPROJECTS

The project monitoring program will focus on the environment within the project's area of influence. A typical environmental monitoring program is summarized in the table below. The program also considers the scope of monitoring and frequency. The monitoring results will be assessed against the following standards and corrective management implemented in cases of exceedance of the standards therein.

(i) The sub-decree No. 27 ANRK.BK on Water Pollution Control dated 6 April 1999. (Table for Lake and Reservoir)
(ii) The sub-decree No. 36 ANRK.BK on Solid Waste Management dated 27 April 1999.
(iii) Ministry of Industry Mines and Energy Drinking Water Quality Standards, January 2004
(iv) The sub-decree No. 42 ANRK.BK on Air Pollution Control and Noise Disturbance dated 10 July 2000.

For the re-use and disposal of silt from canal cleaning or dredging, there is no government standard, and the most recent standards applying to soil contamination, Soil Guideline Values of the UK Department for Environment Food & Rural Affairs (https://www.gov.uk/government/publications/contaminated-soil-assessing-risks-on-human-health), is recommended.

During construction, the commune councils will make appropriate arrangements for monitoring according to the progress of implementation. Routine monitoring of dust, noise, construction runoff and construction solid waste disposal by the commune council will be undertaken by visual inspection and consultation with local people as appropriate. The performance standards in these cases will be comparison with pre-subproject (ambient) levels of pollution and community reporting. When complaints are received from the public (either directly or via the formal grievance redress mechanism), monitoring staff will conduct additional inspections immediately

Typical Environmental Monitoring Plan

Parameters	Location	Frequency	Responsibility
Pre-Construction: Irrigation Subproject			
Baseline surface water quality: pH, SS, EC, NH_4+, NO_3-, PO_4 3-, DO, BOD5, COD, Oil& Grease, Coliform	At the water source of the subproject canal (usually a primary or secondary canal of the local command area) to establish baseline water quality for surface water entering subproject area.	Two times: once at beginning of construction period, and once at beginning of wet season irrigation period.	CC to contract an organization to do sampling and testing.
Baseline groundwater quality: "Priority Parameters": pH, Turbidity, Arsenic, Iron, TDS, Pesticides, coliforms.	At least one household well located within each of the water user commune area scheme.	Once at beginning of wet season irrigation period.	CC to contract an organization to do sampling and testing.
Pre-Construction: Road Subproject			

Parameters	Location	Frequency	Responsibility
Traffic counts: Average daily traffic numbers	In selected village areas through which road passes and adjacent to any school.	Once before construction period	CC to contract an organization to do sampling and testing.
Dust and noise: Site inspection and visual appraisal.	In selected village areas through which road passes and adjacent to any school.	Once at beginning of wet season irrigation period.	CC to inspect
During Construction: Irrigation subproject			
Dust and noise: Site inspection and visual appraisal. Compare to baseline.	At all subproject sites	Monthly	CC to inspect
Surface water quality: Turbidity and petroleum products	Visual inspection of canal waters downstream of major construction sites.	Monthly	CC to inspect
Silt and canal excavation material: Organic matter, Zn, Cu, Pb, Hg, As, Cd, moisture content, phenols, mineral oil,	Canal silt cleared from rehabilitated canal. Three sampling locations - at start, midpoint and end of main canal.	Once at each location to check disposal/reuse safety.	CC to contract an organization to do sampling and testing.
During Construction: Road subproject			
Dust and noise: Site inspection and visual appraisal. Compare to baseline.	At all subproject sites	Monthly	CC to inspect
Surface water quality: Turbidity and petroleum products.	Visual inspection of canal waters downstream of major construction sites.	Monthly	CC to inspect
Construction waste: Storage and disposal. Site inspection and visual appraisal.	At all subproject sites	Once at each location to check disposal/reuse safety.	CC to inspect
Operation Phase: Irrigation subproject			
Surface water quality: pH, SS, EC, NH_4+, NO_3-, PO_4 $_3$-, DO, BOD5, COD, Oil & Grease, Coliform	Canal waters at midpoint of secondary canal.	Semi-annual until PCR	IA to contract an organization to do sampling and testing.

Parameters	Location	Frequency	Responsibility
Groundwater quality: "Priority Parameters": pH, Turbidity, Arsenic, Iron, TDS, Pesticides, coliforms.	Five household wells located within each of the water user commune areas of the irrigation scheme.	Semi-annual until PCR	IA to contract an organization to do sampling and testing.
Operation Phase: Road subproject			
Traffic counts: Average daily traffic numbers	In selected village areas through which road passes and adjacent to any school.	Annually until PCR	CC to inspect
Dust and noise: Site inspection and visual appraisal.	In selected village areas through which road passes and adjacent to any school.	Semi-annual until PCR	CC to inspect
Drainage structures and culverts: Check for proper operation – snags and siltation.	All culverts along road.	Annually, before wet season	CC to inspect

CC = commune council; IA = implementing agency; PCR = project completion report; TDS = total dissolved solids.
Source: PPTA team.

ENVIRONMENTAL CODE OF CONDUCT FOR CATEGORY C SUBPROJECTS

The matrix below summarizes the typical potential impacts of category "C" subprojects developed as part of the project. It also outlines corresponding mitigation measures designated to minimize those impacts. This code can be suitably adapted to particular subprojects and locations, it will be included in the bidding documents.

Potential Impacts and issues	Nature of Impacts	Significance[a]	Duration	Mitigation Measures and/or Safeguards	Costs	Who Implements	Who Supervises
Design and Pre-construction							
Subproject is impacted by future climate change.	Increased temperatures may lead to increased IWR affecting irrigated cropping plans. Increased rainfall in wet season and intensity of rainfall events might damage infrastructure through flooding.	D4	Long term	Final design of subproject(s) will incorporate all relevant recommendations of the CRVA appropriate to the type of subproject.	Design costs	CC and ESCC	IA and ADB
Irrigation extraction planning and command area management.	Proposed irrigation area needs to be matched with water availability so that (i) the water supply is sustainable; and (ii) taking water does not deny water to users downstream.	D4	Ongoing	Water allocations and drainage will be documented and approved by the CC, IA, and ADB before procurement and construction commences.	Design costs and supported by SSPs	CC and ESCC	IA and ADB
	Where new irrigation areas not previously farmed or long abandoned, regrowth shrubland or forest which provide habitat for local wildlife may have occurred.	D2	Ongoing	Key linked refuge vegetation, corridors and windbreaks should be reserved and retained by the extraction plan. Where natural regrowth vegetation is removed from a locality during construction, replacement planting will be undertaken.	Design costs	CC and ESCC	IA
Incorporate environmental management into contract documents.	The environmental measures in this code of conduct need to be given power so that they will be carried out.	D3	At tendering	Contract documents: Preparation of the environment section in the terms of reference for bidders for construction contracts, and environmental contract clauses for contractors comprising the special conditions for the protection of the water, soil, and air environments.	Design costs	CC and ESCC	IA
Construction							

Potential Impacts and issues	Nature of Impacts	Significance[a]	Duration	Mitigation Measures and/or Safeguards	Costs	Who Implements	Who Supervises
Site planning	To ensure that environmental matters are implemented properly at each construction site.	D3	Part of construction preparation	Prepare a construction site environmental management plan which incorporates the relevant provisions of this EMP for each subproject construction site. The plan will also include an emergency preparedness and response plan for construction emergencies, site environmental health and safety plan, identification of sensitive receptors, and vegetation to be retained.	Part of construction costs	Contractors	CC and ESO
Construction wastewater	Construction wastewater discharged into waterways or agricultural land can spread contamination and sediments.	D1	Short term	Construction wastewater will not be discharged directly onto the surrounding soil or into surface water systems All wastewater to be passed through silt traps or temporary sedimentation screens. Oil-containing wastewater will be intercepted, collected and transported to vehicle servicing area for treatment and disposal		Contractors	CC and ESO

Potential Impacts and issues	Nature of Impacts	Significance[a]	Duration	Mitigation Measures and/or Safeguards	Costs	Who Implements	Who Supervises
Polluting materials	Leakage or spills of fuels and lubricants can contaminate soil, surface water, and groundwater.	D3	Long term	To prevent pollution of soil and surface water/groundwater: (i) storage facilities for fuels, oil, cement, and chemicals will be within secured areas on impermeable surfaces, provided with bunds and cleanup installations; (ii) vehicle, machinery, and equipment maintenance and re-fueling will be carried out in such a way that spilled materials do not seep into the soil; (iii) oil traps will be provided for service areas and parking areas; (iv) fuel storage and refilling areas will be located at least 50 m from canals and channels and will be protected by temporary drainage bunds to contain spills.	Construction costs	Contractors	CC and ESO
Air quality	Concentration of machinery working in one area, plus haulage vehicle traffic, can result in local areas of poor air quality.	D1	Short term	Equipment will be maintained to a high standard to ensure efficient running and fuel-burning. High-horsepower equipment will be provided with tail gas purifiers. All vehicle emissions will be in compliance with relevant Cambodian emission standards.	Construction costs	Contractors	CC and ESO

Potential Impacts and issues	Nature of Impacts	Significance[a]	Duration	Mitigation Measures and/or Safeguards	Costs	Who Implements	Who Supervises
Dust	Dust caused by earthmoving and construction haulage traffic can cause poor air quality and nuisance to householders and farmers.	D3	Short term	Material stockpiles and concrete mixing equipment will be equipped with dust shrouds. For both construction sites and construction roads, water spraying for the suppression of dust and maintenance of driving surfaces will be standard site management practice. Vehicles carrying soil, sand, or other fine materials to and from the construction sites will be covered.	Construction costs	Contractors	CC and ESO
Noise impacts on sensitive receivers	Noise caused by the concentration of machinery working in one area, plus haulage vehicle traffic, can cause a range of impacts from nuisance to health problems. Noise near schools, medical centers, and temples can disrupt normal services.	D3	Short term	Construction at night within 300 m of residences shall be strictly prohibited. During daytime construction, the contractor will ensure that: (i) sites for concrete-mixing plants and similar activities will be located at least 500 m away from residences and schools; and (ii) temporary anti-noise barriers will be installed to shield sensitive receptors within 50 m of the construction site.	Construction costs	Contractors	CC and ESO
Demolition waste	Unauthorized or careless storage and disposal of waste can damage property, vegetation, agricultural land, and block natural drainage.	D1	Short term	Any waste from the demolition of structures will be either sold to building material recyclers or collected and transported to official landfill sites. Metal parts will be broken up and sold to scrap metal merchants. Any excess spoil will be made available to nearby communities for use as building pads and bunds.	Construction costs	Contractors	CC and ESO

Potential Impacts and issues	Nature of Impacts	Significance[a]	Duration	Mitigation Measures and/or Safeguards	Costs	Who Implements	Who Supervises
Excavated channel spoil	Field canals are the sink for runoff and drainage from paddy fields and the bottom sediment in canals may accumulate agricultural chemical residues. If reused in the structure of embankments this contamination will be exposed to farmers.	D3	Long term	The sediment quality of spoil from old channel clearing or deepening will need to be tested and assessed for contamination before reuse in levee banks or disposal. The sediment testing results will determine the requirements to ensure safe disposal or reuse.	Construction contingency costs (if disposal is required)	Contactor and CC	IA
Waste from workers	The construction workforce will generate domestic wastewater and garbage (food wastes, kitchen wastes, paper, and other solid waste including food-laden wash water). Proper disposal of this waste is essential.	D1	Short term	Contractors will provide sufficient garbage bins at strategic locations and ensure that they are (i) protected from birds and vermin; (ii) emptied regularly (using the nearest township licensed solid waste system and landfill); and (iii) are not left to overflow.	Construction costs	Contractors	ESO
Erosion impacts	Both canal and road construction will require earthworks which will leave erodible surfaces especially in heavy rain periods.	D2	Short term	Erosion control will include: (i) limiting construction and material handling during periods of rains and high winds; and (ii) stabilizing all cut slopes, embankments, and other erosion-prone working areas while works are going on. All earthwork disturbance areas shall be stabilized within 30 days after earthworks have ceased at the sites.	Construction costs	Contractors	CC and ESO
Flora and fauna	Vegetation along overgrown canals have local biodiversity and amenity value. Trees and vegetation along the road in villages produce fruit and other products, protect residences from sun and wind and adjacent agricultural land from dust and	D1	Medium term	Clearing of vegetation along canal embankments, levees and road verges will be minimized to assist in stabilization and retention of habitat values.	Construction costs	Contractor	CC and ESO

Potential Impacts and issues	Nature of Impacts	Significance[a]	Duration	Mitigation Measures and/or Safeguards	Costs	Who Implements	Who Supervises
	run-off.			Trees marked for retention will be protected and any removed native trees will be replaced.			
Impacts to local cultural sites	Although areas with significant physical cultural resources are excluded by the selection criteria, there may still be sites or item which are important at a local or household level.	D2	Short term	Contractors will ensure that all local cultural sites (including small shrines and graves) will be kept clear of construction material and protected from dust and other disturbance. Access to these sites will not be impeded. After construction is finished any disturbed surroundings will be restored to pre-construction standards.	Construction contingency costs	Contractors	CC and ESO
Community health and safety	Construction work poses safety hazards and threats to livelihood to both village communities and farmers. Excavations, unstable slopes, loss of access and movements of large machinery and vehicles all potentially impact on community safety and day-to-day life.	D2	Short term	Community health and safety will be safeguarded by: Planning construction activities so as to minimize disturbances to residents, utilities and services. Temporary land occupation will be planned well ahead of construction to minimize its impact and after consultation with the affected community. Land will be reinstated to its original condition after construction. Implementing safety measures around the construction sites to protect the public, including warning signs to alert the public to potential safety hazards, barriers to prevent public access to construction sites and a watch person, where necessary.	Construction costs	Contractors	CC and ESO

Potential Impacts and issues	Nature of Impacts	Significance[a]	Duration	Mitigation Measures and/or Safeguards	Costs	Who Implements	Who Supervises
Occupational health and safety	Workers are subject to safety hazards while operating and/or moving around machinery, as well as dust and noise impacts from extended exposures at the work site.	D2	Short term	Measures to ensure occupational health and safety will include: (i) contractors shall be required by the CC to ensure that their workers and other staff engaged in the proposed constructions are in a safe environment; and (ii) following the award of construction contracts, the successful contractors will prepare site environmental health and safety plan, for approval by the CC and PST. Contractors shall ensure that: (i) all reasonable steps are taken to protect any person on the site from health and safety risks; (ii) the construction site is a safe and healthy workplace; (iii) machineries and equipment are safe; (iv) adequate training or instruction for occupational health and safety is provided; (v) adequate supervision of safe work systems is implemented; and (vi) means of access to and egress from the site are without risk to health and safety.	Construction costs	Contractors	ESO
Operation							
Implementation of extraction and drainage plans	The water extraction and distribution plan for irrigation needs to be strictly implemented, monitored, and controlled.	D3	Long term	Irrigation schemes to be operated strictly in concurrence with agreed extraction and irrigation plans which ensure sustainability of supply.	Operations cost and capacity building outputs supported by SSPs	IA and CCs	IA and ESCC

Potential Impacts and issues	Nature of Impacts	Significance[a]	Duration	Mitigation Measures and/or Safeguards	Costs	Who Implements	Who Supervises
Canal fisheries	Where fisheries in primary and secondary canals supplement poor farmers food or income, these need to be retained and protected in any canal rehabilitation works.	D1	Medium term	Informal canal fisheries rights safeguarded for local farmers	Costs under project capacity building output and supported by SSPs	CCs	IA
Pesticide use	Excessive nitrogen and phosphorus can contribute to eutrophication in water and risk of oxygen depletion in waterbodies. Excessive nitrogen as ammonia can lead to gradual acidification of soils. Organochlorines, organophosphates, pyrethroids and carbamates (the common pesticide types used) can lead to direct poisoning of farmers through misuse and unsafe handling. Organochlorines and organophosphates can enter the food chain and groundwater resources.	D3	Long term	Farmers will be trained in IPM to reduce chemical use. Training will include safe handling, application and disposal of pesticides.	Costs under project capacity building output and supported by SSPs	SSP and ESO	IA and ESCC
Increased road safety hazards	With improvement in alignment and surfacing of village roads, higher vehicle speeds may be expected, with consequently increased risk of accidents with pedestrians and other vehicles.	D3	Long term	Implement community road safety awareness training and traffic-calming resources.	Costs under project capacity building output and supported by SSPs	IA and Communes	IA and ESCC

Potential Impacts and issues	Nature of Impacts	Significance[a]	Duration	Mitigation Measures and/or Safeguards	Costs	Who Implements	Who Supervises
Road maintenance	Strict maintenance of the road will be required to ensure that the road subproject's benefits will not be negated. In particular, the road's surfacing, which promotes noise and pollution reductions, and flood resilience structures need to be regularly monitored and managed	D2	Medium term	Surfacing - Regularly inspect surface and fill potholes and ruts early before they enlarge. Commune to have a stockpile of suitable gravel and fill material and sections of the road should be under the care and supervision of adjacent landholders or user groups. Embankments and side batters of road across flood-liable land need to be checked regularly for stability and cracks. Embankments should be well vegetated to increase stability. All culverts and pipes must be regularly cleared to allow free passage of water. Any debris and silt must be totally removed from site to ensure it is not back into drainage structures by the next runoff event.	An O&M fund established under the project will assist with subproject maintenance costs (up to 10% of the subproject cost) during the life of the project.	IA and Communes	IA and ESCC
Floods and extreme weather events	Floods and extreme weather events are prevalent in the rural districts of Cambodia, and will affect subproject areas.	D4	Long term	The project will promote the enhancement of community based DRR and disaster management programs at the irrigation and drainage communes with particular reference to flooding and other natural disasters.	Directly funded under project output and supported by SSPs	Project output	ADB

ADB = Asian Development Bank; CC = commune council; CRVA = climate risk and vulnerability assessment; EMP = environmental management plan; ESCC = Environmental Safeguards and Climate Change Specialist (of PIC); ESO = environmental safeguards officer; IA = implementing agency; IPM = Integrated Pest Management; IWR = irrigation water requirement; m = meter; O&M = operation and maintenance; PST = provincial support team; SSP = special service provider.

[a] There is a range of numbers used ranging from: D1 = little significance to D4 = significant impact.

Source: PPTA team.

TERMS OF REFERENCE FOR ENVIRONMENTAL SAFEGUARDS AND CLIMATE CHANGE SPECIALISTS – IN THE DESIGN AND SUPERVISION TEAM (DSC ESSC)

International Environmental Safeguards and Climate Change Specialist

The International Environmental Safeguards/Climate Change Specialist will have a Bachelor degree or higher in environmental science, environmental management, or a related field, from a recognized institution. He/she will have at least 10 years' experience in environmental safeguards, environmental management, climate change adaptation and/or disaster risk management including experience of roads and irrigation. He/she must be familiar with ADB's Safeguard Policy Statement (SPS) 2009 including environmental safeguards procedures and policies related to the environment. He/she will be fully conversant with the protected and sensitive areas of the country, and will be knowledgeable of the environmental laws of Cambodia and their practical application. Knowledge of the use of remote sensing and of the use of digital imagery for environmental planning, climate resilience planning and disaster risk reduction (DRR) and disaster risk management is important. He/she must have good computer skills, be a good administrator, be able to analyze data and write well-structured reports. Familiarity with programs such as the National Adaptation Programmes of Action (NAPA), Pilot Program for Climate Resilience (PPCR) or Cambodia Climate Change Alliance (CCCA) would be an advantage.

The International Environmental Safeguards/Climate Change Specialist will be responsible for preparing all safeguard classifications, assessment and monitoring reports for infrastructure subprojects, and supervising and monitoring implementation of the environmental assessment and review framework (EARF), initial environment examination (IEE) and environmental management plans (EMPs). Further, he/she will be working in close cooperation with both design and supervision (DSC) and project implementation consultant (PIC) teams for overall monitoring of compliance with ADB environmental safeguards requirements for all project activities that may have environmental impacts, including both hard infrastructure subprojects and other activities. Frequent travel to the target communes will be required. He/she will report to the DSC Team Leader. Main tasks will include:

Subproject preparation:

- For each candidate subproject, implement the requirements of the project EARF and the ADB SPS (2009) to: (i) screen out subproject proposals which do not meet the selection criteria; (ii) categorize the subproject for the level of environmental assessment required; (iii) prepare an IEE/EMP or Environmental Code of conduct for the subproject according to the categorization.
- For subprojects which are Category B for environment, prepare an EMP based on the initial environmental examination for a subproject, or a number of subprojects of the same type or located in the same geographical area, and ensure that:
  - environmental design measures specified in the EMP are incorporated in the detailed design; and
  - the EMP is included in the bid and contract documents for the infrastructure subprojects;
- For subprojects which are Category C for environment, provide an Environmental Code of Conduct and ensure that:
  - Environmental requirements listed in the Environmental Code of Conduct are incorporated into subproject design; and
  - The Environmental Code of Conduct requirements are included in the construction bid and contract documents.
- Ensure integration of the environmental safeguards into planning and

implementation of infrastructure subprojects;

- For each candidate subproject, implement the requirements of the climate and disaster risk assessment (CDRA), appropriate to the subproject type and location, to include adaptation and operating measures into subproject planning and design.
- Advise DSC staff and provincial support teams on the implementation of the government climate change policies and procedures relevant to infrastructure subprojects;
- Develop check lists for climate change impacts applicable to rural infrastructure and assist the DSC Engineers in the identification of suitable climate resilience/DRR measures for infrastructure subprojects.

