
Concept Note

Enhancing Climate Resilience in Thailand through Effective Water Management and Sustainable Agriculture

Kingdom of Thailand | United Nations Development Programme (UNDP)

21 September 2016



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Concept Note

The Green Climate Fund (GCF) is seeking high-quality projects or programmes.

Accredited entities may choose to submit a concept note, in consultation with the relevant national designated authority, to present the proposed project or programme idea in order to receive early feedback and recommendation.

Project/Programme Title: **Enhancing Climate Resilience in Thailand through Effective Water Management and Sustainable Agriculture**

Country/Region: **Kingdom of Thailand**

Accredited Entity: **United Nations Development Programme (UNDP)**

National Designated Authority: **Director of Climate Change Management and Coordination Division
Office of Natural Resources and Environmental Policy and Planning**

Please submit the completed form to fundingproposal@gcfund.org¹

A. Project / Programme Information	
A.1. Project / programme title	Enhancing Climate Resilience in Thailand through Effective Water Management and Sustainable Agriculture
A.2. Project or programme	Project
A.3. Country (ies) / region	Thailand
A.4. National designated authority(ies)	Director of Climate Change Management and Coordination Division Office of Natural Resources and Environmental Policy and Planning
A.5. Accredited entity	UNDP
A.6. Executing entity / beneficiary	<p>Executing Entity: Royal Irrigation Department (RID) of the Ministry of Agriculture and Cooperatives</p> <p>Beneficiary: <u>Direct beneficiaries</u> – 20,000 households or 62,000 people² <u>Indirect beneficiaries</u> – 25 million people (population of the Chao Phraya river basin area)</p>
A.7. Access modality	Direct <input type="checkbox"/> International <input checked="" type="checkbox"/>
A.8. Project size category (total investment, million USD)	Micro (≤ 10) <input type="checkbox"/> Small ($10 < x \leq 50$) <input checked="" type="checkbox"/> Medium ($50 < x \leq 250$) <input type="checkbox"/> Large (> 250) <input type="checkbox"/>
A.9. Mitigation / adaptation focus	Mitigation <input type="checkbox"/> Adaptation <input checked="" type="checkbox"/> Cross-cutting <input type="checkbox"/>
A.10. Public or private	public
A.11. Results areas (mark all that apply)	<p><i>Which of the following targeted results areas does the proposed project/programme address?</i></p> <p>Reduced emissions from:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Energy access and power generation (E.g. on-grid, micro-grid or off-grid solar, wind, geothermal, etc.) <input type="checkbox"/> Low emission transport (E.g. high-speed rail, rapid bus system, etc.) <input type="checkbox"/> Buildings, cities, industries and appliances (E.g. new and retrofitted energy-efficient buildings, energy-efficient equipment for companies and supply chain management, etc.) <input type="checkbox"/> Forestry and land use (E.g. forest conservation and management, agroforestry, agricultural irrigation, water treatment and management, etc.) <p>Increased resilience of:</p> <ul style="list-style-type: none"> <input checked="" type="checkbox"/> Most vulnerable people and communities (E.g. mitigation of operational risk associated with climate change – diversification of supply sources and supply chain management, relocation of manufacturing facilities and warehouses, etc.) <input checked="" type="checkbox"/> Health and well-being, and food and water security (E.g. climate-resilient crops, efficient irrigation systems, etc.) <input checked="" type="checkbox"/> Infrastructure and built environment (E.g. sea walls, resilient road networks, etc.) <input type="checkbox"/> Ecosystems and ecosystem services (E.g. ecosystem conservation and management, ecotourism, etc.)

¹ Please use the following naming convention for the file name: “[CN]-[Agency short name]-[Date]-[Serial number]” (e.g. CN-ABC-20150101-1).

² Per 2010 Census, household size in the target region is approx. 3.1/household <http://popcensus.nso.go.th/upload/census-report-6-4-54-en.pdf>

A.12. Project / programme life span	5 years
A.13. Estimated implementation start and end date	Start: 1 July 2017 End: 30 June 2022

B. Project/Programme Details

The Fund requires the following preliminary information in order to promptly assess the eligibility of project/programme investment. These requirements may vary depending on the nature of the project/programme.

<p>B.1. Project / programme description (including objectives)</p>	<ol style="list-style-type: none"> 1. Climate change has had a significant impact on Thailand, including higher temperatures and variability in precipitation – shorter, more intense wet seasons, and longer, warmer dry seasons. These impacts are consistent with the fifth assessment report (AR5) from the Intergovernmental Panel on Climate Change (IPCC), which indicates that temperatures in Southeast Asia have been increasing at a rate of 0.14°C to 0.20°C per decade since the 1960s, and predicts increases from 0.8°C to 3.2°C by the end of this century. The report further highlights the positive trend in the occurrence of heavy (top 10% by rain amount) and light (bottom 5%) rain events³. 2. Key determinants such as the amount and intensity of rainfall, and the rate of evaporation⁴, affect surface water flow and water availability. In Thailand, this has translated to greater frequency and intensity of flooding during the wet season and extended drought periods during the dry season – challenging effective water management. 3. Thailand is also affected by the El Niño Southern Oscillation (ENSO). Exacerbated by climate change, these events bring greater rainfall variability with increasingly dangerous floods and droughts. Due to the late onset of the rainy season, Thailand has just experienced the worst drought in decades, with significant impacts on overall food production and water availability. 4. The Great Chao Phraya River Basin Area is particularly vulnerable to the impacts of climate change. It consists of eight sub-river basins including Ping, Wang, Yom, Nan, Chao Phraya, Sakaekrung, Pa Sak and Tha Chin, covering an area of 158,586 km² with a population of approximately 25 million people. The average annual rainfall is 1,100 mm while the average annual runoff is 34,600 million m³. In the northern part of the basin, the entire storage capacity is approximately 27,446 million m³, while the central area can store only 1,808 million m³. The Chao Phraya River will not overflow its banks, if the discharge does not exceed 2,800 m³ per second. Under historic temperature and rainfall patterns, the Yom and Nan rivers basins, in the Uttaradit, Phitsanulok, Sukhothai provinces, provided the critical function of managing the river flow. However, with longer dry seasons and shorter more intense wet seasons, these basins are retaining less water and are unable to slow runoff to the central plains and ultimately the Bangkok and vicinity area. 5. Moreover vulnerable agriculture households in the impacted area struggle to cope with the increasing challenges brought on by droughts and flooding. Changes to the seasonal rainfall have resulted in extended dry periods and drought, impacting crop yield and thus livelihoods. 6. Agriculture is one of the key sectors in the country's economic and social development and is also the source of raw materials for various downstream industries. Agriculture accounts for approximately 10% of GDP⁵, but engages half of the population and accounts for 75% of water consumption in Thailand⁶. The 2015 drought affected over 250,000 people, resulting in US\$400 million in government spending. In response to the devastating 2016 drought, the
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³ Climate Change 2013: The Physical Science Basis, IPCC, 2013

⁴ Impact of Climate Change Assessment on Agriculture Water Demand in Thailand (W.Chaowiwat, S. Boonya-aroonnet, S. Weesakul, 2016)

⁵ <http://data.worldbank.org/indicator/NV.AGR.TOTL.ZS>

⁶ National Water Management Strategy, 2015

Ministry of Agriculture and Cooperatives has made US\$2 billion available to farmers in the form of soft loans, to mitigate the impact of the water shortage on the agricultural sector⁷.

7. Improved water management is needed to better respond to climate change – to mitigate flooding, to prepare for times of drought, and to ensure more efficient use of water resources. Efficiency is a priority in Thailand's adaptation strategy, which is guided by the philosophy of Sufficiency Economy – moderation, reasonableness, and the need of self-immunity for sufficient protection from impact arising from internal and external changes⁸.

8. Meeting this goal will require addressing a number of barriers.

Existing Infrastructure

9. Thailand already practices water management techniques in the critical Chao Phraya River basin to stave off flooding during the wet season and to ensure water availability during the dry season, using canals and regulators, including reservoir operations. In the upper section (upland area), dams and reservoirs are used to store and regulate the flow of water. In the middle section (low lying area), water is drawn into designated low lying area to store the water for certain periods for release when the rainy end preventing flooding in the lower (urban) part. And in the lower section of the basin (urban and industrial area) flood diversion canals are used to divert excess water to the Gulf of Thailand, and dams are used to further regulate the distribution of water for industrial and agricultural use. These existing investments however, particularly in the middle section, are no longer adequate to respond to the increasing pressures of climate change.

10. The canals and regulators currently in place in the Yom and Nan river basins can no longer cope with the increased pressures of climate change. A recent feasibility study of the Yom and Nan river basins explored ways to better manage water resources in order to support communities for a better quality of life, to make use of excess water, and to reduce impact from flooding in the lower area of the basin. The study, which took into consideration engineering, social, environmental and economic aspects, identified strategic upgrades to flood gates and canals, which would best support flood and drought mitigation efforts.

Early Warning/Climate Information to Inform Planning and to Support Farmers

11. While there is a hydro-meteorological network in place, data collected is not analyzed, tailored or disseminated in way that adequately supports water management and agriculture.

12. Damage to the above infrastructure is in part due to accurate climate projections not adequately informing the planning stage. Further, the early warning system for farmers has not been systematically implemented, and there are only fragmented cases of actual application of climate information for agricultural planning. Support to farmers is mostly at the local level supported by development agencies and CSOs for use of climate change information to inform agriculture practices. Support is needed to improve dissemination of tailored climate information to farmers to improve preparedness to changing climatic conditions.

13. At the national level, the Thai Metrological Department provides climate change/weather information on its website and via radio broadcast but systematic and institutional coordination, such as with the agricultural and irrigation departments, has not been effectively established.

14. The objective of the proposed GCF project is thus **to mitigate the social and economic impacts of climate change in the Yom and Nan river basins**. Addressing the above barriers, the proposed project is structured across three complementary outputs, focused in the Uttaradit, Phitsanulok, Sukhothai provinces (please see Annex I: Maps):

Output 1: Improved climate risk-informed planning in the water and agriculture sectors

Output 2: Strengthened water management infrastructure for greater resilience to projected climate change

Output 3: Increased resilience of agriculture livelihoods in drought and flood prone areas

⁷ <http://www.thailand-business-news.com/economics/53473-thailands-drought-weakens-agricultural-outlook.html>

⁸ Thailand's Intended Nationally Determined Contribution (INDC), 2015

Output 1: Improved climate risk-informed planning in the water and agriculture sectors

15. The project area is situated in the lower area between two of the four main rivers that form Chao Phraya River, the Yom and the Nan rivers. In this area, the flood height is approximately 1.5 - 2 meters above the rice field during the rainy season. Normally, this area provides a water retention function, slowing the flow of water before it gets to central plain and Bangkok area.

16. Controlled water management through the use of canals and flood gates have contributed to the predictability of this practice. Climate change however has shifted rainfall patterns and changed the intensity of the rainfall during the wet season. These changes have forced adjustments to controlled water management, which are more responsive in nature and not yet systemically applied at the planning stage. These changes have not yet been adequately analyzed and reflected in public water management, nor have they been tailored to the needs of farmers and disseminated to inform agriculture practices.

17. GCF resources will support the development of tailored climate information for both enhanced water management and agriculture planning. GCF resources will support related training to government staff on climate scenarios to project rainfall, runoff, temperature, and evaporation, and to predict with greater accuracy incidence of flooding and drought. While some risk mapping has been done, GCF resources will also ensure comprehensive risk mapping in the target area.

18. GCF resources will facilitate inter-ministerial coordination, to ensure that projections and predictions are analyzed, tailored and disseminated in a way which supports integration into policies and planning across sectors (especially the water and agriculture sectors) – comparing supply to use and demand, and making adjustments in line with the philosophy of sufficiency economy.

19. GCF resources will also ensure coordination with other relevant sectors, such as infrastructure and communications, to ensure that budgets are adequate, and consider the necessary upgrades to adapt to climate change. Given the increased incidence of disasters in Thailand, such planning is critical to minimize loss and damage, and ensure continuity of public services during and after extreme events.

Output 2: Strengthened water management infrastructure for greater resilience to projected climate change

20. The climate analysis of Output 1 will inform the necessary upgrades to existing infrastructure, namely the canal and regulator network in the Yom and Nan river basins. Per the recently-conducted feasibility study, in order to adequately regulate water during wet and dry season, four water gates need to be upgraded and three existing canals need to be enlarged to ensure greater climate resilience. Specifically the recommended interventions, per the feasibility study include:

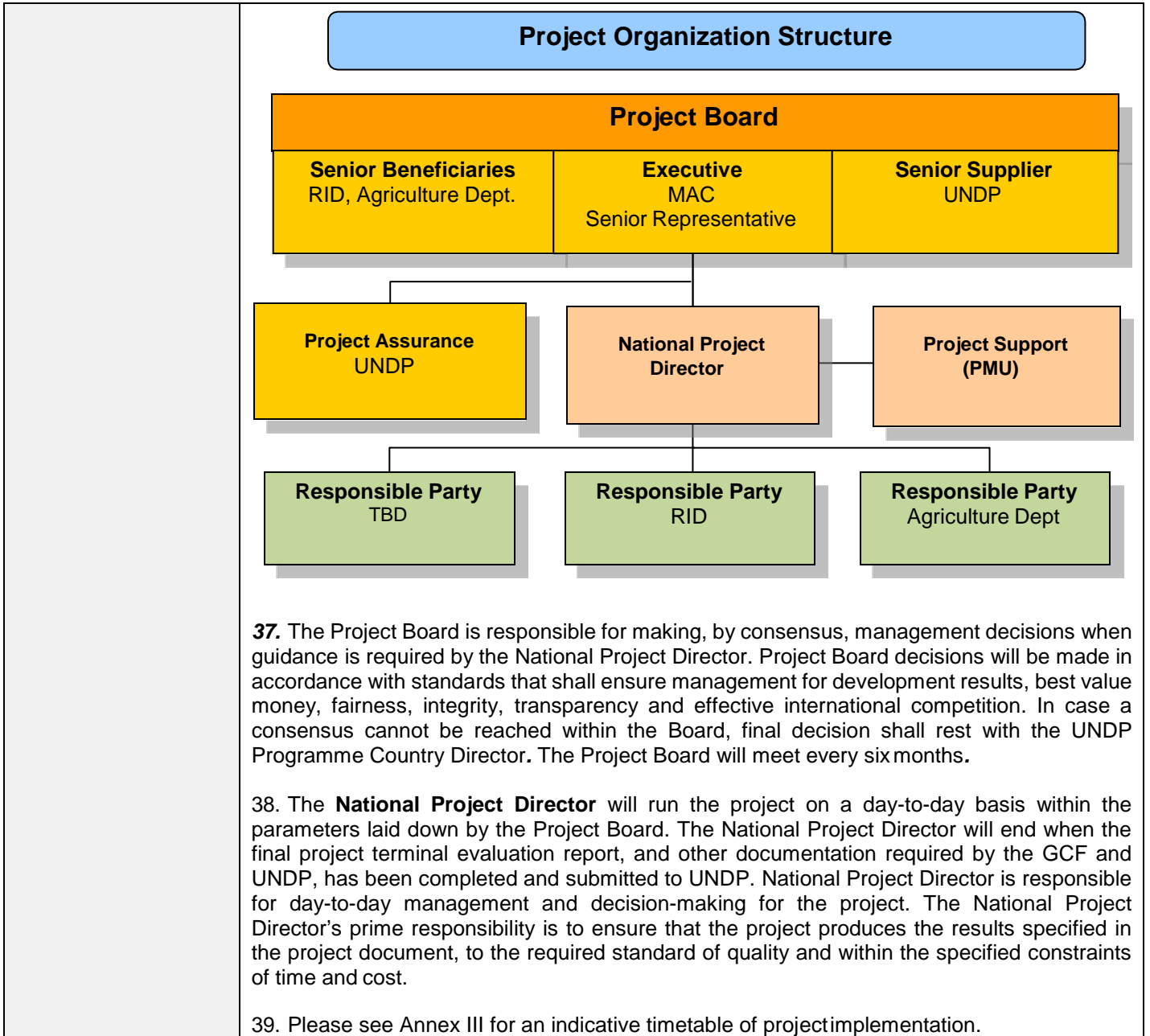
- The capacity of drainage system should be improved that is capable to drain water from low-lying areas at the beginning of the rainy season. Canals and waterways are needed to be dredged to the depth that can drain these low-lying areas. These waterways should be manage to connect to each other.
- The capacity to store water volume within the areas during the late of rainy season and the beginning of the dry season should be increased as well as the storage of enough amount of water to irrigate the area during the dry period. The dredging of waterways with the constructions of additional water regulators (flood gates) should be implemented for the purpose especially at the end of waterways connecting to the Yom River and Khlong Bang Kaeo Canal.
- The capacity to divert water into the area should be improved. Water volume expected to be able to divert into the area is from the Yom River (possibly to be drawn from the Ping River that the project is underway) and from the Nan Basin through the feeder canal of the Nan River- Khlong Mem and the ditch of Khlong Wang Khon. The construction of water regulator facilities (Wang Sa Tu and Wang Khi Lek Floodgates) in the Yom River and Khlong Bang Kaeo Canal are needed.