Subproject implementation:

- Supervise and monitor construction to ensure timely and correct implementation of the IEE, EMP and Environmental Code of Conduct requirements.
- For environment Category B subprojects and interventions, assist in the delivery of training in EMP and çonstruction environmental management plan preparation and implementation to commune councils and contractors.
- Support the implementing agencies, National Safeguards Officer and commune councils to fulfill their environmental responsibilities in implementing the subproject EMPs or Environmental Code of Conduct.
- Support the implementing agencies, National Safeguards Officer and commune councils to fulfill their environmental responsibilities on consultations, local safeguards documentation disclosure, and updated IEEs and EMPs and monitoring report information in accordance with the EARF and in compliance with the SPS 2009.
- Support the implementing agencies, National Safeguards Officer and commune councils in undertaking environmental monitoring of subproject construction and initial operation.
- Assist the implementing agencies and commune councils to establish and publicize the grievance redress mechanism (GRM) for subprojects, ensuring that the GRM publicity is appropriate to the scale and complexity of the subproject and includes, as a minimum, the disclosure of all contact persons for lodging complaints.
- Collaborate with the environmental safeguards and climate change specialist within the PIC team, and assist the implementing agencies to prepare the summary on implementation of environmental safeguards measures in the quarterly project progress reports and prepare the semi-annual environmental monitoring reports.

Specific Outputs

- Classification for each subproject
- An IEE, an EMP or Environmental Code of Conduct based on the environmental assessment categorization for each subproject, or a number of subprojects of the same type or located in the same geographical area.
- Environmental safeguards documents disclosed with translation of the executive summary in Khmer.
- Recommendations on climate and disaster risk and resilience measures to be taken account in subproject design.

- Inputs to quarterly project progress reports.
- Semi-annual environmental monitoring reports.

National Environmental Safeguards and Climate Change Specialist (National)

The National Environmental Safeguards/Climate Change Specialist will have a Bachelor degree or higher in environmental science, environmental management, or a related field, from a recognized institution. He/she will have at least 7 years' experience in environmental safeguards, environmental management, climate change adaptation and/or disaster risk management including experience of roads and irrigation. He/she must be familiar with ADB's Safeguard Policy Statement 2009 including environmental safeguards procedures and policies related to the environment. He/she will be fully conversant with the protected and sensitive areas of the country, and will be knowledgeable of the environmental laws of Cambodia and their practical application. Knowledge of the use of remote sensing and of the use of digital imagery for environmental planning, climate resilience planning and DRR and DRM is important. He/she must have good computer skills, be a good administrator, be able to analyze data and write well-structured reports. Familiarity with programs such as the National Adaptation Programmes of Action (NAPA), Pilot Program for Climate Resilience (PPCR) or Cambodia Climate Change Alliance (CCCA) would be an advantage.

The National Environmental Safeguards/Climate Change Specialist will report to the design and supervision (DSC) International Environmental Safeguards/Climate Change Specialist, and will assist him/her with all tasks and outputs defined in the International Environmental Safeguards and Climate Change Specialist's terms of reference.

TERMS OF REFERENCE FOR NATIONAL ENVIRONMENTAL SAFEGUARDS OFFICER (ESO)

The officer will work on behalf of National Committee for Sub-National Democratic Development (NCDDS) and coordinate with the commune councils and provincial support teams to ensure that environmental safeguards are implemented in the subprojects. The officer will report directly to the NCDDS Project Director and Project Manager. The position is full time and its duration is for at least the first three years of the project. In coordination with subnational government counterparts and working closely with the international and national Environmental Safeguards and Climate Change Specialists of the project implementation consultants (PIC) and the Environmental Safeguards/Climate Change Specialist of the Infrastructure Design and Supervision consultant team, the officer will:

- Assist the commune councils to implement the environmental management plan (EMP) or Environmental Code of Conduct measures for each subproject.
- Provide training to commune councils and contractors as necessary to facilitate implementation of the EMP or Environmental Code of Conduct.
- Assist commune councils in their monitoring responsibilities under the EMP.
- Working with the implementing agency's complaint unit, implement the project grievance redress mechanism (GRM), including: (i) instruct the commune councils and other local agencies on their responsibilities in the GRM; (ii) establish a simple registry system, to document and track grievances received (including forms to record complaints and how they have been resolved); and (iii) prepare reports on progress of the GRM for inclusion in the semi-annual environmental monitoring and quarterly project progress reports to ADB.
- Assist the Environmental Safeguards/Climate Change Specialist within the Infrastructure Design and Supervision consultant team to develop check lists for climate change impacts which can be applied for both rural infrastructure and livelihood supported activities and develop guidelines on how the commune councils and livelihood improvement group, market improvement group, and paddy selling group members can best respond to increasing climatic variability and the prospects of adverse changes during the design processes.
- Support consultations and assist on local safeguards documentation disclosure, and assist in updating the initial environmental examinations and EMPs and monitoring report information in accordance with the environmental assessment resettlement framework and in compliance with the ADB SPS 2009.
- Assist in the preparation of materials for the training of commune councilors, commune mobile access workers, provincial support team, district support team members, as well as trainers at provincial level, in the use of these tools, to enable them to deliver further training at commune level.
- Assist the National Committee for Disaster Management Secretariat to include climate resilience training at the commune level in the national disaster risk reduction program.
- Ensure that the environmental awareness and capacity building of the project adequately covers the requirements for environmental safeguarding.
- Provide the Project Director and Project Manager with progress reports which cover environmental performance of all parties, training progress, issues outstanding and further actions recommended.
- Undertake other tasks as requested by the NCDDS Project Director and Project Manager.

The National Safeguards Officer will have the following qualifications and experience:

- An undergraduate degree or higher in environmental management or related field;
- At least 5 years of experience in environmental management, monitoring, and/or impact assessment;
- Ability to communicate and work effectively with local communities, contractors, and government agencies;
- An understanding of the relevant laws and regulations and ADB requirements for environmental safeguards of projects;
- Ability to analyze data and prepare technical reports;
- At least 3 years of field experience in irrigation and roads;
- Willingness to regularly visit the subproject sites; and
- Ideally, proficiency in spoken and written English.

TERMS OF REFERENCE FOR ENVIRONMENTAL SAFEGUARDS/CLIMATE CHANGE SPECIALIST – IN PIC TEAM (PIC ESCC)

Environmental Safeguards/Climate Change Specialist (National, 8 p-m)

The consultant will work closely with the implementing agencies, other project implementation consultant (PIC) members, the National Safeguards Officer based at the National Committee for Sub-National Democratic Development (NCDDS), the Environmental Safeguards and Climate Change Specialists (ESCC) within the infrastructure design and supervision consultant team and other relevant personnel and agencies. He/she will be responsible for overall monitoring of compliance with ADB environmental safeguards requirements for all project non-infrastructure activities. The specialist will:

- Prepare the due diligence reports on non-infrastructure activities proposed in the annual workplans, and confirm anticipated environmental impacts and specific mitigation measures during implementation.
- Monitor the compliance of all parties with the requirements due diligence reports.
- The PIC ESCC will supervise the proper implementation of all environmental management plan (EMP) requirements. For this, the PIC ESCC will develop a checklist or other format for ranking the environmental performance on a case-by-case basis and include the results in the EMP compliance monitoring report.
- Provide inputs on non-infrastructure activities for quarterly project progress reports and semi-annual environmental monitoring reports.
- Provide other inputs as reasonably requested by the PIC team leader and the DSC international environmental safeguards and climate change specialist.

Minimum qualifications: (i) an undergraduate degree or higher in environmental management or related field; (ii) at least 7 years of experience in environmental management, monitoring, impact assessment and environmental safeguards implementation; (iii) familiarity with ADB environmental safeguards requirements and national environmental management procedures; (iv) ability to communicate and work effectively with local communities, contractors, and government agencies; (v) ability to analyze data and prepare technical reports; (vi) willingness to regularly visit the subproject sites; (vii) proficiency in spoken and written English; and (viii) a proven track record as an environmental safeguards specialist in at least three rural development projects funded by bilateral or multilateral donors in Cambodia.

CLIMATE RISK AND VULNERABILITY ASSESSMENT

I. OVERVIEW

A. Background

1. This report is prepared as part of Asian Development Bank (ADB) project preparatory technical assistance (PPTA) TA-9167 CAM, for additional financing (AF) to the Tonle Sap Poverty Reduction and Smallholder Development Project (TSSD). The TSSD project, which is coming to end of its implementation phase, focused on (i) commune development; (ii) enabling policy environment improvement; and (iii) project management. The small infrastructure interventions of TSSD (less than $20,000 per intervention) mainly involved the rehabilitation or construction of commune market centers, rehabilitation and upgrading of feeder roads and drainage structures, rehabilitation and upgrading of small embankments, reservoirs and canals. The AF project will carry on the infrastructure development in irrigation and roads, but an equal focus will be on capacity building at the local level and climate change adaptation strategies and disaster risk reduction (DRR) and disaster risk management at the commune level.

2. ADB requires the assessment of climate risks for all projects. It has issued guidelines for climate proofing projects and the appropriate guidelines used for TSSD-AF are *Guidelines for Climate Proofing Investments in Agriculture, Rural Development and Food Security (2012)* and *Guidelines for Climate Proofing Investments in the Transport Sector: Road Infrastructure Projects (2011)*. The assessment of climate risks is initiated in the rapid environmental assessment (REA) undertaken by ADB during project identification. This included a *Checklist for Preliminary Climate Risk S*creening for irrigation projects (Attachment 1) which assigned a medium climate risk rating.

3. Climate risk and adaptation considerations have been incorporated into the project's environmental safeguards documents (initial environmental examination and environmental management plan) recommendations for detailed design and are based upon the findings of this climate risk and vulnerability assessment (CRVA).

B. Project Components

4. TSSD-AF will modify the ongoing project scope by strengthening activities in the existing 196 communes of the TSSD project and scale up the current project activities in an additional 75 communes. With the additional financing, the overall project impact will be improved livelihoods in target communes in seven provinces in the Tonle Sap Basin. Banteay Meanchey, Kampong Cham, Kampong Thom, Siem Reap, and Tboung Khmum provinces are in the current project. These five provinces, plus Battambang and Prey Veng are proposed to be included in the AF project.

5. The impact of the overall project, which is aligned with the Cambodia Country Partnership Strategy 2014-2018, ADB's Assessment, Strategy and Roadmap for the Agriculture, Natural Resources and Rural Development Sector, and the Government Rectangular Strategy for Growth, Employment, Equity, and Efficiency Phase III, will be: improved livelihoods and resilience in target communes in seven provinces (Banteay Meanchey, Battambang, Kampong Cham, Kampong Thom, Prey Veng, Siem Reap, and Tboung Khmum) in the Tonle Sap Basin by 2023. The outcome of the overall project will be: agricultural productivity increased, climate resilience strengthened and access to markets improved in 37 districts in seven provinces in the Tonle Sap Basin. This will include improved rural infrastructure, improved agricultural support and rural financial services, increasing diversification of household economic activities, and the creation of on- and off-farm livelihood opportunities.

6. The project will focus on assisting communities establish livelihood improvement

strategies for resource-poor farming households with assets that give them the potential to increase their farm based income. Outcomes will be measured on the basis of (i) average rice yields increasing to more than 3.50 t/ha; (ii) average rice yields of identified poor households in target communes increased to minimum 3 t/ha for wet season rice production; (iii) diversified farming systems reduce share of household income from rice by 20%; (iv) marketed farm and off-farm products increased by 25%; and (v) awareness of climate smart agriculture and DRR planning increased.

7. The project has three major Outputs:

Output 1: Rural productive infrastructure and livelihood improved with capacity in disaster risk management enhanced.

- Rural roads, small scale irrigation, and other production related infrastructure;
- Support to new and old LIGs; and
- Capacity building in disaster risk management.

Output 2: Enabling environment for increased agricultural productivity, diversification and climate resilience created

- Value chain and agribusiness support;
- Support to market improvement groups; and
- ICT/Mobile Commune Access (MCA) program.

Output 3: Project management strengthened.

8. The output with most relevance to the CRVA is Output 1, since it includes civil works for the construction of irrigation and rural road infrastructure which must be adapted to future climate change. The capacity building outputs of Output 2 (and part of Output 1) support the sustainability of investment in irrigation and roads. Two areas of capacity building will support the recommendations of the CRVA in particular: these are the support for climate smart agriculture and disaster risk reduction.

9. Climate smart agriculture capacity building will introduce a national climate smart agricultural curriculum, work with farmers to train them in the curriculum with rice and other diversified production elements, and trialling four new climate resilient rice varieties on selected plots and brokering supply contracts where trials are successful.

10. The National Committee for Disaster Management (NCDM), established in 1995, is the country's main disaster management agency for facilitating inter-ministerial responses to emergency and disaster events. A commune level training and planning program has been developed and TSSD-AF will support the NCDM Secretariat (NCDMS) to scale this program up into all 271 TSSD-AF target communes. The training and planning process will gradually support the commune councils in identifying and planning DRR infrastructure improvement, supporting improved DRR at commune level.

C. Scope of the CRVA

11. The adaptation measures appropriate to the subprojects are derived from the six step process described in the ADB Guidelines for Climate Proofing Investment (in agriculture and roads). The six steps are:

(i) Project risk screening and scoping;
(ii) Impact assessment;
(iii) Vulnerability assessment;
(iv) Adaptation assessment;

(v) Implementation arrangements; and
(vi) Monitoring and evaluation.

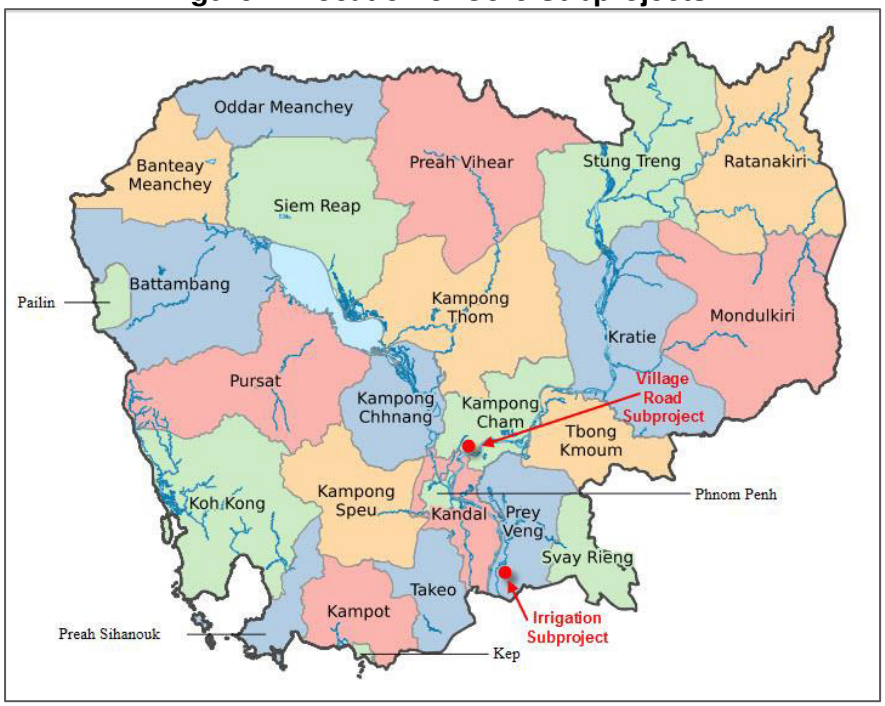
12. A long list of candidate subprojects for infrastructure construction or rehabilitation under Output 1 was developed during the course of the PPTA. These are located in 19 Districts and 130 communes in Banteay Meanchey, Battambang, Kampong Cham, Kampong Thom, Prey Veng Siem Reap, and Tboung Khmum provinces selection criteria were developed for identifying the preferred ones. These criteria identified the first two subprojects to be funded (called "core" subprojects). These are the **Lvea Commune irrigation rehabilitation** in Prey Veng Province and the **Banthaey to Chbar Ampov village road rehabilitation** in Kampong Cham Province.

13. This CRVA addresses the climate risk and vulnerability of the two core subprojects in detail because the exact locations, specifications and environmental context of them are known. The climate change adaptation measures identified in the CRVA for these two subprojects are also specific to the local situation. Climate risk and vulnerability is also considered for the other provinces for which a long list of candidate infrastructure subprojects has been identified. For these, a combination of methodological guidelines for identifying adaptation measures and reference to measures developed for the core subprojects which might have wider application, is provided. The environmental review and assessment framework, which will guide the environmental due diligence of future subprojects for funding, references the recommendations of this CRVA as a necessary part of environmental due diligence.

1. Core subprojects

14. The specifications of the proposed core subprojects comprise works to improve selected secondary canals of an irrigation command area in Lvea commune and to rehabilitate and provide enhanced flood resilience of a small road running between villages in Banthaey and Chbar Ampov communes Figure 1).

Figure 1: Location of Core Subprojects



Source: NIRVn - Map created using QGIS, CC BY-SA 3.0, https://en.wikipedia.org/w/index.php?curid=43121523.

a. Irrigation Rehabilitation in Lvea Commune

15. Irrigated agriculture in Prey Veng province is wet season rice-based. If sufficient irrigation water is available a second crop of rice is sown. At the subproject site in Lvea commune, poor design, silting up and sometimes blockage of secondary canals constrains irrigation penetration into large areas and during dry season, many lands are observed to be fallow. In general, lands are quite level.

16. Under this subproject it is proposed to rehabilitate three secondary canals with a total length of 4 km. Water will come from primary and secondary canals supplied by Pumping Station No. 2 on the Traebek River. These are:

Secondary canal 1: a 1 km canal north of Highway 1 in Thnaot village, flowing south from a secondary canal: adding a command area of 57 ha for a dry season crop.

Secondary canal 2: a 3 km long canal south of Highway 1, starting at an intake gate on main canal (no. 10) and flowing eastward through Boeung Snao and Takork villages and finishing at a ruined Pol Pot era gate: adding 179 ha for a dry season crop.

Secondary canal 3: a 1 km long canal south of Highway 1, starting at an intake gate on main canal (no. 10) and flowing westward: adding 69 ha for a dry season crop.

17. Expected increases in dry season cropping areas from the rehabilitation of these three secondary canals is 305 ha:

(i) 57 ha at Thnaot Village
(ii) 179 ha at Boeung Snao and Takork Villages
(iii) 71 ha at the western extension of the Boeung Snao and Takork canal

b. Village Road Rehabilitation in Bathaey-Chbar Ampov Communes

18. Under this subproject it is proposed to rehabilitate a 7.6 km long rural road which starts at Highway 6 in Batheay Commune and finishes in Chbar Ampov village, Chbar Ampov Commune. The road will be rehabilitated in four sections. The first priority will be the section across the floodway, spanning the border between Banthaey and Chbar Ampov communes. The remaining sections will be implemented as separate future subprojects and in an order and schedule yet to be finalized.

19. The major constraint which is considered during subproject design is that every year up to 3.5 km of the road floods to a depth of about 0.5 m and twice in the last 20 years sections of the road have flooded to a depth of 2 m.