	<p>Output 3: Increased resilience of agriculture livelihoods in drought and flood prone areas</p> <p>21. Effective application of climate information into agriculture planning will require shifting the crop calendar to correspond to the change in seasonal patterns. For this, inter-agency coordination at the local, provincial and central levels is needed in order to support agriculture households to make the necessary changes in order to successfully adapt to climate change. Based on the tailored climate information of Output 1, GCF resources will support knowledge sharing and training to extension officers and agriculture households on climate change impacts on agriculture in the Yom and Nan river basins.</p> <p>22. In response to changing conditions, agriculture households have been adapting to climate change autonomously (e.g. raising the floor of their homes, shifting to other crops such as fruit trees, and adopting aquaculture livelihoods). Household levels changes however are not informed by climate projections or risk maps, nor do the changes consider the increased pressure on water resources from the growing population and the overall decline in precipitation. GCF resources will support awareness raising, informed adaptation measures and training to communities, such as agriculture practices which are less water-intensive.</p> <p>23. Consultations are underway regarding the potential to link this proposed GCF project with a support programme being developed by the Ministry of Finance. The Ministry of Finance concept targets the province of Udon Thani (one of the poorest provinces in Thailand), and seeks to increase farmer's incomes over the long term through greater engagement of the private sector, specifically to:</p> <ul style="list-style-type: none"> • Utilize private sector, profit motivation and market forces to attract investment, technology and forward looking, professional management. • Align the incentives among the incumbent farmers and agribusinesses in order to reduce risk. • Provide farmers with incentives to participate in restoring and sustainably working the land (e.g. organic agriculture) over the long term, as well as provide safety nets to ensure that their income does not fall below current levels. <p>24. This potential link will be further explored during proposal development.</p>
<p>B.2. Background information on project/programme sponsor</p>	<p>25. The Royal Irrigation Department (RID), plays a vital role in water management in Thailand. Per Ministerial Regulation of the Ministry of Agriculture and Cooperatives B.E. 2554, RID is responsible for:</p> <ul style="list-style-type: none"> • Implementation of activities aimed at achieving, collecting, storing, controlling, distributing, draining or allocating water for agricultural, energy, household consumption or industrial purposes under irrigation laws, ditch and dike laws and other related laws. • Implementation of activities related to prevention of damages from water; safety of dams and appurtenant structures; safety of navigation in commanded areas and other related activities that may not be specified in annual plan. • Implementation of land consolidation for agriculture under the Agricultural Land Consolidation Act. • Implementation of other activities designated by laws or properly assigned by Cabinet or Minister. <p>26. RID is also a member of the national water management and disaster risk management committees as well as a member to the sub-committee on integrated policy and planning for climate change which is under the national climate change committee chaired by prime minister.</p> <p>27. UNDP has worked closed with RID on a number of projects including the ongoing Climate Change Finance project, aimed at strengthening capacities of RID to formulate climate-informed projects and secure finance for implementation.</p>
<p>B.3. Market overview</p>	<p>28. Agriculture accounts for more than 65% of Thailand's water consumption, leaving the sector as well as the national economy highly vulnerable to low rainfall. Estimates of total losses resulting from the 2016 drought are estimated at US\$3.4 billion or 0.85% of GDP⁹. In</p>

⁹ <http://www.bangkokpost.com/news/general/994313/relief-as-rain-falls-but-droughts-aftermath-to-linger>

	<p>March the Asian Development Bank lowered its forecast for Thailand's GDP growth in 2016, cutting its projection from 3.5% to 3%, due to a slowdown in growth in major industrial economies. The actual growth figures for 2016 could be worse as drought impacts continue to be tallied, and the expected flood impacts of the recently-started rainy season are not yet known.</p> <p>29. As a result of the recent drought, Thailand's total rice production, including the main and second crop, fell to 27.4 million tons in 2015-6, the lowest since 2000-1. Declining yields impact GDP, but especially households – both in direct household income as well as market prices. The Thai Rice Packers Association has stated that its members would have to increase the prices of packaged rice by September if new supplies cannot be secured - Thai rice is already at a two year high of US\$441/ton, up from US\$397 just last month¹⁰. These impacts on market prices are being felt most acutely by low-income consumers, as higher food prices cut into disposable income, ultimately having effects throughout the economy.</p> <p>30. Strengthening water management around key river basins and improving the resilience of farmers to climate change, could have exponential benefits to the broader market.</p>
<p>B.4. Regulation, taxation and insurance</p>	<p>31. Any licenses or permits required for the implementation of the project will follow the established policies and processes by the Government.</p> <p>Tax Considerations for UN-supported Projects</p> <p>32. UN-supported projects are tax-exempt in Thailand.</p> <p>Foreign Exchange and Insurance Policies</p> <p>33. UNDP's currency hedging policy is based on the use of natural hedges (matching cash flows (i.e. revenues and expenses) in non-USD currencies) to the extent possible. UNDP Country Office bank account balances are managed not to exceed approximately one month's disbursement requirements to minimize risk.</p> <p>34. The Government signed a Special Fund Agreement with the UN in 1960. Consistent with the Article II, the responsibility for the safety and security of the Implementing Partner (executing entity) and its personnel and property, and of UNDP's property in the Implementing Partner's custody, rests with the Implementing Partner (executing entity).</p>
<p>B.5. Implementation arrangements</p>	<p>35. The project will be implemented following UNDP's National Implementation Modality (NIM), according to the Standard Basic Assistance Agreement between UNDP and the Royal Government of Thailand, the Country Programme Action Plan (CPAP), and as policies and procedures outlined in the UNDP POPP (see https://info.undp.org/global/popp/ppm/Pages/Defining-a-Project.aspx).</p> <p>36. The national executing entity - also referred to as the national 'Implementing Partner' in UNDP terminology - is required to implement the project in compliance with UNDP rules and regulations, policies and procedures, including the NIM Guidelines. These include relevant requirements on fiduciary, procurement, environmental and social safeguards, and other performance standards. In legal terms, this is ensured through the national government's signature of the Special Fund Agreement, together with a UNDP project document which will be signed by the Implementing Partner to govern the use of the funds. The (national) Implementing Partner for this project will be accountable to UNDP for managing the project, including monitoring and evaluation of project interventions, achieving project outcomes, and for the effective use of UNDP resources.</p> <p>Indicative Schematic of the Management Arrangements for the Proposed Project</p>

¹⁰ <http://www.bangkokpost.com/news/general/994313/relief-as-rain-falls-but-droughts-aftermath-to-linger>



C. Financing / Cost Information						
C.1. Description of financial elements of the project / programme	<p>40. The proposed project seeks to enhance effective water management, and increase climate resilience of resource-dependent agriculture households. Revenue generated as a result of project interventions apply directly to the beneficiaries, and does not lend itself to significant reflows back to the government or the GCF. The proposed project is therefore structured as 100% grants.</p> <p>41. As the proposed project is non-revenue generating, a financial model is not appropriate.</p>					
C.2. Project financing information		Financial Instrument	Amount	Currency	Tenor	Pricing
	Total project financing (a) = (b) + (c)		50.000	<u>million USD (\$)</u>		


	(b) Requested GCF amount	(i) Senior Loans	.....	<u>Options</u>	() years	() %
		(ii) Subordinated Loans	.....	<u>Options</u>	() years	() %
		(iii) Equity	.....	<u>Options</u>		() % IRR
		(iv) Guarantees	.....	<u>Options</u>		
	(v) Reimbursable grants *	.....		<u>Options</u>		
	(vi) Grants *	30.000 ¹¹		<u>million USD (\$)</u>		
		* Please provide detailed economic and financial justification in the case of grants.				
		Total Requested (i+ii+iii+iv+v+vi)	30.000	<u>million USD (\$)</u>		
(c) Co-financing	Financial Instrument	Amount	Currency	Name of Institution	Seniority	
	<u>Grant</u>	20.000	<u>million USD (\$)</u>	Ministry of Agriculture and Cooperatives (MAC)	<u>Options</u>	
	<u>Options</u>	.....	<u>Options</u>	.....	<u>Options</u>	
	<u>Options</u>	.....	<u>Options</u>	.....	<u>Options</u>	
	<u>Options</u>	.....	<u>Options</u>	.....	<u>Options</u>	
Lead financing institution: N/A						
(d) Covenants	N/A					
(e) Conditions precedent to disbursement	N/A					

D. Expected Performance against Investment Criteria

Please explain the potential of the Project/Programme to achieve the Fund's six investment criteria as listed below.

D.1. Climate impact potential [Potential to achieve the GCF's objectives and results]	42. The Great Chao Phraya River Basin Area is particularly vulnerable to the impacts of climate change. It consists of eight sub-river basins including Ping, Wang, Yom, Nan, Chao Phraya, Sakaekrung, Pa Sak and Tha Chin, covering an area of 158,586 km ² with a population of approximately 25 million people. The average annual rainfall is 1,100 mm while the average annual runoff is 34,600 million m ³ . In the northern part of the basin, the entire storage capacity is around 27,446 million m ³ , while the central area can store water only 1,808 million m ³ . The Chao Phraya River will not overflow provided that the speed of the water flow does not exceed 2,800 m ³ per second. Under historic temperature and rainfall patterns, the Yom and Nan rivers basins, in the Uttaradit, Phitsanulok, Sukhothai provinces, provided the critical function of managing the river flow. However, with longer dry seasons and shorter more intense wet seasons, these basins are retaining less water and are unable to slow runoff to the central plains and ultimately the Bangkok area.
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¹¹ The proposed project amount may change based on the results of the feasibility study and further consultations with stakeholders.

	<p>43. As climate change is impacting seasonal rain patterns, the shorter, more intense rainy seasons are having an impact on flood events in the Chao Phraya river basin. The frequency of flood events has increased considerably over the past 50 years.</p>  <p>Source: RID, 2016</p> <p>44. Increases in temperature and longer dry seasons, on the other hand, are leading to water stress and at times water scarcity – impacting livelihoods as well as overall economic activity through reduced agriculture production.</p>
<p>D.2. Paradigm shift potential <i>[Potential to catalyze impact beyond a one-off project or programme investment]</i></p>	<p>45. The Yom and Nan river basins are of critical importance, as water management in this area would not only prevent flooding for farmers in the vicinity, but also further downstream in the Great Chao Phraya river basin. The enhancements detailed would minimize loss and damage related to flooding and drought - benefiting vulnerable agriculture households and relieving pressure on public resources for related relief and programmes.</p> <p>46. Policy support activities under the proposed GCF project could also inform planning in the other river basins in Thailand (25 total).</p>
<p>D.3. Sustainable development potential <i>[Potential to provide wider development co-benefits]</i></p>	<p>47. The proposed GCF project supports various benefits, not only technological advancement in climate change informed analysis, but also contributions towards social and economic development:</p> <ul style="list-style-type: none"> • Climate risk informed planning across various sectors: <ul style="list-style-type: none"> ○ Reduced losses and damages due to enhanced planning for investment and preparation for slow onset climate change impacts as well as extreme events ○ More efficient use of water resources, in line with sufficiency economy goals of the country ○ More stable market pricing for commodities, benefiting stable economic development as well as livelihoods ○ Promotion of less water-intensive agriculture practices to relieve pressure on water resources • Greater predictability and security for agriculture planning at household level: <ul style="list-style-type: none"> ○ Improved food security and nutrition ○ Greater financial security in livelihood activities
<p>D.4. Needs of recipient <i>[Vulnerability to climate change and financing needs of the recipients]</i></p>	<p>48. More than half of the population of Thailand is engaged in agriculture, where incomes are relatively low. The project target area was selected based on vulnerability and urgency, given proximity of communities to overwhelmed river basins and reliance of water-intensive agriculture as a livelihood.</p> <p>49. The above-mentioned feasibility study includes field surveys and interviews with agriculture households in the targeted districts of the proposed GCF project. Field surveys and interviews with local administrators and community leaders of the inundated lands show that households are well aware of the fact that their lands are low lying and vulnerable to floods every year, and that they have long been adapting themselves to the environmental situation. The villagers uplift their houses (higher from the ground) and catch fish for selling during the flood as part of income, which now becomes normal way of life.</p> <p>50. While households have been coping with flooding, great concern was expressed about drought and water scarcity. The communities want irrigation gates and canals in</p>

	<p>the area to be enhanced so that they store and distribute water more effectively. The communities also request that the Royal Irrigation Department pull additional volume of water from the Ping and Nan rivers and release it into the lands to support their farming during drought season.</p>
<p>D.5. Country ownership <i>[Beneficiary country ownership of project or programme and capacity to implement the proposed activities]</i></p>	<p>51. The project concept was designed in close consultation with the Royal Irrigation Department (RID) and the Office of Natural Resources and Environmental Policy and Planning (ONEP), addressing the needs identified in assessments and in line with national development priorities.</p> <p>52. Thailand's Technology Needs Assessment (TNA) report formulated in 2012 identified three highly impacted sectors in urgent need of adaptation technologies, namely:</p> <ul style="list-style-type: none"> • Agriculture - in need of forecasting and early warning system technologies, crop improvement technologies, and precision farming technologies • Water Resource Management - in need of networking (via pipes and canals) and management of infrastructures (including zoning), seasonal climate prediction, and sensor web using observation and/or modeling data • Modeling - in need of an integrated national data center, national data transfer/management process and the advanced research, weather research and forecasting (WRF - ARW) model, and an integrated model to address the need of agricultural sector and water resource management sector <p>53. Acknowledging the need to improve sustainable water resources management, the 12th National Economic and Social Development Plan (2017-2021) aims to promote economic and social growth that is environmentally-friendly, specifically by:</p> <ul style="list-style-type: none"> • Reforming water management systems to ensure balance between users' demand and supply as well as provision of access to water; • Enforcing environment acts and promote collaboration among sectors for integrated work plans and budgets; • Developing water resources information centers; • And establishing water management organization at the local level, such as river basin committee and water users association
<p>D.6. Effectiveness and efficiency <i>[Economic and financial soundness and effectiveness of the proposed activities]</i></p>	<p>54. The proposed GCF project is fully aligned with national priorities and builds on existing government programmes. GCF support will address the identified additional activities/costs related to integrating climate change risks into government programmes, thereby extending the value of these investments.</p> <p>55. A thorough economic analysis will be conducted at the proposal development stage.</p>

E. Brief Rationale for GCF Involvement and Exit Strategy

Please specify why the GCF contribution is critical for the project/programme.

56. Existing water management infrastructure is no longer able to effectively respond the changing rainfall patterns impacted by climate change. Greater intensity of flooding and longer periods of drought are putting vulnerable agriculture households at increasing risk. A recent feasibility study commissioned by RID (see Annex II) have confirmed this:

57. "Added with large amount of runoffs in the last half of the season, the flood would be expanding and covering vast area of farmlands. The total volume of flood water was measured at 88.06 million cubic meters. The level of water inundating farmlands was about 1.5 meters. When the water level in the Yom River subsided, large volume of water would gradually drain into the river, leaving about 22.70 million cubic meters of water in the area (the flood level inundating farmlands was about 0.60 meter averagely). Due to the characters of being lowlands, this amount of water would be left in the area for a long period of time. Meanwhile it was unable to drain the area and there was no efficient distribution system in place to divert water into farmlands on the lower part of the plain as well."