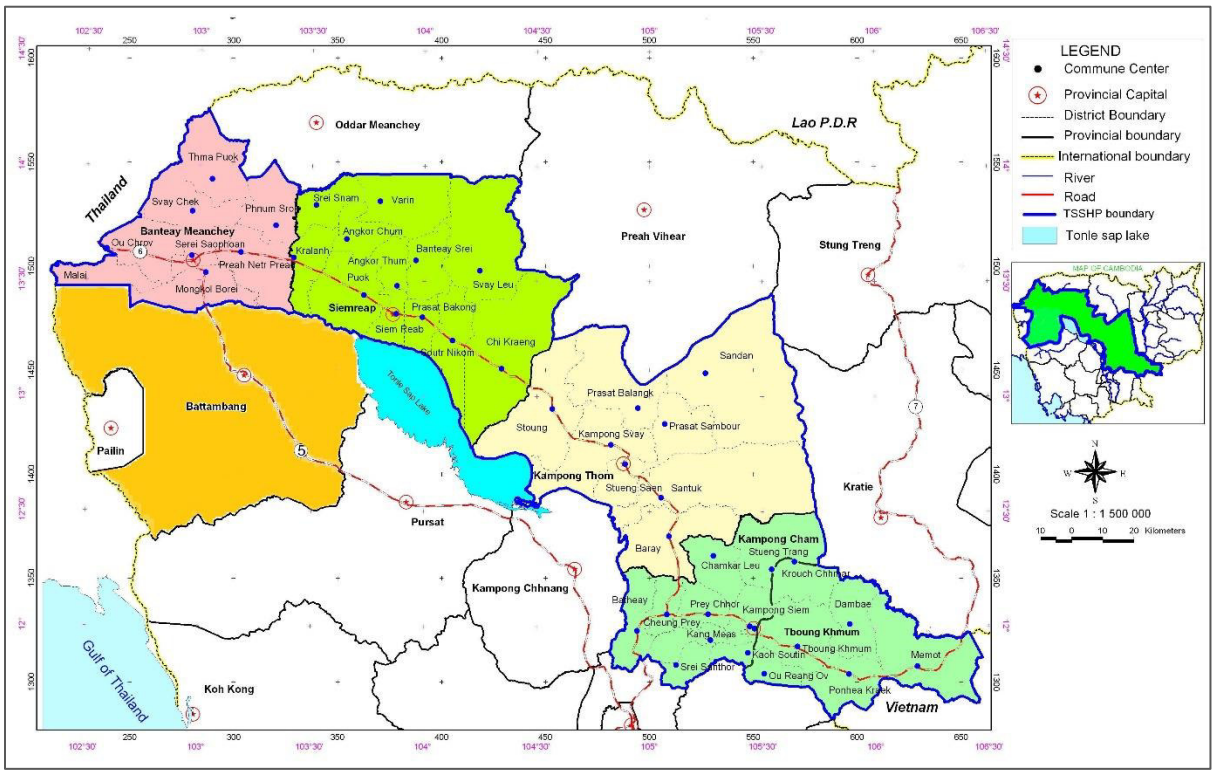
20. Design of the road and structures will conform to the NCDD's Project Implementation Manual (2009), Volume II: Specification for Construction Materials and Works and any other relevant guidelines and specifications.

2. Long List of Future Subprojects

21. The long list of candidate subprojects includes infrastructure development in seven provinces including 19 Districts and 130 communes. It is probable that this list will expand during the course of project implementation.

Figure 2: Provinces with Long List Candidate Subprojects to be considered during

Project Implementation



Source: TSSD IEE 2009 adapted by TSSD-AF PPTA team.

22. The range of candidate subprojects collated to date comprises the following infrastructure developments:

- Concrete road construction (RC)
- Bituminous road construction (SBST)
- Laterite road construction/Rehabilitation (L)
- Earth road construction/Rehabilitation (E)
- Canal construction/Rehabilitation (C)
- Earth dam/Dike construction/Rehabilitation (D)
- Bridge construction (B)
- Pond construction/Rehabilitation (P)
- Concrete structure (Irrigation) (S)

II. CLIMATE RISK SCREENING

23. **Project risk screening and scoping.** During project identification, the REA *Checklist for Preliminary Climate Risk S*creening for irrigation projects (Attachment 1) was completed to assign a climate risk rating.

24. The screening identified **flood risk** as the key risk area affecting siting/design, maintenance and performance of infrastructure. Floods were identified as a danger to infrastructure and the importance of taking account of hydrometerological parameters in the design to ensure flood resilience was emphasised.

25. The screening checklist summarized the potential climate risks as follows:

Screening Questions		Score	Remarks
Location and design of project	Is siting and/or routing of the project (or its components) likely to be affected by climate conditions including extreme weather related events such as floods, droughts, storms, landslides?	1	Infrastructure will be strengthened to withstand anticipated floods.
	Would the project design (e.g., the clearance for bridges) need to consider any hydro-meteorological parameters (e.g., sea-level, peak river flow, reliable water level, peak wind speed etc.)?	1	Hydro-meteorological parameters essential for design.
Materials and maintenance	Would weather, current and likely future climate conditions (e.g., prevailing humidity level, temperature contrast between hot summer days and cold winter days, exposure to wind and humidity hydro-meteorological parameters likely affect the selection of project inputs over the life of project outputs (e.g., construction material)?	0	Irrigation infrastructure Improvements based on technical best practices and not affected. Material selection will suit current climate variability.
	Would weather, current and likely future climate conditions, and related extreme events likely affect the maintenance (scheduling and cost) of project output(s)?	1	Floods may affect infrastructure maintenance if not designed to withstand those.
Performance of project outputs	Would weather/climate conditions, and related extreme events likely affect the performance (e.g. annual power production) of project output(s) (e.g., hydro-power generation facilities) throughout their design life time?	0	The project provides water during the dry season for additional cropping.

26. The overall score for potential climate risk was three (with no individual score of two) and was assigned a medium risk category.

27. Initial screening of subprojects against the selection criteria by the PPTA team emphasized the sustainability of irrigation schemes and in particular, the adequacy of available water without causing water use conflicts. Drought due to climate change was therefore identified as an additional climate risk.

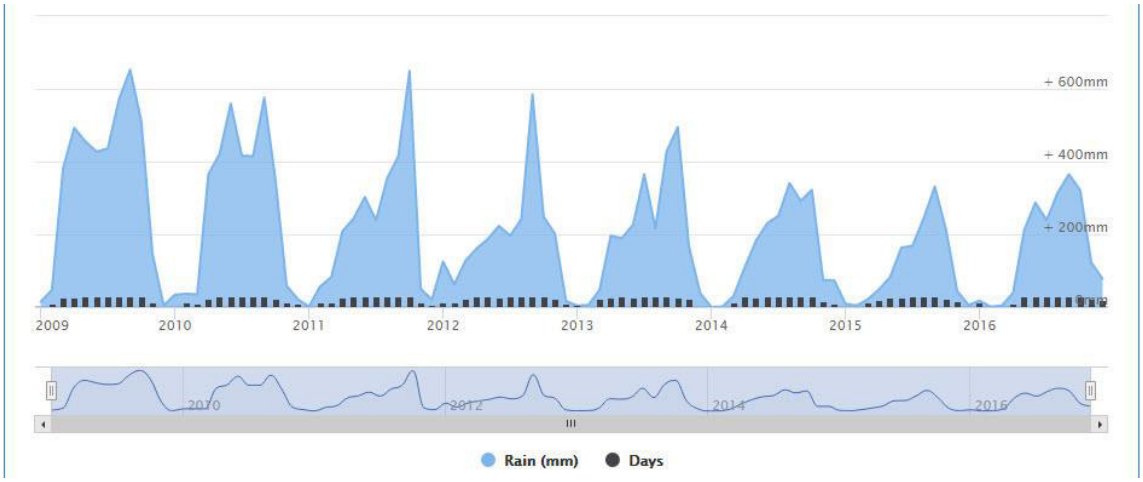
A. Current Climatic and Hydrological Trends

1. Core Subprojects

28. The climates of Prey Veng and Kampong Cham provinces are characterized by distinct rainy and dry seasons. The southwest monsoon starts early in April/May and lasts till October, while from November to March the dry northeast weather patterns predominate.

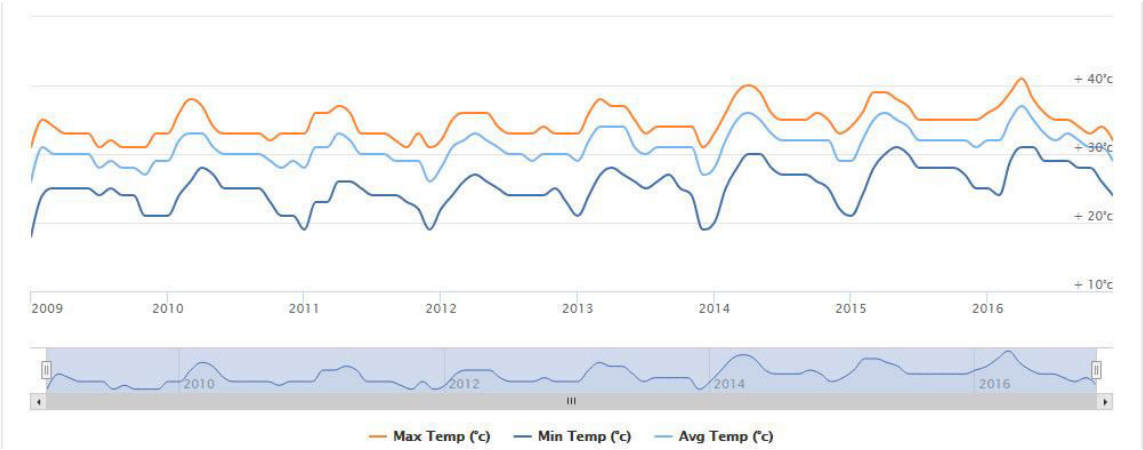
For Prey Veng, the average annual rainfall ranges from 1300 mm to 1400 mm, with peak rainfall occurring in September-October and the lowest rainfall in January. Temperature is lowest in December-January with an average minimum temperature of 23°C and the highest in April with an average maximum of 36°C. The wind direction during the rainy season is prevalent from south-west to north-east and from the south-west during the dry season.

Figure 3: 8-Year Rainfall Data for Prey Veng



Source: https://en.climate-data.org

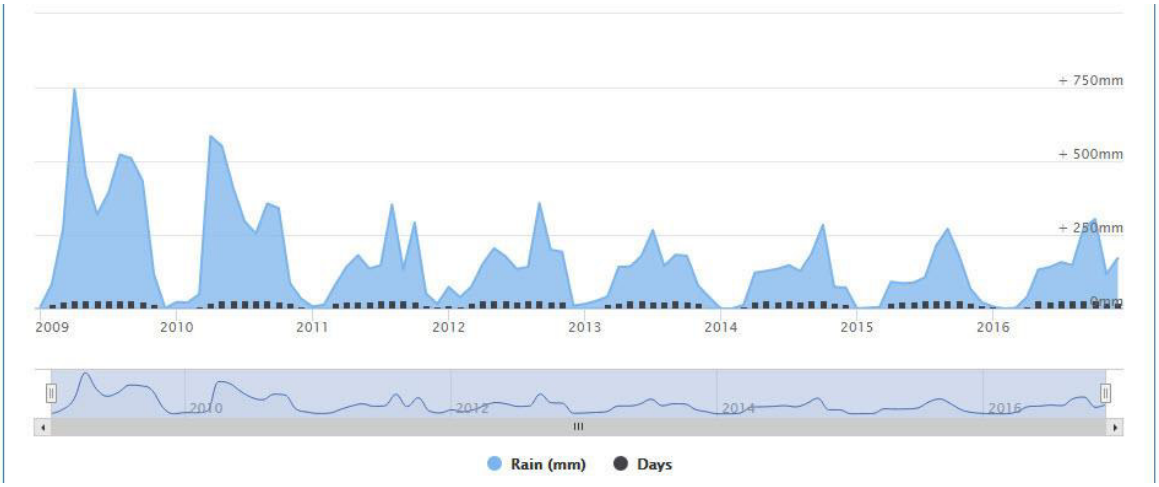
Figure 4: 8-Year Temperature Data for Prey Veng



Source: https://en.climate-data.org

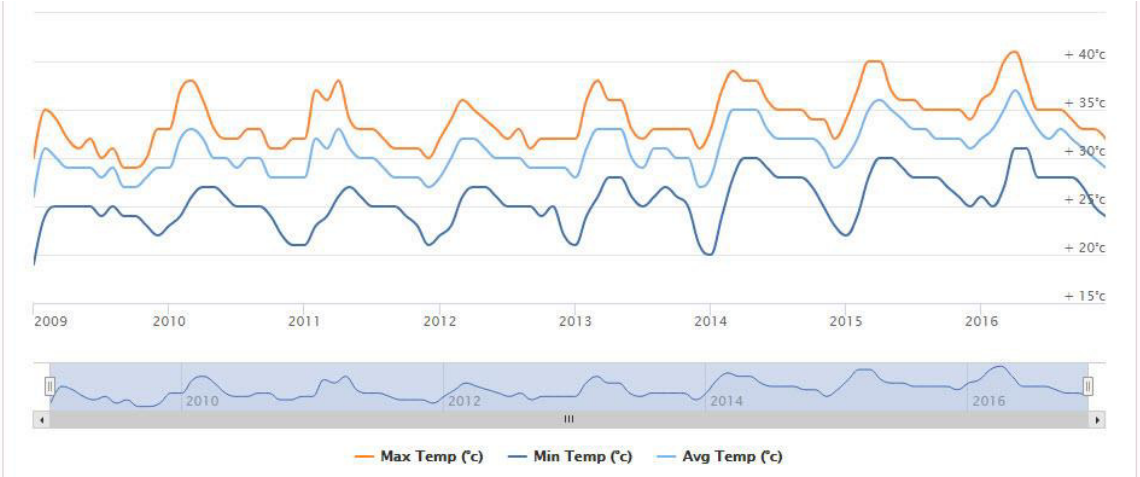
29. For Kampong Cham, the rainfall is lower, with average annual falls of 1200 mm to 1300 mm, with peak rainfall occurring in September/October and the lowest rainfall in February. Temperature and wind patterns are similar to those of Prey Veng.

Figure 5: 8-Year Rainfall Data for Kampong Cham (https://en.climate-data.org)



Source: https://en.climate-data.org

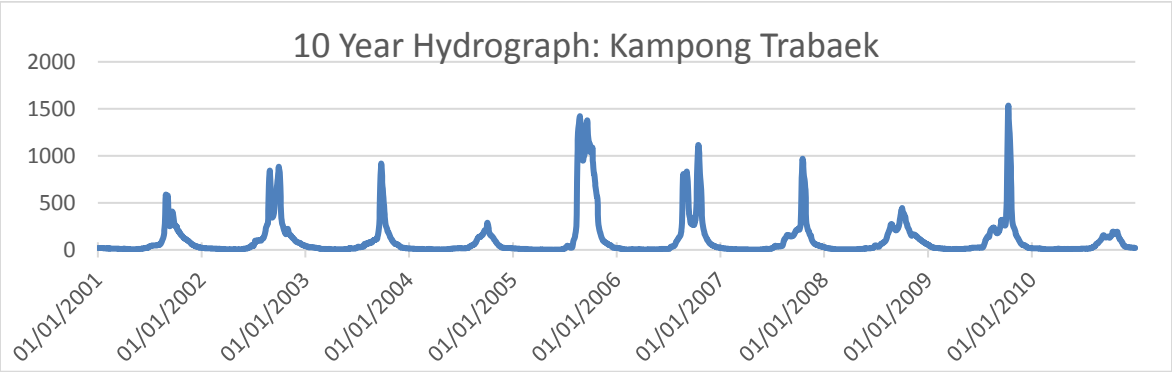
Figure 6: 8-Year Temperature Data for Kampong Cham



Source: https://en.climate-data.org

30. Total flows of the Trabaek River, which provides water for the irrigation subproject in Prey Veng are taken from a 10-year hydrographic data (2001-2010) recorded near the mouth of the Trabaek with the Mekong River (Figure 7). The Trabaek is a distributary of the Mekong, with water flowing “upstream”, away from the Mekong. From this data flows were calculated for a wet year (2005), dry year (2010) and an average year (2001). These are presented in Table 1. Low seasonal river flows are apparent in all years in March-April-May.

Figure 7: Trabaek River Flows 2001 – 2010 (vertical units are m^3/s)



Source: Hydrographic data provided by MOWRAM.

Table 1: Wet, Dry and Average Year Flows in the Trabaek River

	Wet Year 2005		Dry Year 2004		Average Year 2001	
Month	**Ave Flow (m^3/sec)**	**MCM**	**Ave Flow (m^3/sec)**	**MCM**	**Ave Flow (m^3/sec)**	**MCM**
Jan	13.39096774	35.86637	12.05938	32.020704	18.56419355	48.40992
Feb	8.315	20.11565	7.991034	20.022336	13.91785714	34.982496
Mar	4.64516129	12.4416	6.400968	17.144352	10.92967742	29.274048
Apr	4.417666667	11.45059	4.443667	11.517984	8.673666667	23.071392
May	3.441612903	9.218016	8.293871	22.214304	7.944193548	20.68848
Jun	5.359333333	13.89139	15.87467	41.147136	18.98866667	49.218624
Jul	30.81419355	82.53274	19.55871	52.386048	45.10774194	120.816576
Aug	786.4254839	2106.362	66.93871	179.28864	184.0087097	492.848928
Sep	1140.133333	2955.226	170.1667	441.072	354.3	918.3456
Oct	731.7419355	1959.898	167.6087	448.923168	185.0322581	495.5904
Nov	110.7236667	286.9957	44.78333	116.0784	92.266	239.153472
Dec	36.32419355	97.29072	19.48355	52.184736	35.38258065	94.768704
Total		**7591.288**		**1433.999808**		**2567.16864**

m^3/sec = cubic meter per second, MCM = million cubic meter.
Source: Calculated from raw daily hydrographic data.

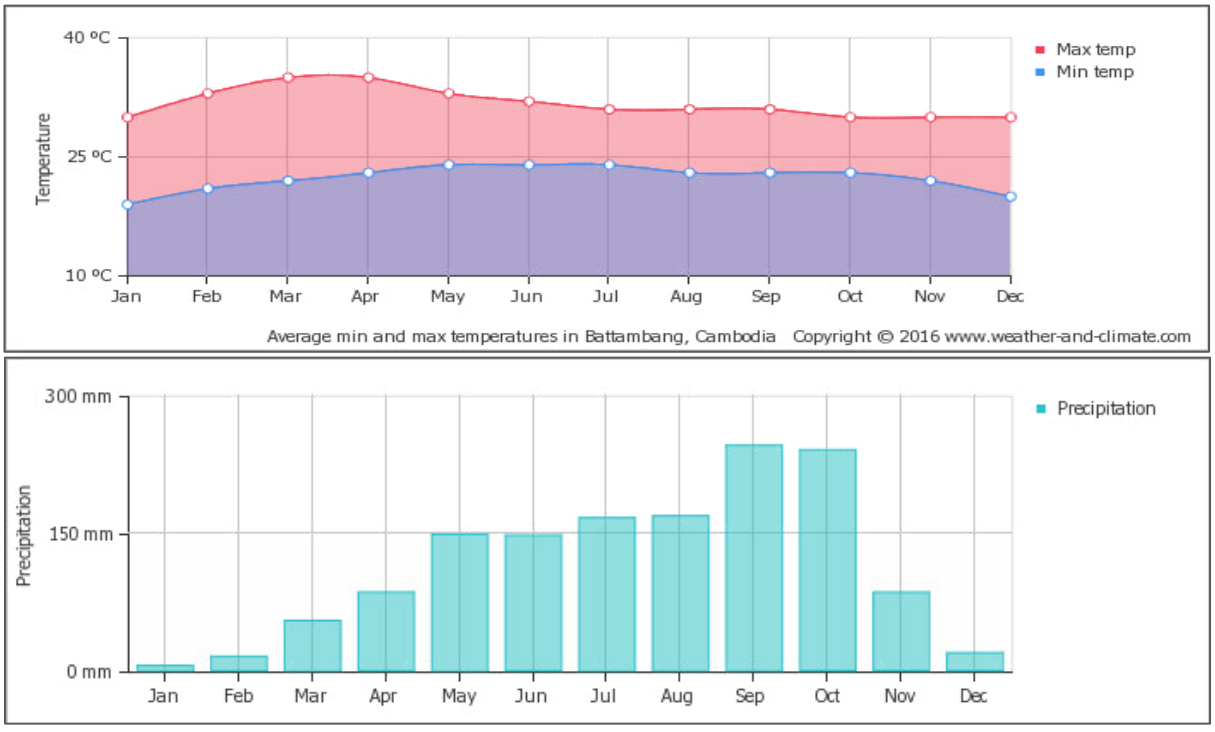
31. The data shows that the annual flows in a wet year can be three times higher than an average year and up to 5-6 times higher than a dry year. In the dry season however, flow rates for a wet, dry and average year are all uniformly low.