58. "The cultivation of most crops has been carried out once or twice a year. Farmers would be cultivating between June and November on high plains where escaped from seasonal flood. There is no farming activity during the dry season due to the shortage of water. On the low-lying plains where are usually submerged by flood for about 1-2 months, the cultivation would start in November after the water subsides and farming activities will continue until February. Farmers utilize water left from flood in the lowlands as water supplies for farming preparation then trying to draw water from the Yom River and Khlong Bang Kaeo Canal to feed crops later. However, these farmers often confront with problems from water shortage. While the cultivation in the rainy season must be done and harvest in hurry before being damaged by the coming seasonal flood."

59. The proposed GCF project would support the Thailand to increase resilience to climate change in a critical part of the country. By supporting climate resilient planning and infrastructure, as well as building capacity of agriculture livelihoods, the proposed project would contribute to effective water management and sustainable water use in the long term.

Please explain how the project/programme sustainability will be ensured in the long run, after the project/programme is implemented with support from the GCF and other sources.

60. RID is responsible for maintenance of water infrastructure in Thailand, and regularly conducts studies to investigate, monitor and evaluate infrastructure performance and resilience. Long term O&M costs will, therefore, be covered by RID.

61. As agriculture is responsible for 75% of water use, the proposed GCF project also includes capacity building for farmers – providing tailored climate information which can be applied to agriculture planning, as well as training to support the government policy emphasizing less water-intensive crops. Ensuring responsible water use in this critical sector will help influence sustainable development.

F. Risk Analysis

62. A number of risks have been identified. A more extensive risk analysis will be conducted during proposal development, including a thorough environmental and social screening.

Identified Risks	Risk Probability	Mitigation Measures
Long term sustainability of investments (e.g. irrigation)	Low	Maintenance of the investments fall under the mandate of the executing entity, RID. This will be further detailed with an operations & maintenance (O&M) plan, and confirmed with a letter of co-financing during proposal development.
Environmental risks associated with water infrastructure investments	Medium	Measures will be taken to minimize any sediment entering waterways, as a result of earthworks (e.g. bioengineering around the canals, upgrading of flood gates). Risks are expected to be 'moderate', this will be confirmed with a more thorough environmental and social screening during GCF proposal development.
Project interventions do not have intended impacts, because behavior that is not conducive to the project objective continues.	Medium	Project interventions are expected to increase crop yield and minimize loss and damage, through improved water and flood management and the provision of early warning messages to beneficiaries. Climate data will be integrated into water planning and management, and related training provided to government staff - ensuring informed adaptation to changing climatic conditions and increasing climate risks in Thailand. Communities will be engaged throughout the project, from proposal development, to implementation. Field officers will be recruited through the project to ensure communities and district government staff have access technical advice, and opportunities to express concerns as necessary. Through regular monitoring, success of interventions will be measured and communicated to communities to provide assurance, as well as to inspire behavior change.
Staff turnover or lack of technical capacity within executing entity	Medium	Capacity needs assessments will be undertaken to identify any specific needs and gaps. As necessary, training programmes will use a training-of-trainers approach for continuity. Training materials will be packaged and made

		available online for continued learning or as refresher courses.
Extreme event disrupts implementation or damages investments, resulting in delays and additional costs.	Low	Timing of activities during implementation will be scheduled to minimize risk, to the extent possible.

G. Multi-Stakeholder Engagement

63. The project concept was designed in close consultation with the Royal Irrigation Department (RID) and the Office of Natural Resources and Environmental Policy and Planning (ONEP), addressing the needs identified in assessments and in line with national development priorities.

64. As part of the feasibility study (see Annex II), field surveys and consultations local administrations, community leaders and members were undertaken.

65. During proposal development, a broader stakeholder engagement plan will be developed and implemented.

H. Status of Project/Programme

- 1) A pre-feasibility study is expected to be completed at this stage. Please provide the report in section J.
- 2) Please indicate whether a feasibility study and/or environmental and social impact assessment has been conducted for the proposed project/programme: Yes No
(If 'Yes', please provide them in section J.)
- 3) Will the proposed project/programme be developed as an extension of a previous project (e.g. subsequent phase), or based on a previous project/programme (e.g. scale up or replication)? Yes No
(If yes, please provide an evaluation report of the previous project in section J, if available.)

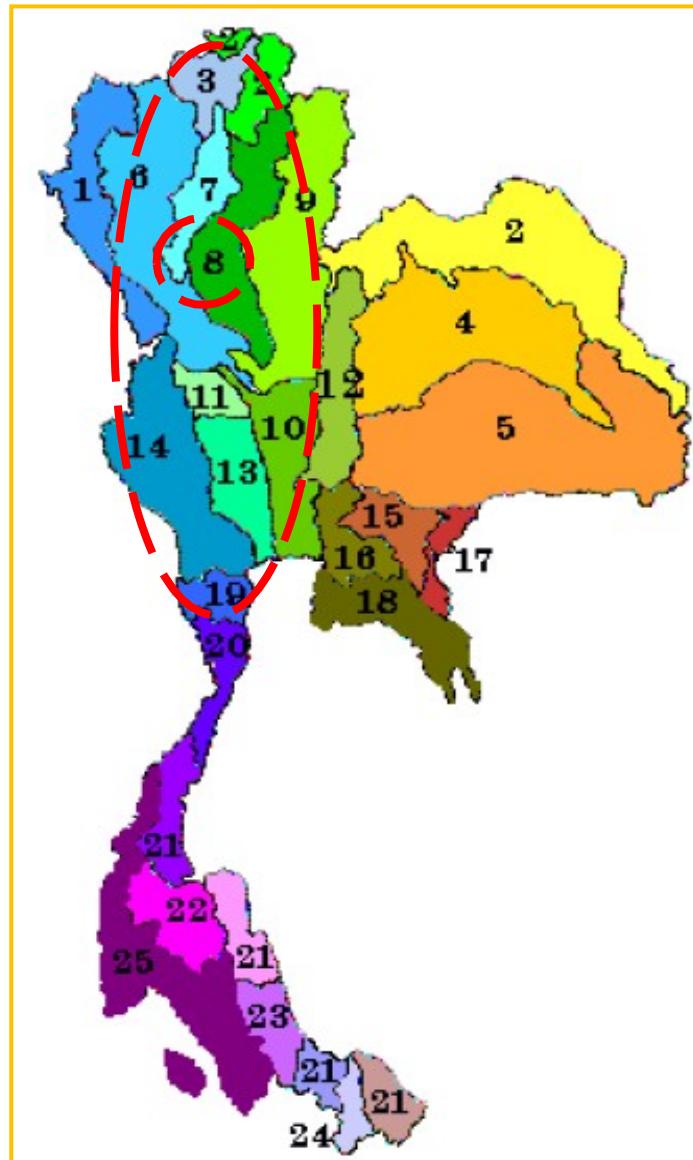
I. Remarks

J. Supporting Documents for Concept Note

- Map indicating the location of the project/programme
- N/A Financial Model
- Pre-feasibility Study
- Feasibility Study (if applicable)
- Environmental and Social Impact Assessment (if applicable)
- Evaluation Report (if applicable)
- Indicative Timetable of Project/Programme Implementation

Annex I: Map Indicating the Location of the Project

Below is a provincial map of Thailand. The larger area highlighted by a red dashed line is the larger Chao Phraya river basin. The smaller circle within that area is the site of the proposed GCF project, between the Yom and Nan rivers.



Annex II: Pre-feasibility Study

Below is the Executive Summary of the feasibility study commissioned by RID for the needed enhancements to water management infrastructure in the Chao Phraya River Basin. The existing feasibility study will be elaborated to include the proposed GCF project interventions during proposal development.

1. Introduction

1.1 Background

Yom River Basin is a main river basin of the northern part of the country. The river is one main tributary of the Chao Praya River. Its catchment area covers 23,618 square kilometers of 11 provinces comprising of Payao, Nan, Lampang, Phare, Tak, Kamphangphet, Sukhothai, Uttaradit, Phitsanulok, Pichit and Nakhon Sawan. In the dry season residents have been confronting with drought following with flood in the rainy season almost every year for decades. In the process of the budget allocation for 2009 fiscal year, the ac-hoc sub-committee, chaired by Worawat Auapinyakul, had been set up to find out solutions to tackle water resource related problems in the northern region, commissioned a study in order to establish a sustainable solutions under people participation concept in accordance with Prime Minister Office Regulation on Public Hearing B.E.2548.