2. Long List Candidate Subprojects

32. Generally, over the TSSD-AF project provinces the climate features warm to hot temperatures throughout the year and an annual monsoon cycle of alternating wet and dry seasons. The main wet season, the southwest monsoon, occurs between June and October, when reduced air pressures over Central Asia cause air to be drawn landward from the Indian ocean. Approximately 80% of all rainfall occurs during this season. Conversely, during the cooler months between November and May, air flows over Cambodia originate from Central Asia and are drier, resulting in cooler and less rainy weather. Average monthly rainfall is around 1,500 mm. However, total rainfall can vary considerably from year to year, resulting in occasional years of severe flooding and conversely, years of significantly low rainfall. Temperatures are fairly uniform throughout the Tonle Sap Basin area, with only small variations from the average annual mean of around 25°C.

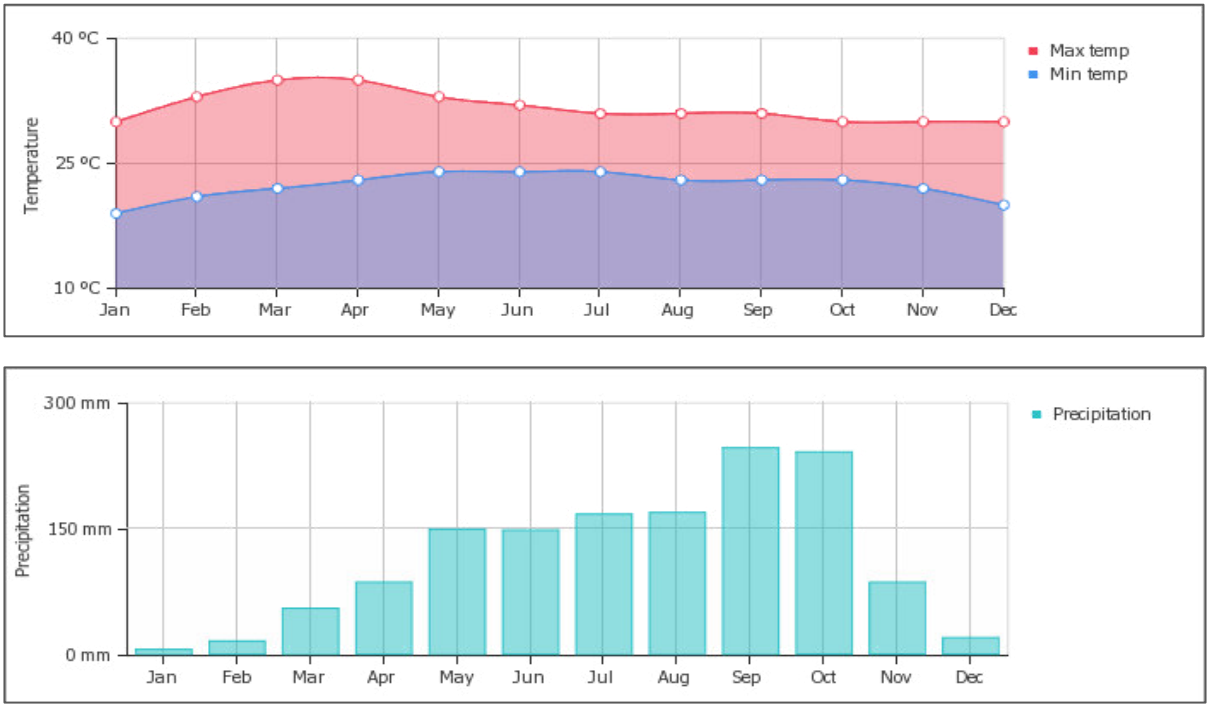
33. Typical temperature and rainfall profiles for these provinces are shown below for Battambang, Siem Reap and Kampong Thom (Figures 8, 9, and 10). The western locations, Battambang and Siem Reap, show similar temperature and rainfall profiles.

Figure 8: Temperature and Rainfall Averages for Battambang



Source: 2016. www.weather-and-climate.com

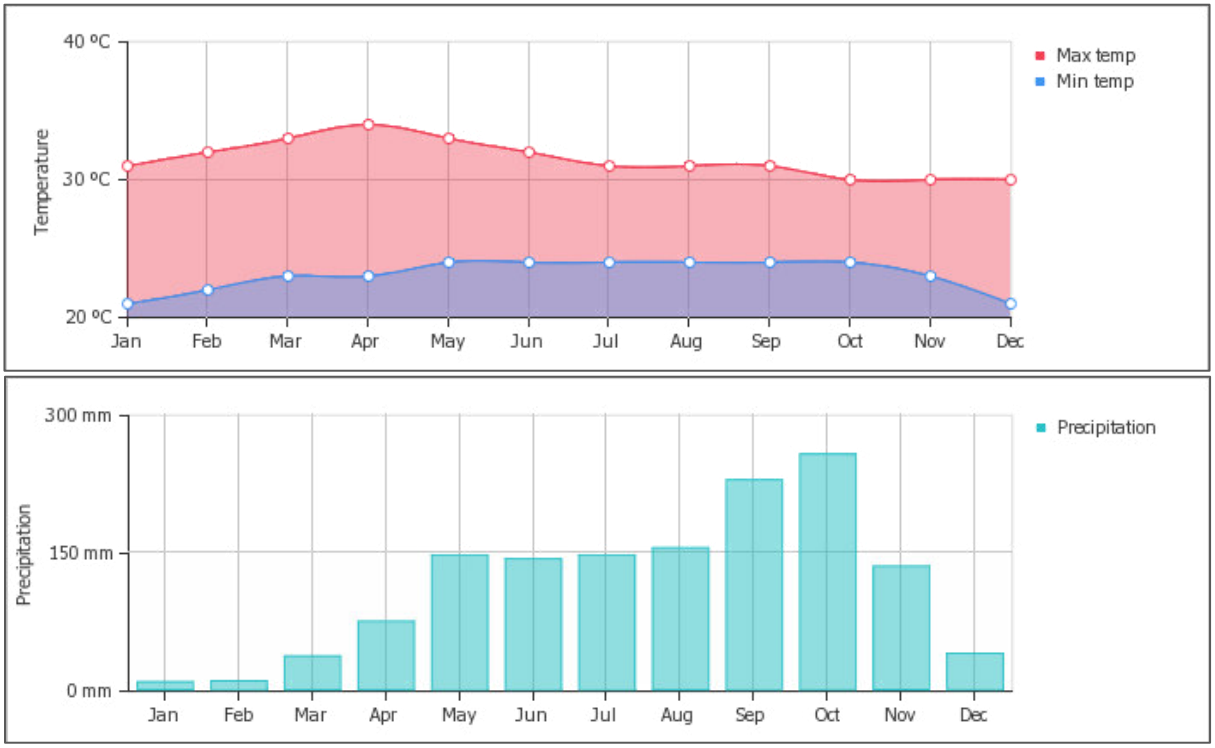
Figure 9: Temperature and Rainfall Averages for Siem Reap



Source: 2016. www.weather-and-climate.com

34. The more eastern locations, represented here by Kampong Thom below (and also by Kampong Cham and Prey Veng in the description of climate of the core subproject areas above) show a greater diurnal difference in temperatures with maximum temperatures generally hotter and minimum temperatures cooler. The rainfall profile for the eastern provinces with slightly lower rainfall in the wet season and a later peak rainfall period (in October).

Figure 10: Temperature and Rainfall Averages for Kampong Thom

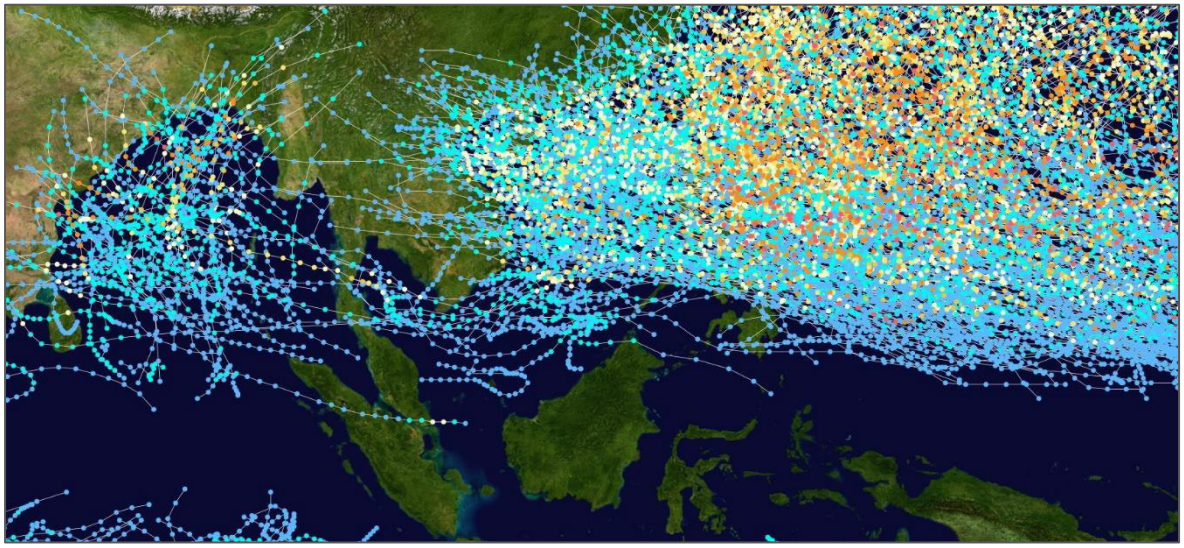


Source: 2016. www.weather-and-climate.com

B. Floods and Extreme Weather Events

35. Flooding is a regular phenomenon in Cambodia, with rainfalls commonly exceeding 500 mm per month in the rainy season. However, recent flooding in the Mekong region has been very damaging and the Mekong River Commission records show an increasingly shorter return period for major floods. Additionally, though major tropical cyclone originating in the South China Sea rarely penetrates into Cambodia (see Figure 11), cyclonic effects in central Cambodia have been more common in the last decade.

Figure 11: Tropical Cyclone Tracks[6] 1985-2005



Source: National Hurricane Center and the Central Pacific Hurricane Center.

1. Core Subprojects

36. The flood statistics for the two core subproject provinces (in Table 2) for the last major flood in 2013 illustrate the levels of damage.

Table 2: Impact of Flooding
(18 October 2013)

Province		Kampong Cham	Prey Veng
Affected Districts		13	13
Affected communes		72	84
Affected Families		51,376	44,764
Affected people		236,330	205,914
Evacuated families		3.546	866
Evacuated people		16,312	3,984
Houses affects		43,759	32,193
Victims	Deaths	29	26
	Injured		
Flood Affected	Schools	268	155
	Pagodas	144	53
	Health centers and hospitals	17	8

[6] Tracking data for storms within the Atlantic and Eastern Pacific basins is taken from the National Hurricane Center and the Central Pacific Hurricane Center's Northeast and North Central Pacific hurricane database.

Source: Humanitarian Response Forum (HRF), Situation Report No.4, 23 October 2013.

37. Table 3 below compares data collected by NCDM in 2013 and 2011, which have been ranked as the two biggest flood events in the last 20 years, at the peak of the floods in each year, for the core subproject provinces. Changes in the number of affected or evacuated families in 2013 compared to 2011 are highlighted.

Table 3: Affected and Evacuated Families in 2013 and 2011
(Kampong Cham and Prey Veng)

Province	2013	2011	Comparison (affected families) 2013 and 2011	2013	2011	Comparison (evacuated families), 2013 and 2011
	affected families	affected families		evacuated families	evacuated families	
Kampong Cham	51,376	33,436	17,940	3,546	6,085	-2,539
Prey Veng	44,764	40,615	4,149	866	10,227	-9,361

Source: Humanitarian Response Forum (HRF), Final Report No.07, December 2013.

38. The effects of flooding on rice production is an important part of the Lvea subproject due diligence. The following table, taken from the HRF Situation Report of October 2013 covering the devastating floods of September that year, show that the agriculture of the subproject provinces were among the worst hit.

Table 4: Damage to Agriculture Sector by Floods in 2013

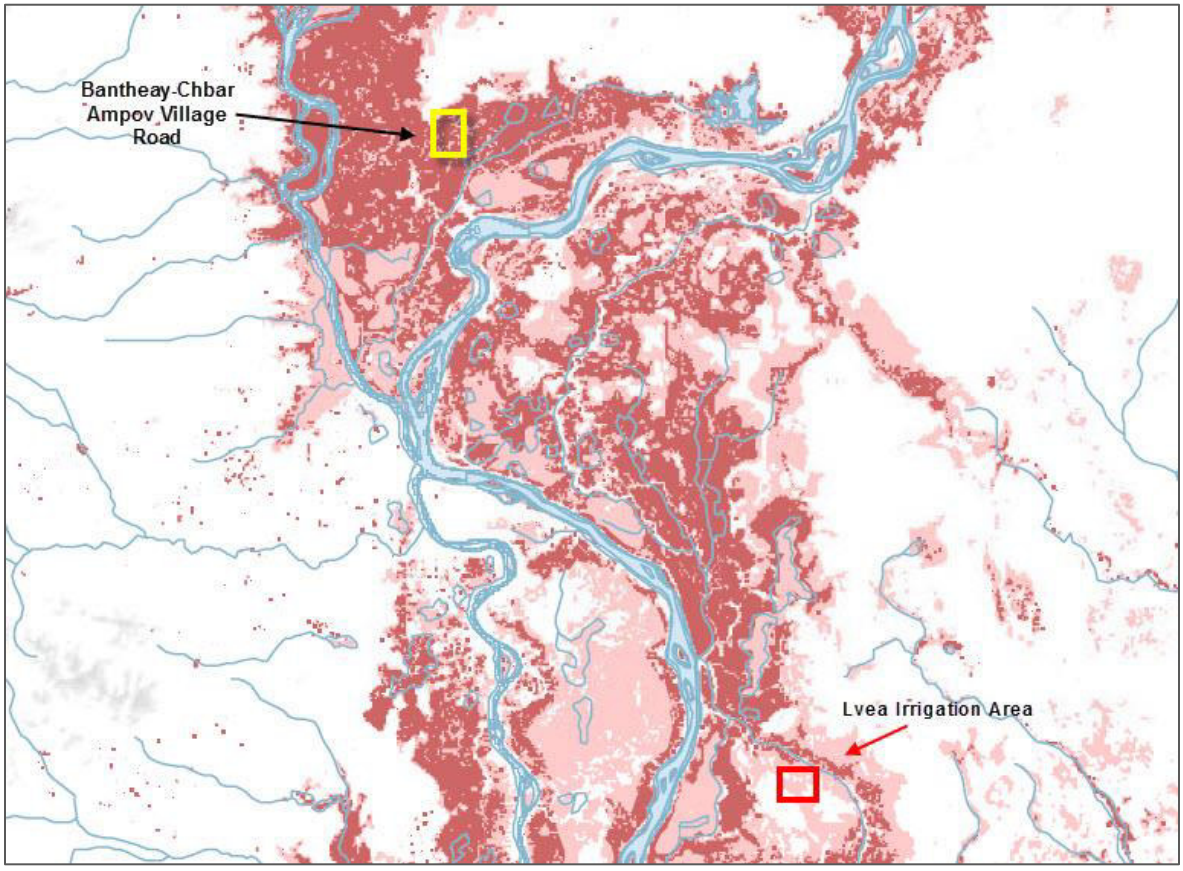
Province	District	Commune	Agriculture sector					
			attle/Livestock		Rice transplanting		Rice seedling	Secondary crop
			cuated	ath	affected (ha)	aged (ha)	damaged (ha)	
Kampong Cham	3	72	,398		10,798	60	28	166
Prey Veng	2	65	,555		45,528			203
All Provinces	**101**	**416**	**1,051**	**9**	**221,476**	**101**	**357**	**1,508**

ha = hectare.

Source: Humanitarian Response Forum, Final Report No.07, December 2013.

39. Data on flooding in the subproject communes is unavailable, but national mapping of the 2011 and 2013 floods (Figure 12) shows that the village road subproject in Kampong Cham was fully affected by both floods, but that the Prey Veng irrigation subproject area was mainly affected by the 2011 flood, and only partly.

Figure 12: Flood Map Detail for 2011 and 2013 Floods showing Core Subproject Areas



Source: World Food Programme. Cambodia. 2013.

2. Long List Candidate Subprojects

40. The flood statistics for the provinces included in the long list of candidate subprojects (in Table 5) for the last major flood in 2013 illustrate the levels of damage.

Table 5: Impact of Flooding
(18 October 2013)

Province		Kampong Thom	Siem Reap	Battam-bang	Banthaey Meanchey	Tboung Khmum
Affected Districts		7	10	14	9	
Affected communes		61	60	102	59	Figures combined with Kampong Cham
Affected Families		17,463	19,022	74,160	54,463	
Affected people		80,330	87,501	341,136	250,530	
Evacuated families		1,114	3,550	4,504	8,902	
Evacuated people		5,124	16,330	20,718	40,949	

Province		Kampong Thom	Siem Reap	Battam-bang	Banthaey Meanchey	Tboung Khmum
Houses affects		17,463	3,645	62,451	15,027	
Victims	Deaths	24	15	17	9	
	Injured	3	2	4	1	
Flood Affected	Schools	121	39	77	249	
	Pagodas	41	8	14	128	
	Health centers	4	7	9	21	

Source: Humanitarian Response Forum (HRF), Situation Report No.4, 23 October 2013.

41. Table 6 below compares data collected by NCDM in 2013 and 2011, at the peak of the floods in each year, for the long list candidate subproject provinces. Changes in the number of affected or evacuated families in 2013 compared to 2011 are included.

Table 6: Affected and Evacuated Families in 2013 and 2011
(Kampong Cham and Prey Veng)

Province	2013 affected families	2011 affected families	Comparison (affected families) 2013 and 2011	2013 evacuated families	2011 evacuated families	Comparison (evacuated families), 2013 and 2011
Kampong Thom	17,463	54,414	-36,951	1,114	2,448	-1,334
Siem Reap	19,022	23,198	-4,176	3,550	0	3,550
Battam-bang	74,160	13,921	60,239	4,504	1,194	3,310
Banthaey Meanchey	54,463	13,008	41,455	8,902	5,372	3,530
Tboung Khmum	Grouped with Kampong Cham					

Source: Humanitarian Response Forum (HRF), Final Report No.07, December 2013.

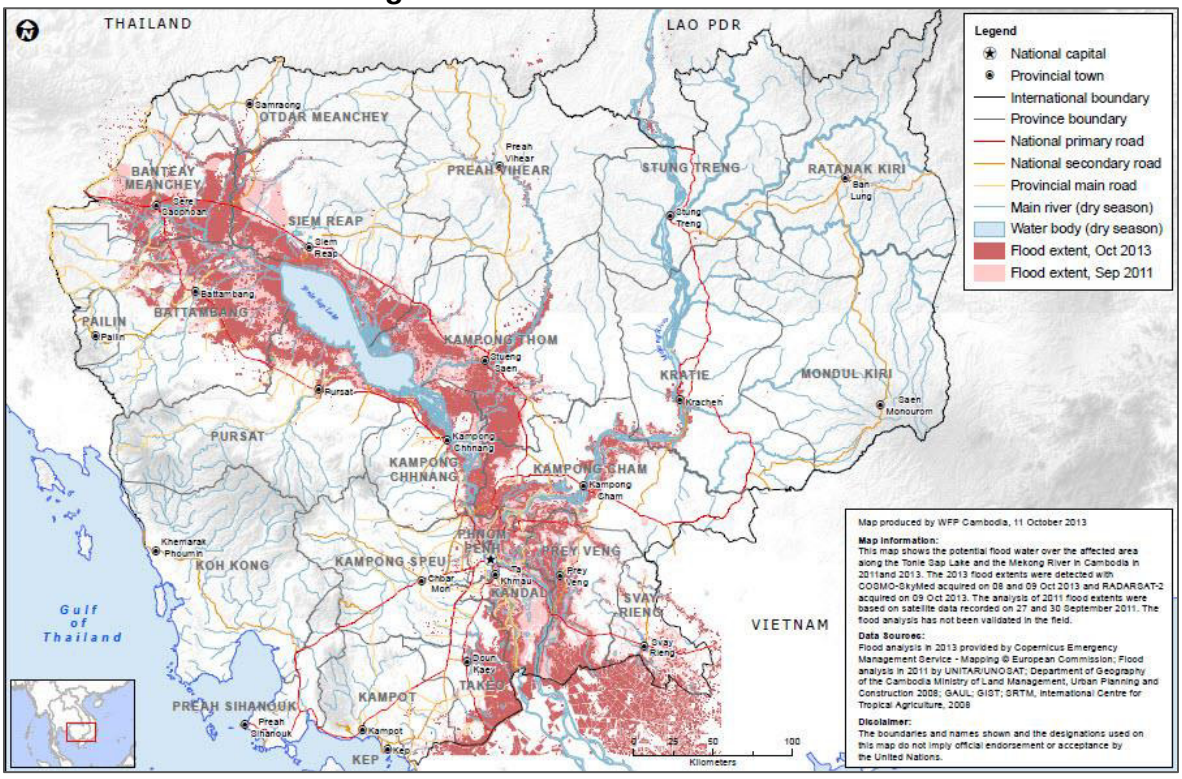
42. The effect of flooding on rice production is an important consideration for candidate irrigation subprojects. The following table, taken from the HRF Situation Report of October 2013 show that the agriculture of Battambang and Banthaey Meanchey were severely damaged, in terms of area affected, 15% and 12% respectively of the sector affected.