The sub-committee had drafted the framework of study into the preparedness and mitigation plan for people who may be affected from water development projects in the Yom River Basin and/or other stakeholders, then the amendment had been made to include the budget for studying the Initial Environmental Assessment and the special zone development plan for people affected from integrated development projects on the Yom River Basin, to be carried by several government agencies. These shall be made guidelines for the future project to be created to solve the drought and flood problems in the area sustainably with participation of the people residing in this very basin.

More studies into various alternatives are needed in order to find out appropriate solutions for solving water resource problems in the Yom River Basin which includes medium-sized and large-sized water development projects, the development of so called Monkey's Cheek area or the water retention basin, the water diversion project, the management of flood plains and the development of special zone to accommodate affected people from water development projects as well as the integrated development plan for the Yom River Basin that is able to provide water to meet the demand of local people and also solve problems related to this resource in short, medium and long-term.

1.2 Objectives of the study

1. To review the development projects and plans carried out by concerned agencies in the Yom River Basin.
2. To propose appropriate water development projects for the Yom River Basin aiming to alleviate problems related to water resources sustainably.
3. To assemble engineering data of medium-sized and large-sized water development projects in the Yom River Basin as well as to prescribe the guideline for the development and potential projects in the basin.
4. To initiate the action and budget plans according to the guideline for suitable and potential development projects for the Yom River Basin.
5. To initiate the feasibility study and the initial environmental assessment of the special development zone to be created to accommodate and mitigate impacts for groups of people affected from the expected construction of the Yom river development projects in line with concerned government regulations.
6. To initiate the feasibility study and initial environmental assessment of the large water resource development project as well as the prefeasibility study and the initial environmental assessment of four medium-sized projects which have been prioritized in the action plan.
7. To create database and GIS systems for water management in accordance with the development guideline for the Yom River Basin.

8. To carry out public relations activities with local people including of all groups of stakeholders, target groups and general mass media in order to raise awareness and understanding on the issue of the sustainable development of the Yom River Basin.

1.3 Project Outputs

The Integrated Planning of Special Area Development Project's Initial Environmental Assessment leads to the development plan for alleviating drought and flood in the Yom River Basin. These following plans have been created as results;

- 1) The master plan for the Yom River Basin Development.
- 2) The prefeasibility studies and IEAs of four selected medium-sized water development projects.
- 3) The feasibility study and IEA of the large-sized water development project.
- 4) The feasibility study and IEA of the special zone development project designated to accommodate affected people from the large-sized development project.
- 5) The study report of the management of the flood retention area in the lower Yom River Basin.
- 6) The database and GIS systems for water management in accordance with the guideline for the Yom river development.
- 7) The operation of public relations activities and the implementation of people participating process.

The study into the water retention area management has been considered over areas in the Lower Yom River Basin, where are threatened by flood frequently. It is expected that people in the designated detention area would have better quality of life by enabling them to utilize the large amount of water for farming and be able to lessen damages from excessive water affecting the area located downstream. However, the issues of technical, engineering, social, environment and economic are to be taken into account in the feasibility study. The flood-prone Tung Bang Rakam area in Phitsanulok province has been selected as a case study.

2. Geography of the Designated Retention Area

2.1 Geographic characteristics and Administrations

The area under study for the flood retention basin was the floodplain called Tung Bang Rakam, covering the area of tambons or sub-districts of Krai Nok, Chum Saeng Songkram, Tha Nang Ngam and parts of Ban Mai Suk Kasem, Dong Duay and Bang Rakam sub-districts.

The area designated to be the flood retention area is the lowland between the Yom River on the west and Khlong Mem or Bang Kaeo Canal on the east. It resembles the pan-like basin and has been separated by a road connecting Ban Krang (Sukhothai's Kong Krilat district) and Ban Bang Kaeo (Phitsanulok's Bang Rakam district). The lowest area of this planned retention area located on the north of Ban Krang-Ban Bang Kaeo route, mostly in Krai Nok and Chum Saeng Songkram sub-districts, at the average elevation of about 37-38 meters above mean sea level (MSL).

While area south of the Ban Krang- Ban Bang Kaeo route, where mostly locates in Cham Saend Songkram and Tha Nang Ngam sub-districts is similarly the lowland. Its elevation is measured at about 38-39 meters MSL. The river bank and the road elevation stand at about 40-41 meter MSL.

2.2 Stream System and Drainage System

The planned water retention area is the lowland between two main waterways which lies the Yom River on the west and Khlong Mem or Khlong Bang Kaeo canal on the east. These two waterways converge at Bang Rakam's Bang Rakam sub-district. The conclusions are these followings;

- 1) The upper part of the designated retention area (north of Ban Krang-Ban Bang Kaeo route and the north of Khlong Wang Rae canal) contains a number of stream and river systems including,
 - Khlong Muang Chang Canal (Khlong Nong Luang Canal), Khlong Ban Mai Canal and Khlong Bung Kok Canal are flowing through Highway No.12 (Sukhothai-Phitsanulok) and entering the area from the north.
 - Khlong Kod Canal (Khlong Tung Koo or Khlong Khi Lek Canal) splits from Khlong Mem Canal (Khlong Bang Kaeo) on the east side of the area. This canal empties into the end course of Khlong Klam Canal then joining Khlong Mem Canal (Khlong Bang Kaeo).

- Khlong Samrong Canal connects to the Yom River on the west. A part of the canal also connects to Khlong Klam Canal and another part flows southward emptying into Khlong Wang Rae (Khlong Lahan) Canal.
- Khlong Klam Canal receives water supply from several canals such as Khlong Samrong, Khlong Muand Change (Khlong Nong Luang) Khlong Ban Mai, Khlong Bung Kok and Khlong Kod (Khlong Tung Koo or Khlong Khi Lek) Canals and empties into Khlong Mem Canal on the east.
- Khlong Wang Rae or Khlong Lahan Canal is considered the main waterway in the mid of the planned retention area. It connects to the Yom River on the west and also receives water supply from Khlong Samrong and Khlong Ket Canals. Khlong Klum canal empties into Khlong Ket Canal on north-south axis then joining Khlong Wang rae Canal, after that merging into Khlong Mem or Khlong Bang Kaeo Canal on the east part of the area.

2) The lower part of the planned retention area (south of Ban Krang-Ban Bang Kaeo Road and south of Khlong Wang Rae Canal) contains these following water systems,

- Nong Krao is only large lake in the planned retention area project with its length of about 3 kilometers and the width of 100 meters at the widest part. A dike has been built across the end part of the lake in order to collect water for consumption. Nong Krao Lake receives water supply from Khlong Lahan or Khlong Wang Rae Canal from the north and flows southward through the low-lying area in Chum Saeng Songkram sub-district. Then this canal separates into two streams,

The first stream runs to join Khlong Dai Cha Lued and Khlong Huay Yai Canals before emptying into the Yom River at Ban Yan Yao Village.

The second stream runs to join Khlong Pla Krai Canal then emptying into Khlong Bang Kaeo Canal.

- Khlong Nong Suang Canal receives water supply from Khlong Wang Rae and flows southward. A branch of Khlong Nong Suang Canal flows southward joining Khlong Cha Dai Lued Canal which emptying into the Yom River. Another branch joins Khlong Pla Krai Canal then emptying into Khlong Bang Kaeo Canal.
- Khlong Kra Kok and Khlong Tha Mo Canals are splitting from Khlong Nong Suang Canal and flow eastward to join Khlong Mem Canal.
- Khlong Huay Yai Canal collects run-off water from the lowland located near the part of Nong Krao Lake and flows into Khlong Dai Cha Lued Canal then emptying into the Yom River.

2.3 Volume of Water Supply

There are three main sources of water supplying Bang Rakam area including the Yom River, Khlong Bang Kaeo Canal and runoffs from high plains located on the northern part of the area. The details of water supplies from each source as these followings;

1) Water supplies from the Yom River. This large river originates from high mountains of Phare and Lampang Provinces. Its catchment area supplying water to Tung Ban Rakam floodplain is measured at about 20,000 square kilometers. According to water volume monitoring database of the Yom River Water Monitoring Station in Bang Rakam sub-district, the average annual runoff flowing through the area was measured at about 3,767 million cubic meters. However, there is no large reservoir developed in the upper part of the basin while the increasing demand of water for various activities has caused the water shortage in the dry period at the serious level. The monitoring report has shown that, during four months of the dry season between January and April, the total runoff water left was about 56.40 million cubic meters (1.5 percents of annual runoff) and would be much less in the year hard-hit by drought conditions. This amount of water is insufficient for utilizing and irrigating farming activities in the project area.

At present, to utilize water from the Yom River must be done under the operation of Bang Ba Rubber Dike. Built across the river, the dike has elevated water level in the river then diverting water into Khlong Wan Rae (Khlong Lahan) Canal and then flowing into Khlong Nong Krao Canal before being distributed for farmlands. But the limit of the rubber dike has caused inefficiency of water diversion into Khlong Nong Krao Canal. This made local residents decidedly build a temporary clay dike across the river, lying downstream from Bang Ba Rubber Dike, every year. The temporary dike could elevate water to the height that made the water diversion for farmlands be more efficiently.

2) The volume of water supply from Khlong Bang Kaeo Canal (the old Yom River or Khlong Mem Canal). This canal is a Yom River's tributary splitting from the river in Sawankhalok district. It flows southward through lowland lying between Yom and Nan Rivers. The course of the canal when flowing through Phrom Phiram and Muang Phitsanulok districts has been used as a boundary line of the project as well as being a water distribution

canal of Plai Chum Pol Operation and Maintenance Project before emptying into the Yom River in Bang Rakam district. The floodgate of Khlong Bang Kaeo Canal has elevated water level so it has been able to distribute water to farmlands in Bang Rakam and Tha Nang Ngam sub-districts. However, there is no reservoir to store large amount of water in Khlong Bang Kaeo Canal for utilizing in the dry season. Meanwhile farmlands along the canal route have tapped water for their own agriculture purposes that left a little amount of water for farmlands in the project area. Occasionally, farmers have to ask Plai Chum Pol Operation and Maintenance Project to distribute water through irrigation and distribution canals into Khlong Bang Kaeo Canal to help feeding farmlands in the dry season. However, such this operation would affect irrigated farmlands under Plai Chum Pol Operation and Maintenance Project as well as other farmlands located downstream under Dong Setthi and Tha Bua Operation and Maintenance Projects due to the limit of water supply and the size of distribution system.

3) Water supplies from highlands in the upper part drain into several waterways including Khlong Muang Change, Khlong Klam, Khlong Bang Kok, Khlong Ban Mai, and Khlong Tha Luang Canals and travel through farmlands. These canals collect runoffs during the heavy rain period but almost dry up in the dry season.

It is obvious that water supplies from many sources would be flowing into the project area only in the rainy season and often submerge low-lying farmlands in the project area for a long period of time. In the dry season, the area would face water shortage due to insufficient water supply and the lack of irrigation and water distribution systems to draw water from outside sources to feed the area.

2.4 Agricultural Characteristics and Water Demand

Almost all the farmlands in the project area are rice paddies which depends mainly on rainfall. Total rice paddies have covered 71,787 rai (81.15 percent of all the project area) of the project land area. The remaining has been used for residences, forest, water sources, other types of crops and for other purposes as these following details.

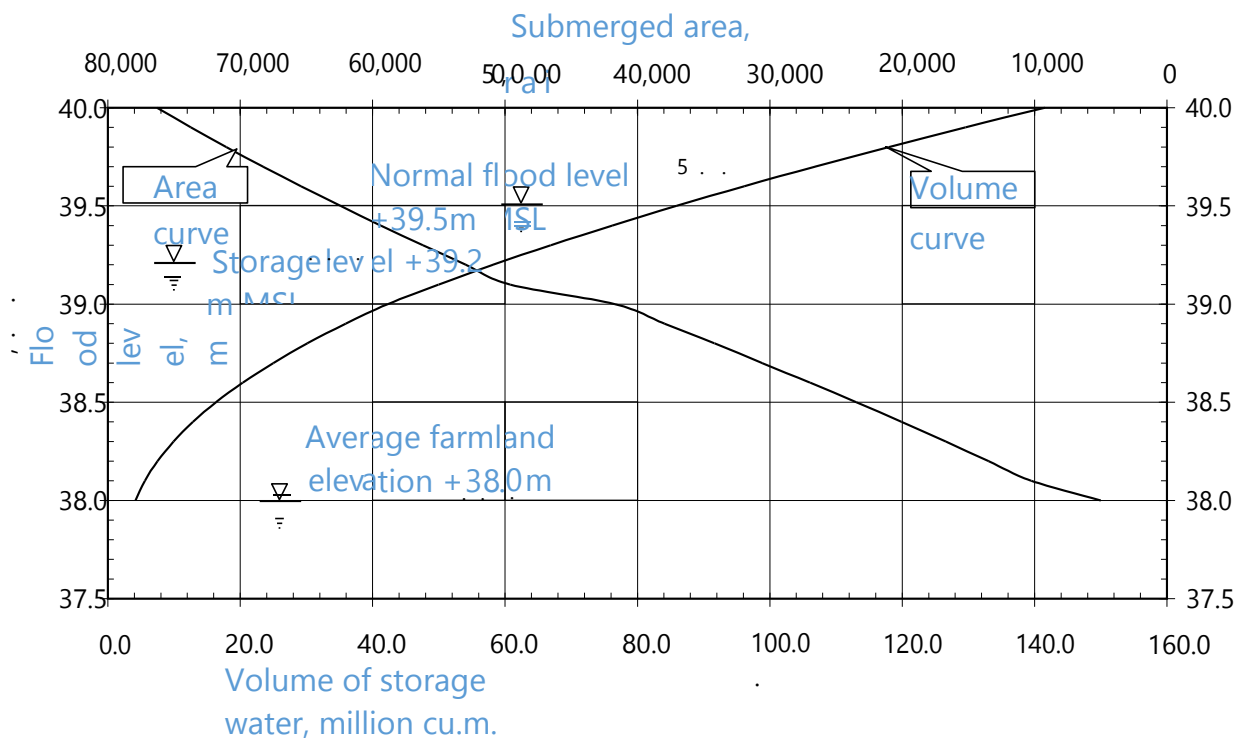
Land Use in the Project Area (rai)							
Residence	Rice paddy	Other crops	Orchard	Perennial	Forest land	Water source	Others
1,878	71,787	32	62	313	2,796	2,464	9,126

The cultivation of most crops has been carried out once or twice a year. Farmers would be cultivating between June and November on high plains where escaped from seasonal flood. There is no farming activities during the dry season due to the shortage of water. On the low-lying plains where are usually submerged by flood for about 1-2 months, the cultivation would start in November after the water subsides and farming activities will continue until February. Farmers utilize water left from flood in the lowlands as water supplies for farming preparation then trying to draw water from the Yom River and Khlong Bang Kaeo Canal to feed crops later. However, these farmers often confront with problems from water shortage. While the cultivation in the rainy season must be done and harvest in hurry before being damaged by the coming seasonal flood.

According to the study on the water demand of main crops in the project area which were including of rice paddies, the demand was approximately 1,600 cubic meters/rai/crop (or around 300-400 cubic meters/rai/month). The total demand in the project area was around 115 million cubic meters/rai/crop (in the dry season).

2.5 Volume of Flood Water in the Project Area

It was found that the lowlands situated in the upper part of Tung Bang Rakam plain would be submerged, starting in the mid of rainy season and the situation would continue till the end of the rainy season. Added with large amount of runoffs in the last half of the season, the flood would be expanding and covering vast area of farmlands. The total volume of flood water was measured at 88.06 million cubic meters. The level of water inundating farmlands was about 1.5 meters. When the water level in the Yom River subsided, large volume of water would gradually drain into the river, leaving about 22.70 million cubic meters of water in the area (the flood level inundating farmlands was about 0.60 meter averagely). Due to the characters of being lowlands, this amount of water would be left in the area for a long period of time. Meanwhile it was unable to drain the area and there was no efficient distribution system in place to divert water into farmlands on the lower part of the plain as well. **Picture 2.5-1** shows the relationship between the peak of flood level and the volume of flood water.