Table 7: Damage to Agriculture Sector by Floods – 2013.

Province	District	Commune	Agriculture sector					
			attle/Livestock		Rice transplanting		Rice seedling	Secondary crop
			cuated	ath	affected (ha)	damaged (ha)	aged (ha)	
Kampong Thom	6	20	,361		2,802			
Banthaey Meanchey	9	9			25,943	30		3,389
Siem Reap	6	40		5	8,800			72
Battambang	8				33,367			1,622
Tboung Khmum	Results merged with Kampong Cham							
All Provinces	**101**	**416**	**1,051**	**9**	**221,476**	**101**	**357**	**1,508**

43. Data on flooding in the long list candidate subproject communes is unavailable, but national mapping of the 2011 and 2013 floods (Figure 13) shows that Thoung Khmum was minimally affected by the floods with only the immediate floodplain bordering the Mekong being inundated. Siem Reap and Battambang experienced both floods along their floodplain fringing Tonle Sap. Banthaey Meanchey and Kampong Thom were both significantly affected by the two flood events.

Figure 13: 2011 and 2013 Floods



Source: World Food Programme Cambodia 2013.

III. IMPACT ASSESSMENT

A. Applicable Climate Change Models

44. In recent relevant climate change analyses for agriculture and roads in Cambodia[7] two climate change prediction methodologies have been used. These comprise the IPCC Special Report on Emission Scenarios (SRES) using the A1, A2, B1 and B2 scenarios describing differing emission rates and geopolitical settings and the IPCC's latest "radiative" scenarios adapted by the CSIRO (2013) in its Conformal Cubic Atmospheric Model (CCAM) and have been used to predict future climatic determinants for project design.

45. **Special Report on Emission Scenarios (SRES).** The SRES projections for Cambodia were used in the modelling studies in the Initial National Communication (INC) and the Second National Communication (SNC) of the Cambodian National Climate Change Committee indicated that Cambodia's mean surface temperature has increased by 0.8°C since 1960, and that it will continue to increase at a rate of between 0.013°C and 0.036°C per year up to 2099. The rate of temperature increase will be higher in low altitude areas such as the subproject sites which are between 10 m and 20 m above sea level.

46. Most recently promoted by UNDP (2008), Mekong River Commission (2014) and Ministry of Water Resources and Meteorology (MOWRAM) (2013). The SRES models are statistically downscaled, by calibrating against current climate data sets, to 50 km scale and usually focus on two SRES scenarios for projecting future temperature and precipitation (A2 and B2).[8] These scenarios and projections have been used in the Loans 3006/3007/8271 and Grants 0349/0350-CAM: Climate-Resilient Rice Commercialization Sector Development Project (Rice-SDP).

47. **Conformal Cubic Atmospheric Model (CCAM)**. The CCAM projections use bias-corrected sea surface temperatures from six CMIP5 general circulation models (GCMs) to drive a global atmosphere-only model at 50 km horizontal resolution (CCAM). Downscaling for the Loans 2839/8254 and Grant 0278-CAM: Provincial Roads Improvement Project was carried out by using the 50 km simulations to drive a regional model at a 10-km grid spacing. Two emissions scenarios were considered: Representative Concentration Pathways (RCP) 4.5 (lower greenhouse gas concentrations) and RCP 8.5 (higher greenhouse gas concentrations).[9]

Modeling	Comments
MOWRAM *Carried out by* TA7610–CAM: Supporting Policy and Institutional Reforms and Capacity Development in the Water Sector Project	The modeling was carried out in 2010 Data from nine general circulation models (GCMs) (pixels 125-400 km) was downscaled to smaller pixels (data from World Bank web portal) Using statistical downscaling final pixel size 50 km Older generation Intergovernmental Panel on Climate Change (IPCC) models
Mekong River Commission *Carried out with assistance from* The Commonwealth Scientific and Industrial Research Organisation (CSIRO) and The Southeast Asia SysTem for Analysis,	The modeling was carried out in 2012 Data from one GCM - Max Planck Institute for Meteorology's ECHAM4 (pixels ~250 km) was downscaled to smaller pixels Using a regional climate model final pixel size of 50 km

[7] Loans 3006/3007/8271 and Grants 0349/0350-CAM: Climate-Resilient Rice Commercialization Sector Development Project and Loans 2839/8254 and Grant 0278-CAM: Provincial Roads Improvement Project

[8] A2: Comprises a more divided world: (i) operating independently, self-reliant nations; (ii) continuously increasing population; and (iii) regionally oriented economic development; B2: scenario describes a world in which the emphasis is on local solutions to economic, social, and environmental sustainability. The scenario is oriented toward environmental protection and social equity.

[9] RCPs are four greenhouse gas concentration (not emissions) trajectories adopted by the IPCC for its Fifth Assessment Report (AR5) in 2014. It supersedes SRES projections published in 2000.

Modeling	Comments
Research and Training Regional Center (SEA START).	Older generation IPCC models
ADB TA 7459-REG: Greater Mekong Subregion Biodiversity Conservation Corridors Project – Pilot Program for Climate Resilience Component – Cambodia *Carried out by* The Commonwealth Scientific and Industrial Research Organisation (CSIRO)	The model was developed and run in 2012 CCAM - This is a regional model that was run specifically for Southeast Asia. It uses six GCMs selected for best performance in Southeast Asia The model has a pixel size of 10 km It uses the latest IPCC standard set of model simulations
USAID Mekong Adaptation and Resilience to Climate Change *Carried out by* International Centre for Environmental Management (ICEM)	The modeling was carried out in 2014 Historical data across the basin for the period of 1980 – 2005 which fitted six GCMs was downscaled to 5 km grid using statistical calibration. Modeled SRES A1 scenario only Older generation IPCC models

48. The different scenario generators have particular advantages for the different sectors of the project:

(i) The SRES scenarios can be applied readily to water balances by computing changes in temperature, seasonal rainfall, evaporation to calculate irrigation future water needs for crops. It is therefore most helpful in analyzing adaptation requirements for future irrigation needs.

(ii) The Mekong basin wide study, the USAID Mekong Adaptation and Resilience to Climate Change (2014), used downscaled projections for the SRES A1 scenario to predict regional changes in temperature and rainfall and was able to calculate changes in drought periods under future climate change which is very relevant to assessing risk and vulnerability for future irrigation.

(iii) The IPCC radiative scenarios regional downscaling techniques used in CCAM not only increase resolution to the provincial level, but also allow analysis of local extreme events such as one day and five-day rainstorm intensities. Thus, in addition to general climate change, the scenarios can address flooding and extreme events, scenarios most relevant to road and infrastructure design.

49. **USAID Mekong Adaptation and Resilience.** An additional Mekong basin wide study, the USAID Mekong Adaptation and Resilience to Climate Change (2014), compared the output of 12 GCMs and chose the six that most accurately replicated historical data across the basin for the period of 1980–2005. Downscaled projections for the A1 scenario were derived using in-house developed statistical downscaling. This study predicted regional changes in temperature and rainfall and was able to calculate changes in drought periods under future climate change.

B. Future Temperature, Rainfall and Crop Water Requirements

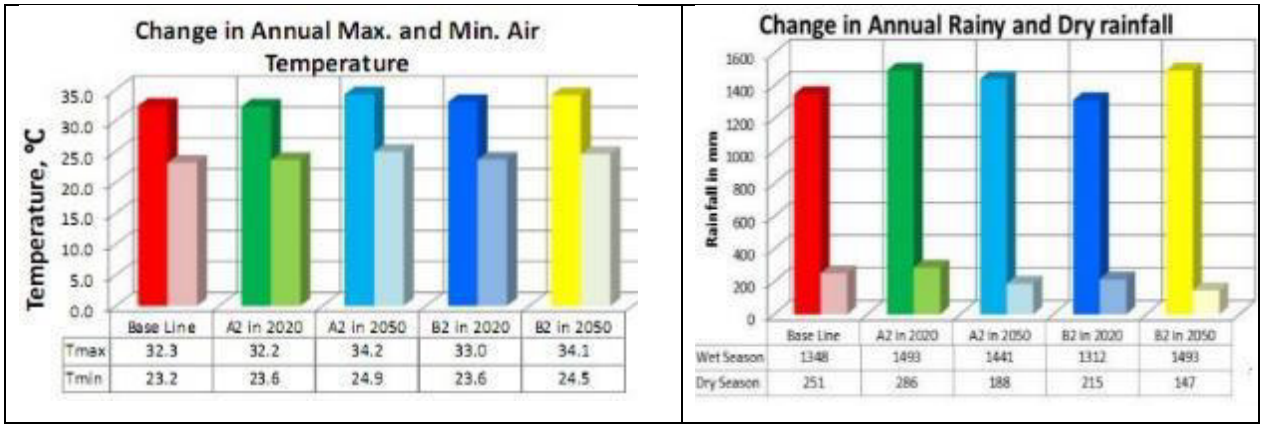
50. SRES scenarios (MOWRAM Model) under elevated CO_2 with low rate of emission scenarios (SRES-B2)[10] showed that it is likely that wet season rainfall will continue to increase in future, and then might decrease again after 2050. But under high emission scenarios (SRES-A2), the direction of change will reverse.[11] An increase in the temperature is likely to affect agricultural

[10] IPCC's Special Report on Emission Scenarios (SRES) has four scenarios A1, A2, B1 and B2 describing differing emission rates and geopolitical settings. In summary; A is economics driven rather than environmental; B is more environmentally drive. One is countries operating in concert; Two is countries pursuing their own aims.

[11] National Climate Change Committee. 2013. Cambodia Climate Change Strategic Plan 2014-2023.

productivity. According to the International Rice Research Institute, rice grain yields decline by 10% for each 1°C increase in minimum (night) temperatures during the growing period in the dry season.[12] The magnitude of these changes are illustrated in the following graphs (Figure 14), and their implications for crop water demand in Figure 15.

Figure 14: Future Scenarios for the Critical Agricultural Parameters of Temperature and Rainfall[a]



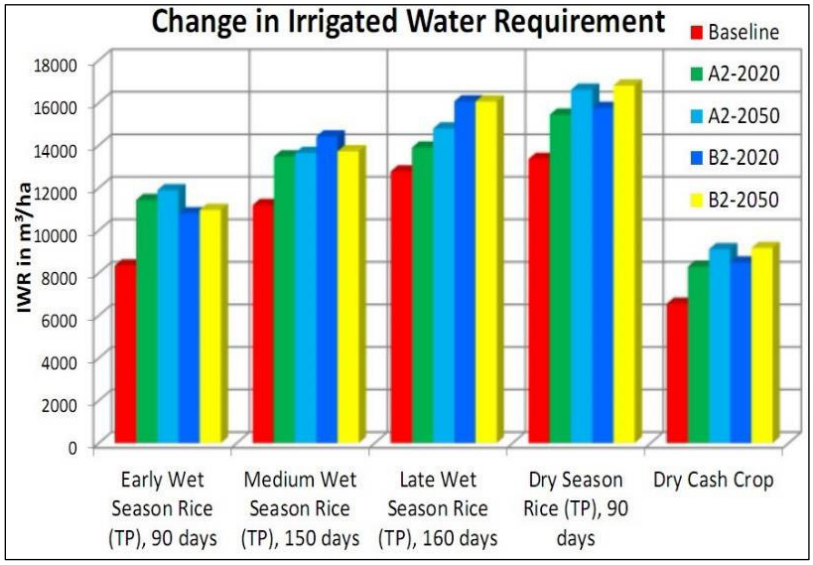
[a] Scenarios are A2 (a more divided world) and B2 (a world more divided, but more ecologically friendly).
Source: Sopharith, 2015.[13]

51. The predicted changes in rainfall and temperature will combine to affect future irrigated water requirements (IWR). Figure 15 below shows predicted IWR for all SRES projections for nation states acting in isolation (A2 and B2 scenarios).

[12] irri.org/news/hot-topics/rice-and-climate-change

[13] Tes, S. Jan 2015. Assessment of Water Resources for Improved Water Governance under Climate Change: Stung Chinit River Catchment. Presentation to Third Steering Committee Meeting Climate Change and Water Governance in Cambodia 20 January 2015, Cambodiana Hotel, Phnom Penh.

Figure 15: Irrigation Water Requirements for Cambodian Rice Cropping Alternatives from IPCC SRES



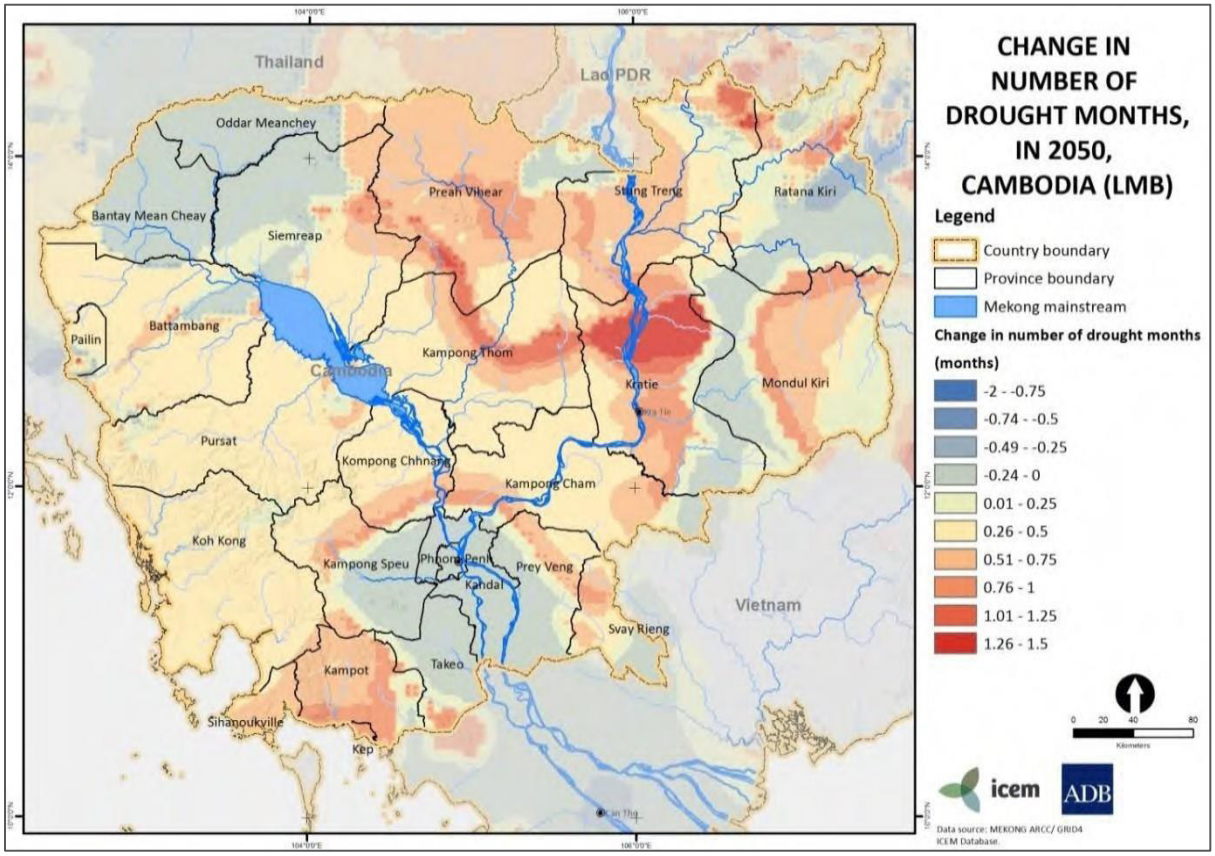
Source: Sopharith, 2015.

52. The CCAM Scenarios (CSIRO Model) also show warming occurring over Cambodia in the future, projecting warming of 0.03 ˚C to 0.06 ˚C per year. This equates to a warming of 0.35˚C to 2˚C by 2050 and 1˚C to 5˚C by 2100. The projected change in temperature output by the CSIRO's CCAM model is very similar to the one produced by the MOWRAM modelling carried out in 2010. The CCAM model (at RPC 8.5) downscaled to the sub-provincial level, predicts a dryer wet season of -8.4 mm/yr in the central and south lowlands and an increase at the start of the wet season of +1.2 mm/yr. It predicts no change to the dry season.

C. Occurrence of Droughts

53. The USAID Mekong Adaptation and Resilience to Climate Change (2014) was refocused by ICEM for Cambodia in TA 8179-CAM: Mainstreaming Climate Resilience into Development Planning and predicted changes in temperature, rainfall and changes in drought periods. While it is projected that average rainfall will increase in the basin, periods of annual agricultural drought are also expected to lengthen significantly; particularly in the Mekong floodplain in Cambodia. Cambodia is predicted to have up to 30% increases in the number of drought days each year in some provinces (Figure 16).

Figure 16: Changes in Drought Months (2050)



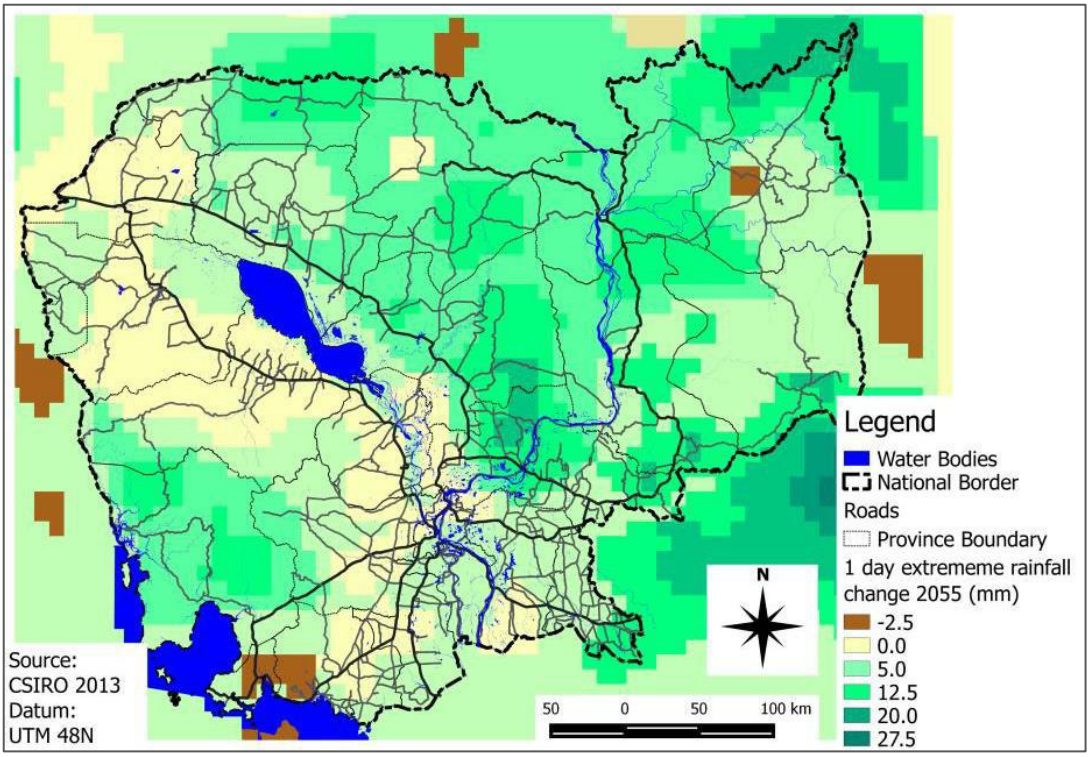
Source: TA 8179-CAM: Mainstreaming Climate Resilience into Development Planning.

54. Figure 16 shows that for the upland agricultural parts of Battambang, Kampong Cham, Kampong Thom, Siem Reap, and Tboung Khmum droughts will increase by up to 0.5 months. However for Banthaey Meanthey, Prey Veng, and the riverside areas of Battambang, Kampong Cham, and Siem Reap, there will be no change or a slight decrease in drought length. The core subproject for irrigation in Lvea commune, Prey Veng, will experience unchanged or slightly shorter drought periods.

D. Rainfall Intensity Leading to Flooding

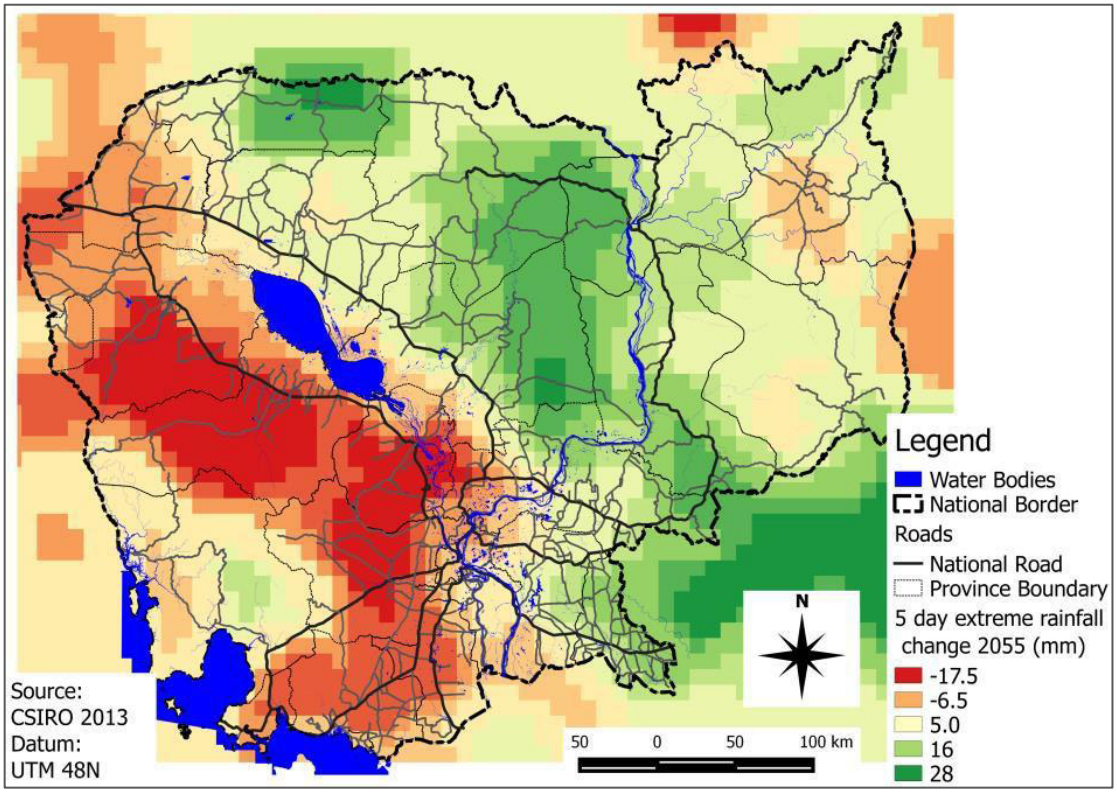
55. The projected extreme rainfall projections are the average results from the six CSIRO CCAM model runs for a 20-year period centred on 2055 using an RCP of 8.5. The projected change in one day extreme rainfall is the difference between current and projected 2055 values and the map is at Figure 17. The model projects an increase in one day extreme rainfall over the coastal mountains and over the hilly regions in the north of the country. There is no change or only a small change projected for the central flat areas, except for a small area north east of Phnom Penh. The five day extreme rainfall map (Figure 18) reflects the spatial distribution of annual rainfall with high values of 300 mm or more in the mountainous region near the coast and in Mondul Kiri and in the far north east. Smaller 5 day extreme events of 150 mm–180 mm occur in the central flat lands and hilly regions in the north. The model shows the lowest values around Tonle Sap.

Figure 17: Projected Change in 1 day extreme rainfall for 2055 for RCP of 8.5 from CCAM



Source: CSIRO 2013.

Figure 18: Projected change in 5 day extreme rainfall for 2055 for a RCP of 8.5 from CCAM



Source: CSIRO 2013.

IV. VULNERABILITY ASSESSMENT

A. Crop Water Demand - Irrigation Subprojects

1. Core Subproject – Lvea Commune, Prey Veng

56. The irrigation subproject for a dry season rice crop will increase existing levels of water extraction. The impact of this on existing water resources must be examined through seasonal water balances for each cropping alternative applicable to the subproject schemes.

57. The data for calculating seasonal water balances are based upon (i) local cropping calendars derived from consultation with farmers and the areas to be irrigated; (ii) hydrological data on the water source (river or primary canal); (iii) estimation of water needs and irrigation efficiency.

58. The cropping calendar at Lvea commune approximates the one promulgated by the Ministry of Agriculture, Forestry and Fisheries (MAFF) in that the dry season crop is planted as soon after harvest of the wet season crop as possible. The water needs for the main cropping alternatives, at a range of irrigation efficiencies, and including water requirements for pre-saturation of paddy and establishment of a 100 mm water layer for planting were taken from calculations for irrigated rice cropping in neighbouring Kampong Thom.[14]

59. The following seasonal water balance for a dry season crop in a normal year and a dry year (Table IV.1) uses inflow data derived from Pumping Station #2, which pumps water from the

[14] TA8702-CAM: Uplands Irrigation and Water Resources Management Sector Project.

Trabaek River into the primary canal, at an irrigation efficiency of 40%. It compares seasonal water needs with water supply for the projected expansion of dry season irrigation area to 305 ha.

Table 8: Water Balance for an Additional 305 ha Irrigation Area of Dryland Cropping at Lvea Commune

Dry Season			
Year	**Crop**	**Water Need (MCM)**	**Water Available (MCM)**
Dry Season			
Low rainfall year	Short season variety (December-March) 90 day+	4.422	13.24
Normal rainfall year	Short season variety (December-March) 90 day+	4.27	85.93

MCM = million cubic meter.
Note: 90 day+ and 130 day+ refers to the growing period plus land preparation.
Source: PPTA team.

60. The shaded cells in the water balance show where water availability is sufficient for irrigation needs. The balance shows that the dry season rice crop in the additional areas is possible and likely to be sustainable in average years and that surplus water exists for downstream uses. However, in a dry year, the balance demonstrates that the irrigation is possible but that extraction of the water is likely to put pressure on downstream supplies, since it takes about 17% of the available water. The high water need and limited water availability shown in the water balance indicates a significant vulnerability to increased crop water demand and/or reduced rainfall due to climate change. This is not exacerbated by predicted increases in drought. For the subproject area, droughts are predicted to remain the same as historical records or decrease slightly in duration.

61. No major new irrigation schemes on the Trabaek downstream (east) of Lvea are currently planned. New schemes in feasibility planning are on the Stung Slot and focus on drainage of late wet season water to provide cropping options. However incremental downstream use of the Trabaek's water in the future may result in water constraints and there is a need to plan future extraction and irrigation areas, accordingly.

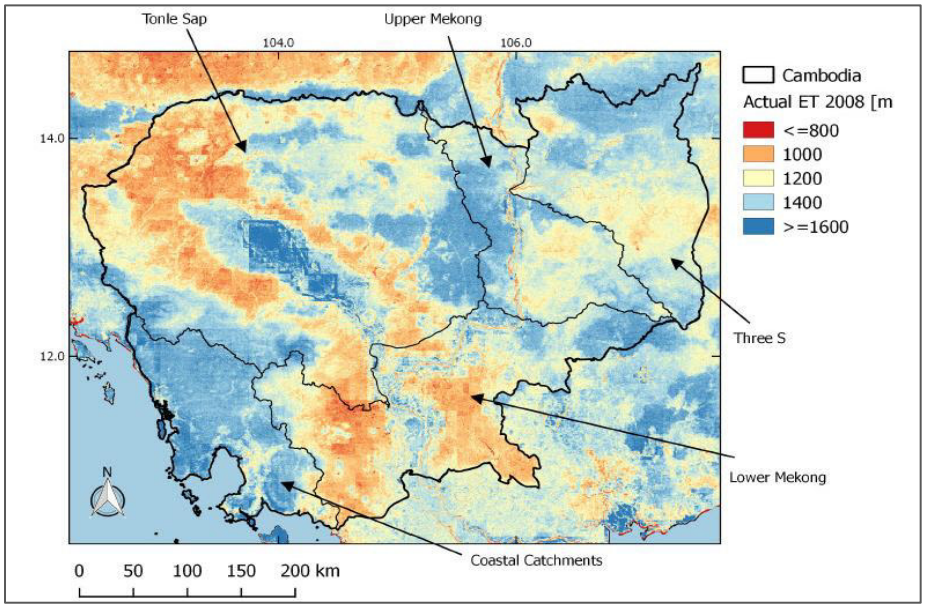
2. Long List Candidate Subprojects

62. The crop water demand for long list candidate irrigation subprojects, both currently and in the future under climate change, can be determined by using evapotranspiration measurements for irrigated crops in the various provinces and calculating how this might change with increases in temperature. Crop evapotranspiration is the water demand that must be met by in-season rainfall, irrigation and stored soil water at sowing. It is therefore a useful measure of crop water demand in the dry season when all water must come from irrigation.

63. However, water availability cannot be determined at this stage, since the locations, water sources and planned irrigation areas are not known for the long list candidate irrigation subprojects. Instead, indicated crop water demand in 2050 using evapotranspiration can be an input into the adaptation strategy for the subprojects by ensuring that local water availability (water sources and planned irrigation areas) are matched to these crop water demands in the design of the subproject.

64. The Water Accounting in Selected Asian River Basins: Pilot Study in Cambodia (2017)[15] has divided Cambodia into five basin areas. The Tonle Sap and Lower Mekong basins contain all the project provinces. The study derived actual evapotranspiration for different crops for all Cambodia using remote sensing tied to surface energy balance models developed by IHT-Delft. The actual evapotranspiration for Cambodia's river basins at a pixel size of 250 m is at Figure 19.

Figure 19: Actual Evapotranspiration for a Typical Year (2008)



Source: IHT-Delft 2017.

65. When the evapotranspiration layer is combined with detailed land cover datasets, evapotranspiration for different crops can be obtained. Actual evapotranspiration for irrigated dry season rice for the project provinces determined in this way are at Table 9.

Table 9: Evapotranspiration for Irrigated Rice

Basin	Crop Type	Area (km^2)	ET rate (mm/yr)	ET per unit area (m^3/ha)
Tonle Sap				
2004 (dry)	Irrigated cereal	9,664	943	9,430
2007 (wet)	Irrigated cereal	9,664	945	9,450
2008 (average)	Irrigated cereal	9,664	1,031	10,310
Lower Mekong				
2004 (dry)	Irrigated cereal	5,637	1,035	10,350
2007 (wet)	Irrigated cereal	5,637	1,095	10,950
2008 (average)	Irrigated cereal	5,637	1,140	11,400

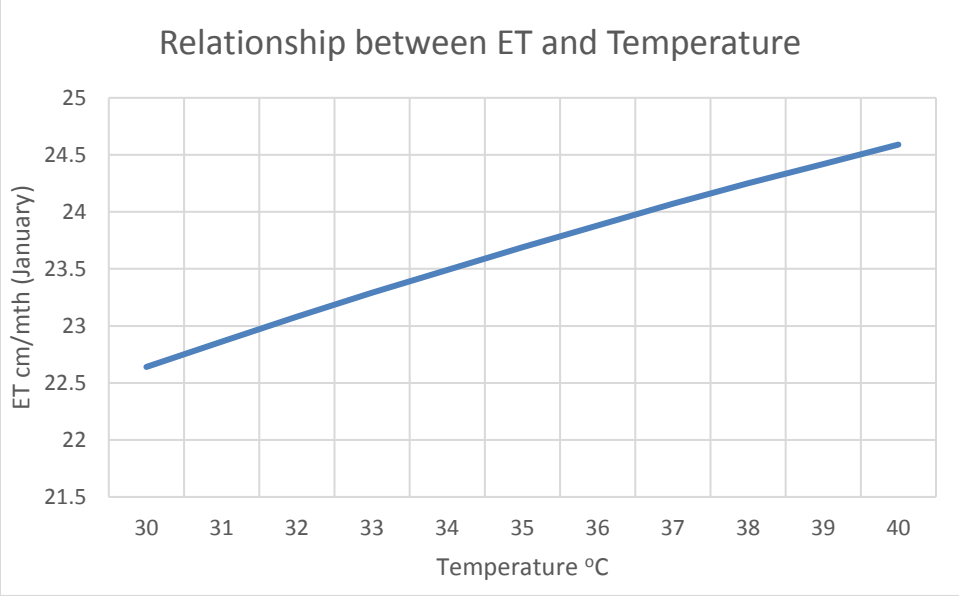
ET = evapotranspiration, km^2 = square kilometer, mm/yr = millimeter per year, m^3/ha = cubic meter per hectare.
Source: IHT-Delft 2017.

66. Using the Penman-Monteith formula[16] for deriving potential evapotranspiration and

[15] Salvadore E and W Bastiaansson 2017, *Water Accounting in Selected Asian River Basins: Pilot Study in Cambodia*, IHT-Delft.
[16] http://onlinecalc.sdsu.edu/onlinepenmanmonteith.php.

keeping inputs for radiation, relative humidity, wind speed and atmospheric pressure at constant median values for Cambodia, changes to evapotranspiration with in increases in temperature can be calculated (Figure 20).

Figure 20: Increase in Potential ET with temperature Rise



cm/mth = centimeter per month, ET = evapotranspiration.
Source: PPTA team.

67. Actual evapotranspiration measured through remote sensing and surface energy balance models gives results which reflect optimal water use by a crop. This would approximate a high irrigation efficiency of >60%. To approximate a more realistic irrigation efficiency of 40% achievable in subprojects, the actual evapotranspiration in 2050 is increased by a factor of 1.5 (60/40) to give an indicative crop water demand for an irrigated dry season rice crop.

Table 10: Evapotranspiration of Dry Season Rice under Irrigation with Temperature Changes

Basin and Province	Year	ET (m^3/ha)	Temperature Change in Dry Season 2050*	ET 2050 (m^3/ha)	Indicative Crop water demand at 40% irrigation efficiency
Tonle Sap Basin					
BTB	2004 (dry)	9,430	2.0 – 2.1 °C	9,594	14,391
	2008 (average)	10,310	2.0 – 2.1 °C	10,490	15,734
BMC	2004 (dry)	9,430	1.5 – 2.0 °C	9,586	14,380
	2008 (average)	10,310	1.5 – 2.0 °C	10,481	15,722
SRP	2004 (dry)	9,430	2.0 – 2.3 °C	9,610	14,415
	2008 (average)	10,310	2.0 – 2.3 °C	10,507	15,760
KPT	2004 (dry)	9,430	2.6 – 2.8 °C	9,649	14,474
	2008 (average)	10,310	2.6 – 2.8 °C	10,550	15,824
Lower Mekong Basin					
KPC	2004 (dry)	10,350	2.3 – 2.8 °C	10,590	15,886

Basin and Province	Year	ET (m^3/ha)	Temperature Change in Dry Season 2050*	ET 2050 (m^3/ha)	Indicative Crop water demand at 40% irrigation efficiency
	2008 (average)	11,400	2.3 – 2.8 °C	11,665	17,497
TBK	2004 (dry)	10,350	2.3 – 2.8 °C	10,590	15,886
	2008 (average)	11,400	2.3 – 2.8 °C	11,665	17,497
PRV	2004 (dry)	10,350	2.3 – 2.4 °C	10,556	15,834
	2008 (average)	11,400	2.3 – 2.4 °C	11,627	17,441

BTB = Battambang, BMC = Banthaey Meanchey, KPC = Kampong Cham, KPT = Kampong Thom, m^3/ha = cubic meter per hectare, PRV = Prey Veng, SRP = Siem Reap, TBK = Tboung Khmum.
Source: TA 8179-CAM: Mainstreaming Climate Resilience into development Planning adapted by PPTA team.

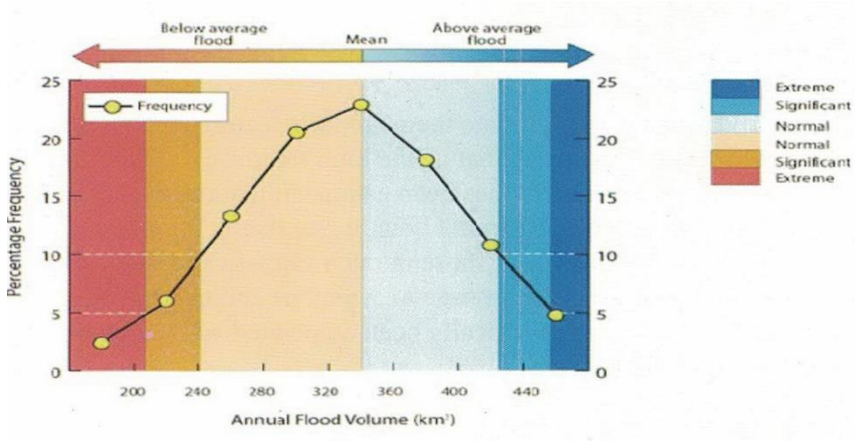
68. Without data on water availability for the irrigation schemes, the vulnerability of the long list irrigation subprojects to increased crop water demand and/or reduced rainfall due to climate change is unknown, but the indicative crop water demands can be used as a determinant of subproject design, ensuring adaptation of the irrigation to future climates.

B. Flooding – All Village Road and Irrigation Subprojects

69. Both the irrigation and village road core subprojects and those long list candidate subprojects in Kampong Cham and Prey Veng are located on the floodplain of the Lower Mekong. Floods here are as a result of (i) the annual flood event of the Mekong (major contribution); and (ii) localized rainfall events (minor contribution).

70. **Annual flood event.** The Mekong's annual flood pulse lasts for several months and defines a distinct hydrological season. The annual flood is predictable in terms of its occurrence and timing and defines a transition from a terrestrial phase during the dry season to an aquatic phase during the wet season, when huge areas are inundated naturally. Under these circumstances the annual flood is not a "hazard" in that it is expected and planned for through long experience. Only when the normal range of the annual flood volume and peak discharges are significantly exceeded do negative impacts occur (Figure 21).

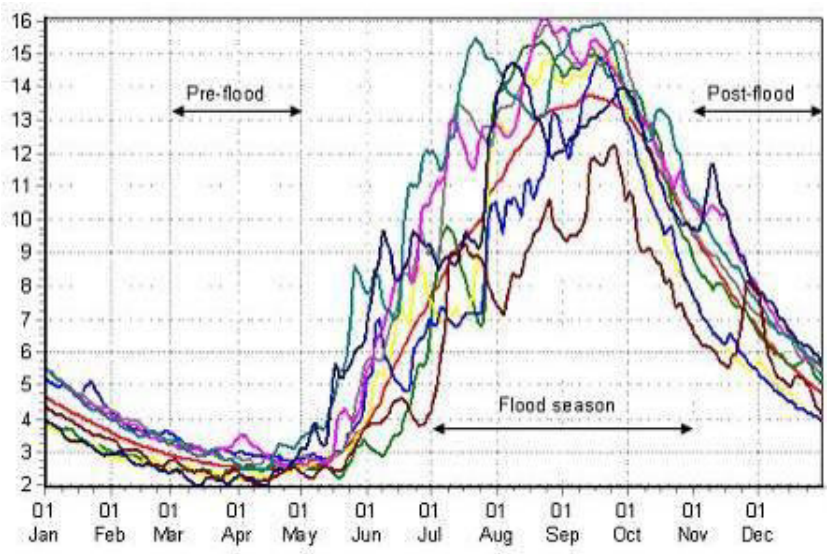
Figure 21: Normal Distribution of Mekong Yearly Pulse showing Extremes of Flood and Drought



Source: Mekong River Commission (MRC). 2011, Annual Mekong Flood Report 2010.

71. The average annual peak discharge is about 45,000 m^3/s at Phnom Penh while the lowest discharge is about 1,500 m^3/s (Figure 22). The year 1978 flood is considered as the highest flood ever regarding discharge which is about 77,000 m^3/s at Kratie (MRC, 2007c). The year 2000 flood had a discharge of about 50,000 to 55,000 m^3/s and a volume of about 475 km^3. The recurrence periods for the discharges are about 50 years for the year 2000 flood and about 10,000 years for the year 1978 flood.[17] During the eight years from 2003 to 2010, the annual flood volume has not risen above average, but in 2011 and 2013, major floods affected Cambodia generally, and the subproject sites in particular.

Figure 22: Mekong Flood Hydrographs at Kampong Cham (1998 until 2005)



[a] On the vertical axis the peak discharges in 1000 m^3/s.

[17] Cited in: Douven, W.J.A.M., M. Goichot and H.J. Verheij (2009), *Best Practice Guidelines for the Integrated Planning and Design of Economically Sound and Environmentally Friendly Roads in the Mekong Floodplains of Cambodia and Viet Nam*, synthesis report of the 'Roads and Floods' project (part of MRC-FMMP Component 2. MRC Technical Paper No. 35, Mekong River Commission, Office of the Secretariat in Phnom Penh. 143 pp.

Source: MRC 2011, Annual Mekong Flood Report 2010.

72. The main ***climatic drivers*** of the magnitude of the Mekong floods in any given year are: (i) the strength or weakness of the south-west monsoon; and (ii) the incursion of typhoons and tropical storms from the South China Sea.

73. The general regional trends for the Lower Mekong from all models indicate a wetter south-west monsoon period. Cambodia's "Strategic Program for Climate Resilience"[18] report supports the Mekong River Commission's (MRC's) conclusions that with anticipated climate change, the Lower Mekong Basin[19] will:

(i) experience later starts to the wet season (by about two to four weeks), which will also be shorter and wetter; and
(ii) experience a higher and increasing intensity of precipitation.

74. Various scenario studies have also been carried out by MRC taking into account not only global climate changes, but also construction of large dams in the Mekong basin upstream of the Lower Mekong Basin, and the expected economic growth.[20] These studies indicated a maximum future discharge of about 65,000 m^3/s and a minimum discharge of about 30,000 m^3/s.

75. Although major tropical cyclones originating in the South China Sea rarely penetrate into Cambodia, the cyclonic effects (including tropical storms) emanating from them have been more common in central Cambodia in the last decade. Without reliable data on the future frequency of these events, it must be assumed that present trends will continue.

76. **Localized rainfall events.** A consideration of localized rainfall events is made possible by the CCAM model (at RPC 8.5) which is downscaled to the sub-provincial level. This predicts a drier wet season of -8.4 mm/yr in the central and south lowlands and an increase at the start of the wet season of +1.2 mm/yr. It predicts no change to the dry season. More precisely, the projected change[21] in one day extreme rainfall is the difference between current and projected 2055 values.

77. **Core subprojects.** The CCAM model (at RPC 8.5) projects a small increase (no change to an increase of 5 mm) in one day extreme rainfall for the village road core subproject area in Kampong Cham. The projected five day extreme rainfall model projects a decrease in five day extreme rainfall over the same subproject area of -6.5 mm to -12 mm. For the core subproject for irrigation in Prey Veng province the same model projects a small increase (no change to an increase of 5 mm) in one day extreme rainfall and a decrease of up to 6 mm in five day extreme rainfall.

78. The studies of the drivers of the Lower Mekong floods indicate that, although predicted localized rainfall will not increase significantly in climate change scenarios, the annual flood pulse of the Mekong will continue with a variability between 65,000 m^3/s and 30,000 m^3/s at Kampong Cham, upstream of both core subprojects – to be exacerbated by the effects of tropical storms and the effects of nearby typhoons at an unknown frequency.

79. Local data on floods and the current frequency of overtopping of canal regulatory structures and canal walls in the Lvea commune is not available. However, there is a yearly long

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[18] RGC, 2011, Strategic Program for Climate Resilience, Prepared for the Pilot Program for Climate Resilience.
[19] MRC, 2009, Adaptation to climate change in countries of the Lower Mekong Basin: regional synthesis report, MRC Technical Paper No. 24.
[20] Douven et al 2009, op cit.
[21] Projected extreme rainfall is the average results from the six CSIRO CCAM model runs for a 20-year period centered on 2055 using an RCP of 8.5.

wet season rice crop and the agricultural calendar for the commune indicates a capacity to cope with and use the yearly floods. Data on floods and the current frequency of overtopping of the existing road is currently limited to anecdotal reports from the commune and individual farmers. These reports range from yearly overtopping of a minimum of 0.3 m to an uncommon depth of 2 m, and the impassability of the road during and after these periods seriously constrains agriculture and commercial activities and access to services.

80. These findings indicate that there is a medium vulnerability for the core irrigation subproject and a high vulnerability for the core rural road subproject to increased flooding as a result of climate change.

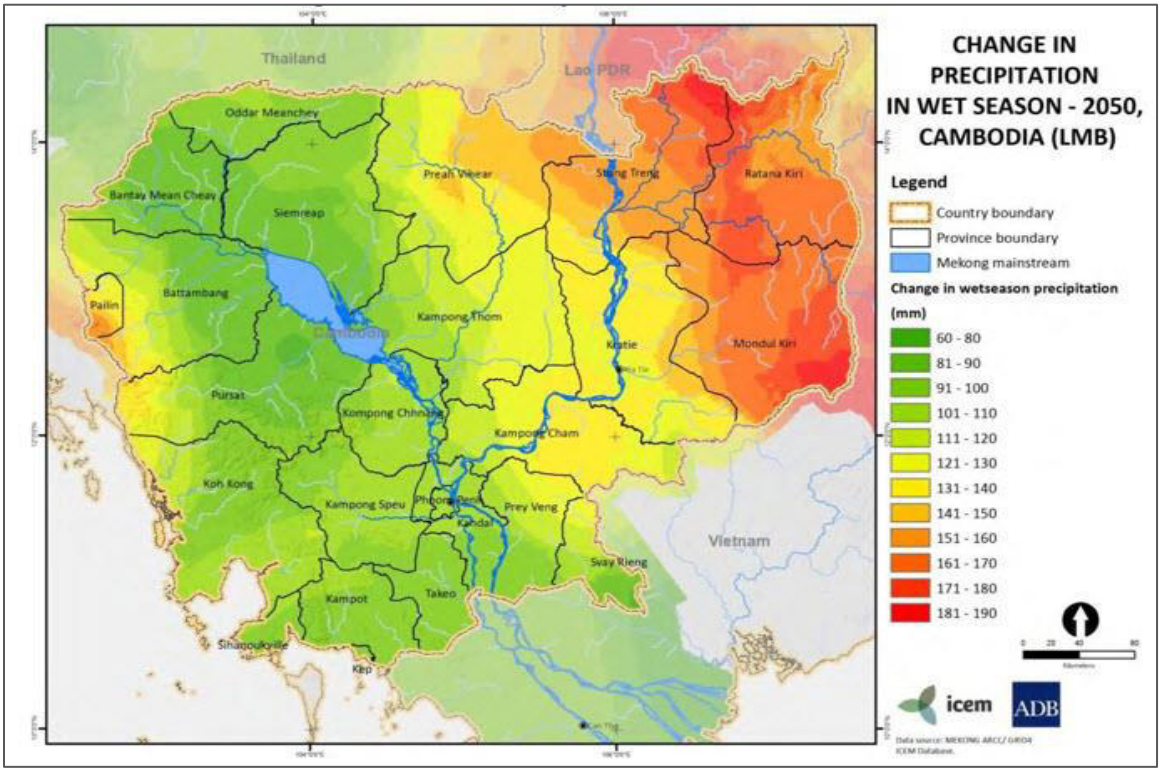
Province	Vulnerability of Core Rural Road Subproject	Vulnerability of Core Irrigation Subproject
Kampong Cham on Mekong floodplain	High	---
Prey Veng on Mekong Floodplain	---	Medium

81. **Long List Subprojects.** All long list candidate subprojects on the floodplain in the Lower Mekong provinces of Prey Veng, and Kampong Cham/Tboung Khmum will have the same vulnerability characteristics: medium vulnerability for irrigation subprojects and high vulnerability for rural road subprojects to increased flooding.

Province	Vulnerability of Long List Rural Road Subproject	Vulnerability of Long List Irrigation Subproject
Kampong Cham on Mekong floodplain	High	Medium
Tboung Khmum on Mekong Floodplain	High	Medium
Prey Veng on Mekong Floodplain	High	Medium

82. Future flooding potential in Banthaey Meanthey, Battambang, Kampong Thom, Siem Reap, and Tboung Khmum, and those parts of Kampong Cham, Prey Veng, and Tboung Khmum away from the Mekong floodplain, will be affected by future changes in rainfall in the wet season and changes in rainfall intensity (one day and five day rain events). Projected rainfall in these provinces in TA8179-CAM: Mainstreaming Climate Resilience into Development Planning (Figure 23) shows that wet season rainfall will increase in 2050 in all provinces, with the highest ranges in Tboung Khmum (120 mm - 140mm) and Kampong Cham, Kampong Thom, and Prey Veng (100 mm – 130 mm). Predicted rainfall intensities (one day and five day rain events) differ with all provinces showing increases in one day events, and mixed predictions of large decreases and smaller increases in five day rainfall (Table 11).

Figure 23: Predicted Change in Wet Season Rainfall in 2050



Source: TA8179-CAM: Mainstreaming Climate Resilience into Development Planning.

Table 11: Predicted Rainfall in Wet Season and Rainfall Intensity in 2050

Province	Predicted Wet Season Rainfall Change (mm)	1 Day Rain Event change (mm) - all increases	5 Day Rain Event change (mm) – increases except where noted
Banthaey Meanchey	81-90 (6-7%)	0.0-2.5 (0-1.9%)	-16.5 to -17.5 (4-10% reduction)
Siem Reap	100-120 (8-8.5%)	2.5-5.0 (2.1-3.4%)	5.0 to 8.0 (3.1-3.3%)
Battambang	81-90 (5-7%)	0.0-2.5 (0-1.7%)	-6.5 to -17.5 (4-9.2% reduction)
Kampong Thom	100-130 (7.3-7.5%)	5.0-12.5 (3.8-7.8%)	5.0 to 28 (2.6-12.7%)
Kampong Cham	100-130 (5.7-7.4%)	5.0-16 (3.1-10%)	5.0 to 20 (2.3-12.7%)
Tboung Khmum	120-140 (6.6-7.7%)	5.0-12.5 (3.1-6.9%)	5.0 to 16 (2.3-7.3%)
Prey Veng	100-130 (7.3-8%)	0.0-5.0 (0-2.9%)	5.0 to 10 (2.3-4.5%)

mm = millimeter.
Source: TA8179-CAM: Mainstreaming Climate Resilience into Development Planning and CCAM Model, CSIRO 2013.

83. Increases in rainfall runoff in the wet season have the potential to increase flood heights and duration, while increases in the intensity of rainfall events can potential for flash floods in the future, which can cause significant damage to crops and roads but over a short duration. From these projections, taken in combination with the following assessments, long list candidate subproject vulnerabilities have been determined (Table 12).

Table 12: Vulnerability Assessment of Long List Subprojects to Future Flooding

Province	Vulnerability of Rural Road subprojects	Vulnerability of Irrigation subprojects
Banthaey Meanchey	Low – medium	Low
Siem Reap	Medium	Medium
Battambang	Low – medium	Low
Kampong Thom	High	High
Kampong Cham[a]	High	Medium - high
Tboung Khmum [a]	High	Medium - high
Prey Veng [a]	Medium	Medium

[a] Areas of province not on Mekong floodplain.

V. ADAPTATION ASSESSMENT

1. Core Subprojects

84. **Irrigation.** The crop of interest for Lvea commune is dry season rice (90-day crop). The projections from SRES scenarios for irrigation planning (MOWRAM Model – see Figure 15 above) show that the irrigation water requirement (IWR) for these crops will be in the following ranges in 2020 and 2050 (Table 13):

Table 13: Predicted IWRs from Climate Change and IWRs used in Subproject Water Balances for 305 ha Dry Season Crop at Lvea

Crop	Predicted IWR in 2020 (m^3/ha)	Predicted IWR in 2050 (m^3/ha)	IWR used in Water Balances in IEE for dry years (m^3/ha)
Dry season rice (short season)	15,000-15,500	16,250-16,400	18,000

ha = hectare, IEE = initial environmental examination, IWR = irrigation water requirement, m^3/ha = cubic meter per hectare.
Source: PPTA team.

85. Table 13 shows that when the IWRs from future climate change scenarios are compared with the IWRs being used for subproject design the project design IWRs are consistently higher and already allow for the eventuality of future increased water demand in both 2020 and 2050.

86. However, that same analysis revealed that, while the irrigation is possible, that rate of extraction of the water will need to be coordinated with downstream schemes and users, since the scheme takes about 17% of the available water in a typical dry year.

87. Floods and extreme weather events can damage crops and irrigation infrastructure. The vulnerability of the Lvea commune irrigation subproject to these impacts has been assessed as medium, since yearly floods are expected and form part of the cropping calendar. Large increases in rainfall intensity are not predicted.

88. Overtopping of irrigation channels and structures and general flooding of the land will continue and flood resistance (i.e., stopping the flooding of the paddy fields) is inappropriate. However, protection of the irrigation infrastructure from flood damage ("flood resilience"), so that it remains functional for the succeeding dry season, is a necessity.

89. **Village road**. Local rainfall and extreme rainfall events are not predicted to significantly increase in the future, but the annual flooding in the Lower Mekong will continue to affect the area and the effect of typhoons and tropical storms in the region will also continue, making the core subproject road highly vulnerable to climate change. However, current adaptation capacity and opportunity for the village road subproject is low. According to anecdotal reports the road is cut by flood waters every year. This cutting of the main access between Banthaey commune and Chbar-Ampov commune both of which are agriculture-based communes and often lasts for extended periods, and leaves the road damaged and impassable for a further period. This has a significant impact on livelihoods. The commune lacks the resources to prepare the road for the yearly impact and relies on outside resources.

2. Long List Subprojects

90. The majority of long list candidate subprojects will mirror those of the core subprojects, with cropping systems and infrastructure adapted to wet season inundation and rainfall events, and with communes lacking resources to fully prepare their roads and infrastructure for yearly flood impacts.

91. **Irrigation.** Adaptation assessment in terms of future water availability for these subprojects to successfully and sustainably irrigate a dry season crop is not possible because the locations, command areas, water sources and cropping calendars of the subprojects are not yet known. However, the calculation of future crop water requirements under changed climate in Section IV.A.2 can be used in the design of these future irrigation schemes to ensure that the proposed cropping regimes and irrigation water availability can match the crop water requirements which already incorporate the effects of future climate change.

92. As with the Lvea core subproject, overtopping of irrigation channels and structures and general flooding of the land will often be a common occurrence and flood resistance (i.e., stopping the flooding of the paddy fields) is inappropriate. However, protection of the irrigation infrastructure from flood damage ("flood resilience"), so that it remains functional for the succeeding dry season should be the focus of adaptation measures.

93. Rural roads. Adaptation to future climate change is a priority for rural road subprojects in Kampomg Cham, Kampong Thom, Tboung Khmum and the Mekong floodplain areas of Prey Veng – all of which have been assessed as being highly vulnerable to future floods and extreme weather. Local circumstances, when they are known, may also mean that long list road

subprojects with lower climate change vulnerabilities in Banthaey Meanchey, Battambang, and Siem Reap should be designed and operated with appropriate adaptation measures.

94. No data on alignments, specifications and hydrological setting is available for the long list road candidate subprojects. However, it is reasonable to assume that the communes that they serve share the same limitations as those of the core subprojects and that the communes lack the resources to prepare their roads for the yearly impact and rely on outside resources.

3. Conclusions

95. The outcome of the adaptation assessment can result in three different types of decisions:[22]

> **Decision of Type 1:** Invest in climate proofing the project at the time the project is being designed or implemented.
>
> **Decision of Type 2:** Do not invest now in climate proofing but ensure that the project is designed in such a way as to be amenable to be climate proofed in the future if and when circumstances indicate this to be a better option than not climate proofing.
>
> **Decision of Type 3:** Do no changes to project design, monitor changes in climate variables and their impacts on the infrastructure assets, and invest in climate proofing if and when needed at a later point in time.

96. Considering the socio-economic circumstances of the rural communities that the TSSD-AF project is targeting, and the limited capacity and resources in the communes of these areas for forward planning, it is considered most beneficial to invest in climate proofing through design and project implementation (i.e., Decision type 1).

97. The project will also put in place capacity building and local administrative structures commune councils, farmer water user groups (FWUG), livelihood improvement groups (LIG) and market improvement groups (MIG) which can, in the future, undertake adaptive management – making additional adaptation Type 3 decisions.

VI. IMPLEMENTATION

98. The Cambodia Climate Change Strategic Plan, 2014 – 2023 identifies two strategic objectives to enhance adaptation to the impacts of future climate change. Strategic Objective 1 (Promote climate resilience through improving food, water and energy security) includes a provision to … *Rehabilitate and build water infrastructures including small-, medium- and large-scale irrigation schemes*. Strategic Objective 2 (Reduce sectoral, regional, gender vulnerability and health risks to climate change impacts) includes …. *Enhance the quality of rural infrastructure (roads, irrigation, wells and culverts) to be resilient to flood and drought*. The implementation of the core subprojects will be in line with these strategic objectives.

99. The ADB Climate Proofing Guidelines for agriculture and road projects cover both structural and non-structural adaptation measures. From the foregoing discussion in Section V, the focus of this CRVA is on infrastructure design (in construction and rehabilitation subprojects) in line with Decision Type 1, and those listed below for irrigation and roads are in line with the climate proofing guidelines. However, the outputs of the TSSD-AF project includes a range of non-structural investments (mainly in the agriculture sector) which also address the approaches

[22] Asian Development Bank. 2012. *Guidelines for climate proofing investment in agriculture, rural development, and food security* Mandaluyong City, Philippines: Asian Development Bank.

listed in the climate proofing guidelines. These include:

(i) Crop development;
(ii) Agricultural information systems;
(iii) Resource management innovations;
(iv) Agricultural support programs;
(v) Resource management programs;
(vi) Crop selection and crop calendar; and
(vii) Water management.

100. The TSSD-AF project will therefore implement both structural and non-structural adaptation measures to address the vulnerabilities identified in this CRVA.

A. Adaptation Response to Drought and Increased Crop Water Requirement

101. **Irrigation.** The PPTA team has confirmed that the IWR calculations used in the core subproject designs are consistently higher than the future increased water demand calculated for climate change scenarios for both 2020 and 2050. This means that IWRs from future climate change scenarios have already been incorporated in subproject designs. Table 14 shows the percentages by which design IWRs exceed predicted IWRs.

Table 14: Predicted IWRs from Climate Change and IWRs used in Core Subproject Water Balances

Crop	Predicted IWR in 2020 (m^3/ha)	IWR used in subproject design are higher by …	Predicted IWR in 2050 (m^3/ha)	IWR used in subproject design are higher by …
Dry season rice	15,000-15,500	20%-16%	16,250-16,400	11%-9.75%

IWR = irrigation water requirement, m^3/ha = cubic meter per hectare.
Source: PPTA team.

102. The design IWRs for the subprojects exceed the additional water requirements predicted for 2020 and 2050 by between 10% and 20%, so adaptation for this effect of climate change has been addressed. However, that same analysis revealed that, while the irrigation is possible, that extraction of the water may put pressure on downstream supplies.

103. For long list subprojects, the CRVA has calculated indicative future crop water requirements (Table 10) which can help ensure that future irrigation subprojects in these provinces will be planned and designed to take account of these conditions and match them to water availability.

1. Adaptation Measures

104. Where crop water requirements and sustainable water availability do not match, for both core and long list subprojects, there are three main activities which are needed to address this. These can be undertaken either individually or in combination:

(i) Increasing the irrigation efficiency. The water balance for the irrigation was based upon an irrigation efficiency of 40%. This is a combination of conveyance efficiency, distribution efficiency, and field application efficiency. The new irrigation area for a dry season crop is starting from a near 0% efficiency and 40% would be a very significant advance in the first 10 years of operation. Only when the irrigation is well established can field trials be undertaken to investigate the opportunity for improvement in each of the constituent efficiencies.

(ii) Reducing the irrigated area. This will be a response to water availability in the long

term and may occur as a planned response to limited flow in the main water source by pumping station operators and commune officers in very dry years, or as a result of inter-commune user group negotiations (especially with downstream communes). Any decrease in the planned total area for dry season irrigation will improve the adaptation response to future increases in crop IWRs.

(iii) Operational procedures. for the sustainable and responsible management of irrigation schemes. These will ensure that agreed irrigation and base flows are maintained and other beneficial water users are not disadvantaged. They will provide a clear and detailed extraction plans for the growing seasons. The plans will be prepared by the subproject commune councils in consultation with farmer groups, as a prerequisite for project commencement. Operational plans and operating practices for water allocations and drainage will be documented and approved by the implementing agency and ADB before procurement and construction commences.

B. Adaptation Response to Increased Flood Potential

105. **Irrigation Subprojects.** Data on floods and the current frequency of overtopping of canal regulatory structures and canal walls for the core subproject is not available. However, modelling of future scenarios indicate that although local rainfall and extreme events are unlikely to significantly increase in the future, the annual flooding in the Lower Mekong will continue to affect the area and the penetration of typhoons and tropical storms into or in the region of this part of Cambodia will continue with an uncertain frequency.

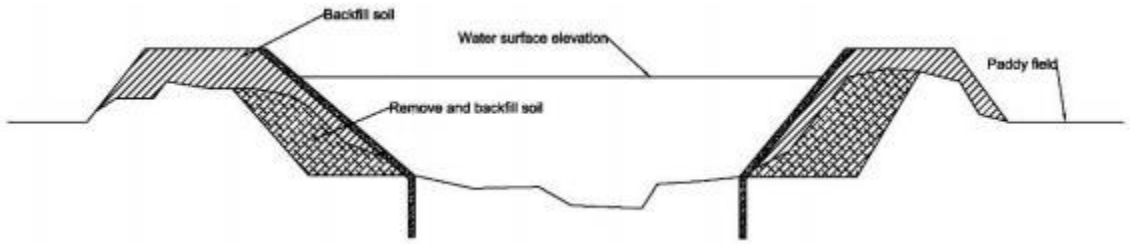
106. The adaptive response to flood vulnerability of long list candidate subprojects, especially those in Kampong Thom, Kampong Cham, and Tboung Khmum provinces which have been assessed as medium-high and high vulnerability, is the same as for the core subproject. These are described below.

1. Adaptation Measures

107. Subproject canals are secondary and tertiary structures. Secondary canals lead off the primary canals and it is here that design for flood resilience is required. Canal walls will be reconstructed where needed and strengthened to withstand flood flows. Sluice gates will be provided with erosion/scour protection to maintain the integrity of control structures against high energy flood flows. The crest height of control gates will be adjusted above the 1 in 100 year level to provide the option of directing flood waters to control release sluices rather than overtopping and scouring the secondary canals.

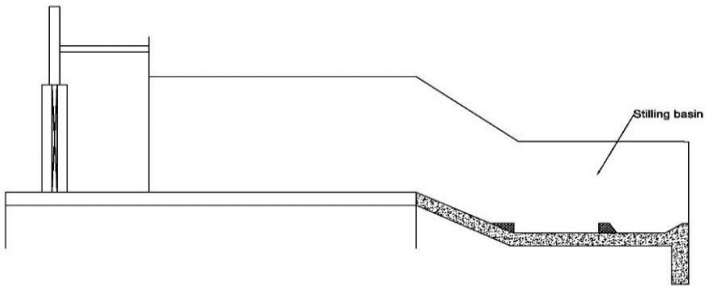
108. Typical canal rehabilitation along high flow sections (closest to offtake from the primary canal) will involve replacement of structurally unsuitable material. This can be combined with an installed lining inside the canal slopes (Figure 24) for the first 20 m - 30 m of the secondary canal which may be affected by high flows from the primary canal. This will retain a natural canal bed and benthic environment for the limited canal fisheries but protect vulnerable side walls from flood scouring and failure.

Figure 24: Typical Canal Rehabilitation Incorporating Side Wall Lining



109. All water (sluice) gates controlling water flow from the main canal into secondary canals may be equipped with small energy dissipation basins to ensure that excessive kinetic energy is dissipated before entering the earth channel section of the canals.

Figure 25: Downstream Erosion and Scour Protection of Area behind Sluice Gates on Secondary Canals



110. **Village Road Subprojects.** It is not possible, within the funding limitations of the project, to design and engineer the subject road to be fully flood resistant in the context of the maximum floods reported. However, a suite of design measures combining flood resistance against lower level floods and flood resilience against all floods are recommended. The following design measures, which comply with NCDD standards for rural road design, are a mixture of flood resistant and flood resilience measures (Figure 26).

2. Adaptation Measures

(i) Within budget constraints, flood resistance of the road (raising the road above the flood level) should be maximized. This will involve identification of high priority flood proofing sections and lower priority sections along the road alignment.

(ii) Armor road surfaces (natural stone or reinforced concrete) along floodway sections to protect during overtopping by floods.

(iii) Embankment batters will be at a slope no greater than 30º (1 in 2) and using imported material which is more erosion resistant than local soil.

(iv) The embankment will be turfed and planted with local shrubs to increase stability and resistance to fast flowing water.

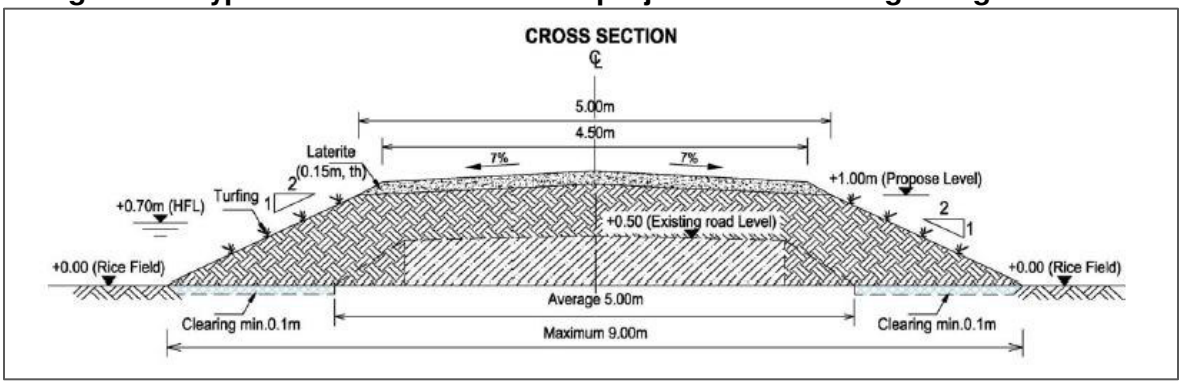
(v) The road surface will have a drainage slope of 2% from the center-line on the floodway section surface and 5% on other sections to shed water.

(vi) The road will have multiple through-drainage structures (culverts and pipes) to ensure that it will not be a flood barrier.

(vii) Culverts will be designed to exceed the height of the existing road level by a factor reflecting the projected increase in rainfall amount and intensity (Table 11) and local flood data.

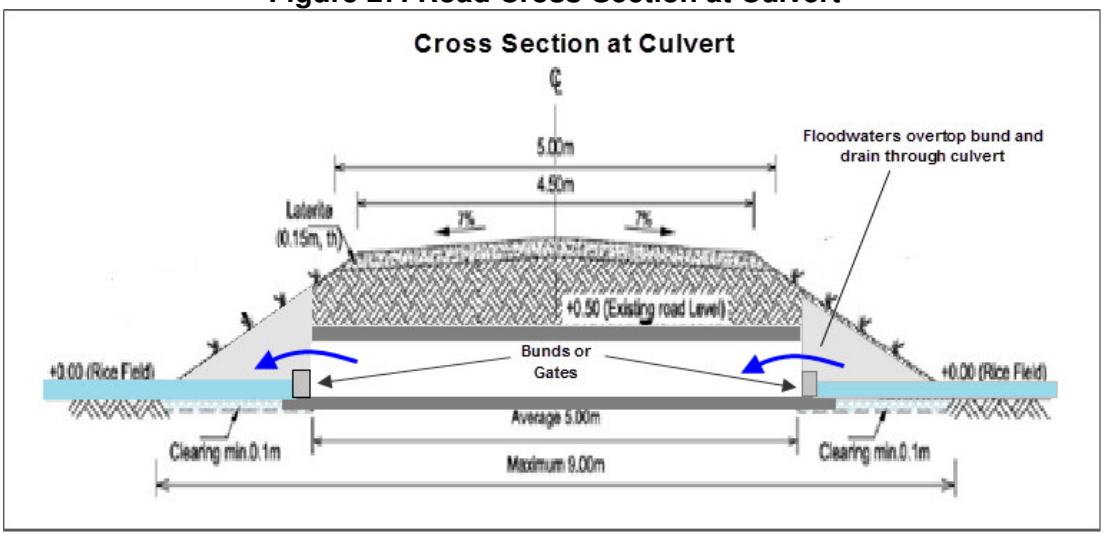
(viii) Where paddy field directly abut the road embankment, culverts will have bunds or water gates at each end which will allow inundation of adjoining paddy fields but which can also be overtopped by floodwaters (Figure 27).

Figure 26: Typical Cross Section of Subproject Road showing Design Features



Source: TSSD-AF PPTA Rural Road Technical Report.

Figure 27: Road Cross-Section at Culvert



Source: Adapted from TSSD-AF PPTA Rural Road Technical Report.

3. Adaptation Costs

111. Adaptation measures were developed for two core projects (one irrigation infrastructure and one rural road reconstruction) for which full feasibility studies were undertaken during the project TA phase. From these costs, unit costs were derived of $130/ha for irrigation subprojects and $14,920/km - $32,830/km for road subprojects (the range is for using natural stone and cement for surface in floodways or using reinforced concrete for floodways, respectively). Extrapolated over the full project implementation of 6,000 ha of irrigation and 175 km of flood resilient rural road, this represents climate change adaptation totals of $0.78 million (irrigation) and $2.61 million to $5.745 million (rural roads). A breakdown of indicative adaptation costs is at **Attachment 2**.

C. Natural Disasters

112. The TSSD-AF will improve on designs for roads and irrigation schemes under the project to incorporate climate resilience and to mitigate disaster risks in communes subject to flooding or drought. Two recent ADB projects have also made recommendations to the government on such measures.[23]

113. Commune-based DRR will be supported by the project through the preparation of a commune action plan and training plan for DRR relevant to the irrigation and village road subprojects. This will be integrated with existing Cambodian government national DRR training and planning programme through the National Committee for Disaster Management (NCDM) Secretariat, which aims to undertake all commune level DRR training and planning. At the sub-commune level and with livelihood improvement groups (LIGs) the projects action plan and training will dovetail with Oxfam's DRR delivery.

114. Commune councillors will be trained in DRR. Training will be delivered by the NCDM secretariat under the ADB Community-Based Disaster Risk Reduction (CDRR) Project and through training applications prepared for commune extension workers to deliver. Capacity development in DRR to increase operational knowledge at commune and village levels will also be delivered through the ICT component including improved DRR and extension information transmitted through radio, TV and mobile access devices.[24]

VII. MONITORING AND EVALUATION

115. The adaptation measures identified in this CRVA are incorporated into subproject design and operational management through recommendations made in the core subproject environmental management plans (EMPs) and long list candidate subproject assessments (with either an EMP or Environmental Code of Conduct) guided by the environmental assessment and review framework (EARF).

116. The effectiveness and performance will be monitored in the short term by the compliance monitoring of the subproject EMP by project implementation consultants (to check that measures are actually put in place) and the environmental performance monitoring of the EMP.

117. In the longer term, the effectiveness of the design and operating measures will be monitored through the project's design and monitoring framework (DMF). The DMF includes verifiable outcomes of continuing serviceability and access of rural roads constructed by the project, and successful dry season cropping through sustainable improvements in agricultural infrastructure.

[23] McDonald A, 2016, ibid.
[24] See Draft Final report. Linked Document 23: *Rural ICT.*

Attachment 1: Rapid Environmental Assessment (REA) Checklist

Instructions:

(i) The project team completes this checklist to support the environmental classification of a project. It is to be attached to the environmental categorization form and submitted to the Environment and Safeguards Division (SDES) for endorsement by the Director, SDES and for approval by the Chief Compliance Officer.

(ii) This checklist focuses on environmental issues and concerns. To ensure that social dimensions are adequately considered, refer also to ADB's (a) checklists on involuntary resettlement and Indigenous Peoples; (b) poverty reduction handbook; (c) staff guide to consultation and participation; and (d) gender checklists.

(iii) Answer the questions assuming the "without mitigation" case. The purpose is to identify potential impacts. Use the "remarks" section to discuss any anticipated mitigation measures.

Country/ Project Title: CAM: Tonle Sap Poverty Reduction and Smallholder Development Project – Additional Financing

Sector Division: SEER/SERD

Screening Questions	Yes	No	Remarks
A. PROJECT SITING IS THE PROJECT AREA ADJACENT TO OR WITHIN ANY OF THE FOLLOWING ENVIRONMENTALLY SENSITIVE AREAS?			Subproject selection criteria will preclude candidate subprojects in or adjacent to environmentally sensitive areas
▪ PROTECTED AREA		X	
▪ WETLAND		X	
▪ MANGROVE		X	
▪ ESTUARINE		X	
▪ BUFFER ZONE OF PROTECTED AREA		X	
▪ SPECIAL AREA FOR PROTECTING BIODIVERSITY		X	
B. POTENTIAL ENVIRONMENTAL IMPACTS WILL THE PROJECT CAUSE…			

Screening Questions	Yes	No	Remarks
▪ loss of precious ecological values (e.g. result of encroachment into forests/swamplands or historical/cultural buildings/areas, disruption of hydrology of natural waterways, regional flooding, and drainage hazards)?	X		Weirs are necessary for the functioning of the irrigation systems. To enable aquatic life migration up and downstream, the IEE/EMP will consider appropriate mitigation measures like fish passages, if necessary
▪ conflicts in water supply rights and related social conflicts?		X	
▪ impediments to movements of people and animals?		X	
▪ potential ecological problems due to increased soil erosion and siltation, leading to decreased stream capacity?	X		
▪ Insufficient drainage leading to salinity intrusion?		X	Irrigation systems will be designed to have adequate outfalls to existing waterways
▪ over pumping of groundwater, leading to salinization and ground subsidence?		X	Over pumping of groundwater is unlikely due to the limited availability and high prices of electricity
▪ impairment of downstream water quality and therefore, impairment of downstream beneficial uses of water?	X		Any increased use of agro-chemicals will be offset by training in sustainable practices involving reduced or optimized use of pesticides and fertilizer.
▪ dislocation or involuntary resettlement of people?		X	
▪ disproportionate impacts on the poor, women and children, Indigenous Peoples or other vulnerable groups?		X	
▪ potential social conflicts arising from land tenure and land use issues?		X	
▪ soil erosion before compaction and lining of canals?		X	
▪ noise from construction equipment?	X		Mitigation provided for in EMP
▪ dust during construction?	X		Mitigation provided for in EMP
▪ waterlogging and soil salinization due to inadequate drainage and farm management?		X	Irrigation systems will be designed to have adequate drainage, capacity development for farmers on farm management

Screening Questions	Yes	No	Remarks
▪ leaching of soil nutrients and changes in soil characteristics due to excessive application of irrigation water?		X	capacity development for farmers on farm management
▪ reduction of downstream water supply during peak seasons?	X		The IEE/EMP has to assess minimum flow conditions for downstream users
▪ soil pollution, polluted farm runoff and groundwater, and public health risks due to excessive application of fertilizers and pesticides?	X		Any increased use of agro-chemicals will be offset by training in sustainable practices involving reduced or optimized use of pesticides and fertilizer.
▪ soil erosion (furrow, surface)?	X		
▪ scouring of canals?		X	Appropriate canals will be built to avoid that issue.
▪ clogging of canals by sediments?	X		Some minor risk, but regular maintenance will be encouraged
▪ clogging of canals by weeds?	X		As above
▪ seawater intrusion into downstream freshwater systems?		X	
▪ introduction of increase in incidence of waterborne or water related diseases?		X	Risks will be reduced by appropriate canals which will limit ponding and therefore habitats for insect vectors of disease
▪ dangers to a safe and healthy working environment due to physical, chemical and biological hazards during project construction and operation?		X	Minor risks are considered in the IEE/EMP and mitigated
▪ large population influx during project construction and operation that causes increased burden on social infrastructure and services (such as water supply and sanitation systems)?		X	
▪ social conflicts if workers from other regions or countries are hired?		X	
▪ risks to community health and safety due to the transport, storage, and use and/or disposal of materials such as explosives, fuel and other chemicals during construction and operation?		X	Only minor risk

Screening Questions	Yes	No	Remarks
▪ community safety risks due to both accidental and natural hazards, especially where the structural elements or components of the project (e.g., irrigation dams) are accessible to members of the affected community or where their failure could result in injury to the community throughout project construction, operation and decommissioning?		X	

A Checklist for Preliminary Climate Risk Screening

Country/Project Title: CAM: Tonle Sap Poverty Reduction and Smallholder Development Project, AF

Sector : Agriculture, Natural Resources and Rural Development

Subsector: Agricultural production and Irrigation

Division/Department: SEER / SERD

Screening Questions		Score	Remarks[1]
Location and Design of project	Is siting and/or routing of the project (or its components) likely to be affected by climate conditions including extreme weather related events such as floods, droughts, storms, landslides?	1	Infrastructure will be strengthened to withstand anticipated floods.
	Would the project design (e.g., the clearance for bridges) need to consider any hydro-meteorological parameters (e.g., sea-level, peak river flow, reliable water level, peak wind speed etc.)?	1	Hydro-meteorological parameters essential for design
Materials and Maintenance	Would weather, current and likely future climate conditions (e.g., prevailing humidity level, temperature contrast between hot summer days and cold winter days, exposure to wind and humidity hydro-meteorological parameters likely affect the selection of project inputs over the life of project outputs (e.g., construction material)?	0	Irrigation infrastructure Improvements based on technical best practices and not affected. Material selection will suit current climate variability.
	Would weather, current and likely future climate conditions, and related extreme events likely affect the maintenance (scheduling and cost) of project output(s)?	1	Floods may affect infrastructure maintenance if not designed to withstand those.
Performance of project outputs	Would weather/climate conditions, and related extreme events likely affect the performance (e.g., annual power production) of project output(s) (e.g., hydro-power generation facilities) throughout their design life time?	0	The project provides water during the dry season for additional cropping

Options for answers and corresponding score are provided below:

[1] If possible, provide details on the sensitivity of project components to climate conditions, such as how climate parameters are considered in design standards for infrastructure components, how changes in key climate parameters and sea level might affect the siting/routing of project, the selection of construction material and/or scheduling, performances and/or the maintenance cost/scheduling of project outputs.

Response	Score
Not Likely	0
Likely	1
Very Likely	2

Responses when added that provide a score of 0 will be considered low risk project. If adding all responses will result to a score of 1-4 and that no score of 2 was given to any single response, the project will be assigned a medium risk category. A total score of 5 or more (which include providing a score of 1 in all responses) or a 2 in any single response, will be categorized as high risk project.

Result of Initial Screening (Low, Medium, High): Medium

Other Comments:_____

_____

Prepared by: Marco Leidel

Attachment 2: Estimate of Climate Change Adaptation (CCA) and Disaster Risk Reduction (DRR) Costs

Incremental Adaptation Costs for Core Subprojects

Adaptation Measure		Cost ($)	
Irrigation subproject (305 ha)			
Additional length of concrete lining at head regulators to protect walls from high velocity water		2,400	
Stone masonry at head regulators to protect walls from high velocity water		9,400	
Steel watergates for secondary canals 2 and 3. Built level with main canal crest to retain minor or early flood in main canal (until overtopped)		5,000	
Establishment of vegetation on canal levees		17,850	
Total		*39,650*	
Rural road subproject (7.45 km)			
Road height will be increased by up to 0.6 m – 0.8 m above existing alignment for the flood prone section of the alignment. Increment is 0.2 m in height for 4,000 m linear (10,800 m^3)		14,040	
Higher embankments for vegetating due to higher road crest. Increment of embankment slope to vegetate for 4,000 m linear (2,160 m^2)		1,382	
Reinforced concrete surface over floodway for 2,800 m linear. (1,764 m^2)	Natural stone and cement binding over floodway for 2,800 m linear.	211,680	111,120
Multiple through-drainage structures (culverts and pipes) to ensure no flood barrier. Additional 10 piped culverts along alignment.		17,500	
Total		*244,602*	*144,042*

Cost per unit for irrigation: $130/ha
Cost for whole project (6,000 ha): $0.78 million

Cost per unit for road: $14,918/km - $32,832/km
Cost for whole project (175 km): $2.61 - $5.745 million

Total CCA/DRR Costs for Project

Item	Cost ($ million)	Explanation
Rural Roads	2.61 – 5.745	Incremental climate change adaptation (CCA)/DRR cost (rock/cement – reinforced concrete respectively on floodway)
Small-scale Irrigation	0.78	Incremental CCA/DRR cost
Support to new livelihood improvement groups	4.50	revolving funds to enhance communities' resilience
Disaster risk reduction (DRR) Training for commune councils	1.38	Training for commune councils
Ministry of Agriculture, Forestry and Fisheries (MAFF) – Department of Agriculture letter of agreement (support to value chain development)	0.34	Training on climate-resilient agricultural practices (provincial level)
MAFF- General Directorate of Agriculture letter of agreement (support to value chain development)	0.77	Training on climate-resilient agricultural practices (national level)

Item	Cost ($ million)	Explanation
At district level - training, meeting, and workshops cost	0.10	Training cost
Total	**10.48 – 13.615**	