Picture 2.5-1 Curves showing the relationship among water level, submerged area and flood volume in the project area

2.6 Local Wisdom in Resource Management

2.6.1 Water Management Overview

The cultivation season of farmers in this planned retention project normally starts after the flood water subsides at the end of the rainy season around November when the water level in the Yom River comes back to normal level. (Before that time the area is usually inundated and would be heavily submerged for three months during August and October). Most farmers are able to cultivate rice or other crops twice a year during November-February and February-May except the extremely low-lying farmlands where are suitable for farming only once a year. During this farming season, local administrations of three sub-districts would cooperate with the Irrigation Department's officers in water management. The network of canals and the diversion of water as well as water elevation are used in distributing water into waterways in the upper part of the project area. The water management is mainly controlled by Bang Kaeo Floodgate which is capable to collect and elevate water level to a height that water can flow back through Chum Saeng Songkram sub-district and fill Khlong Wang Rae or Khlong Lahan Canal, the main waterway in the midst of the area. Khlong Wang Rae Canal has been equipped with Lahan Floodgate built near the meeting point between the canal and the Yom River that help retaining, elevating and distributing water into several connecting canals. In addition, there is Bang Ba Rubber Dike across the Yom River locating down the mentioned meeting point which has retained and elevated water level by inflating the dike, providing water for farmlands. However, from an interview, it is found that the elevation level raised by the dike was not far and high enough to divert water into Khlong Wang Rae Canal.

Meanwhile, in attempts to improve the canal system in the project area, the dredging of waterways has been operated by local authorities. But the small budget allocation did often allow only the dredging of a number of small waterways. Water volume retained in these waterways at the end of the rainy season is barely enough for the second crop's cultivation during February-May. Then with request from local authorities, the Irrigation Department office would supply additional water through Khlong Bang Kaeo for farmlands in the area.

2.6.2 Flood Adaptation

The area designated to be the water retention project is flooded regularly almost every year with different scales. Normally the inundation level on the lowland is 1.5-3 meters over the paddy ground. Interviews with local administrations and local leaders and the survey shown that people residing in this flood-prone area had adapted themselves well to the situation. Accommodations are built on stilts high above the ground and farmers turn to fishing to earn a living during flood season.



Normal flood level



Houses built on high stilts



Household fishing instruments are commonly seen

2.7 Socio-economy

The survey on socio-economy had been carried out by interviewing farmers in Tung Bang Rakam area. These farmers were living in six villages of Bang Rakam's Chum Saeng Songkram and Tha Nang Ngam sub-districts and four villages of Kong Krilat's Krai Nok and Ban Mai Sukkasem sub-district. The conclusions were;

- The main source of income of all the interviewees were from rice farming. Earning from the farming varied on the scale of their farmlands and produces. The average revenue before deduction was about 434,721 Baht per person.

- Total average household income from the main and additional occupations was about 477,264 Baht a year. Total expense, agriculture related excluded, was 73,967 Baht a year averagely. This amount of earning was sufficient for 52.59 percent of household, insufficient for 29.31 percent while 18.10 percent of household could have some savings. Most of the household were in debt of about 291,245 Baht a year averagely.

- The land ownership of farmers was ranging in size from 0.5 to 170 rai. Farmers of 72.58 percent owned the land while 27.42 rented farmlands from landlords.

- The land ownership were mostly the land title deeds counting at 86.29%, the others were Sor Por Kor 4-01 (land right under Agricultural Land Reform scheme) at 4.84%, Nor Sor 3 (certificate of use) / Nor Sor 3 Gor (confirmed certificate of use) at 6.45% and Por Bor Tor 5,6 (local land tax receipt) at 0.40%. In addition, there were two pieces of land owned by the military and rented out for farming counting at 0.81% and another three pieces of land without the title verification counting at 1.21%.

- Most of the rice varieties cultivated was of Phitsanulok Variety (30.83%) Suphan Variety (27.94%) and Chainat Variety (16.63%) The farming seasons were between March/April and June/July and between November/December and February/March. Annual flood was often taken place during August and October causing the suspension of farming activities.

- The production cost could be classified as the seed expenses at 15%, fertilizers expense at 26%, labor and machinery expenses at 19%, pesticide expenses at 20% and expenses for tapping water with pumps at 20%. In total, the average investment cost was about 3,312 Baht per rai. The average harvest was about 730 kilograms per rai and farmers would reap about 5,227 Baht per rai averagely (calculating at the selling price of 7,152 Baht per ton of rice)

- The flood often took place after farmers has been planting rice for 90 days or about two weeks before the harvesting could be made. The average flood level was 1.5-2 meters above the paddy ground. The flood would averagely last 73 days while 82 percent of farmlands have been submerged almost every year.

2.8 Problems and Community Needs

According to local administrations and community leaders, the communities and members have realized the nature of the annual flood over their lowland locations and have adapted their livelihood to such this situation for a long period of time. They earned their living by fishing during the flood submerging their farmlands for example. Their main concern was the water shortage in the dry season. They wanted the waterways and lakes in the area to be dredged and developed in order to be able to store and distribute water more efficiently. The distribution and drainage systems as well as the floodgate should be constructed to increase the capacity of the

water storage. They asked the Irrigation Department to divert water from other basins such as the Ping Basin through tunnels or diversion of water from the Nan Basin to irrigate the area in the dry season.

3. Recommendations on Water Management System

3.1 Recommended solutions

1) The capacity of drainage system should be improved that is capable to drain water from low-lying areas at the beginning of the rainy season. Canals and waterways are needed to be dredged to the depth that can drain these low-lying areas. These waterways should be manage to connect to each other.

2) The capacity to store water volume within the areas during the late of rainy season and the beginning of the dry season should be increased as well as the storage of enough amount of water to irrigate the area during the dry period. The dredging of waterways with the constructions of additional water regulators should be implemented for the purpose especially at the end of waterways connecting to the Yom River and Khlong Bang Kaeo Canal.

3) The capacity to divert water into the area should be improved. Water volume expected to be able to divert into the area is from the Yom River (possibly to be drawn from the Ping River that the project is underway) and from the Nan Basin through the feeder canal of the Nan River- Khlong Mem and the ditch of Khlong Wang Khon. The construction of water regulator facilities (Wang Sa Tu and Wang Khi Lek Floodgates) in the Yom River and Khlong Bang Kaeo Canal are needed.

4) The area should be developed to be the newly opened irrigated zone so the water management plan in the Yom River Basin should be drawn up in particular. This is also the preparation for the development of the large additional reservoir and would benefit the water co-management plan with the neighboring basins.

3.2 Recommendations for Water Management and Agricultural Plan

The efficient management of water will surely be increase water supplies for the project area in Tung Bang Rakam Floodplain and also be able to help retaining water flowing into the lower Yom River and the Chao Phraya River Basins at a certain level. However, the storage of runoffs within the area would definitely increase the water supply but also would have adverse impacts on farmlands and farming patterns. Therefor it is necessary to set up the appropriate level of water storage in accordance with the cultivating timeline of farmers there as these followings;

- During the middle of rainy season with heavy rains and runoffs draining from the upper area, all water regulator facilities should be opened in order to drain water out of the area. This is to be prepared for a large volume of runoffs in the mid-season till the end of the rainy season.

- During the end of the rainy season when water level in the Yom River and the flooding water over the lowland subside and get close to the planned storage level, the existing water regulator facilities should be closed to store water then the farming activities can be started (the period around mid-October to late-October).

- The storage water volume would cover the large area of farmlands in Tung Bang Rakam floodplain at the level of less than 1.20 meters from the ground level. It would be difficult to drain the entire area before the cultivation of the second rice crops and it would cause the loss of storage water. A recommendation for the farmers is that the farming should begin in the area inundated for less than 0.20 meter. The preparations for rice cultivation with transplanting rice seedlings technic is possible to be done in the area inundated with low level of water.

- Farmers should prepare the farmlands and nurse the seedlings at the same time. The preparation for the seedlings nursery should be in small pieces of land equipped with water pumps to drain those submerged pieces of land. Otherwise farmers should pool up to utilize the land on the high ground as their nursery.

- Two weeks after the preparation activities on the least flooded farmlands (of less than 0.20 meter of inundation), when water from the surroundings would be drawn for the farming activities, flood level is expected to be subsided. Then the preparation works can be done in the next less flooded farmlands and such this step can be continued until covering the entire project area. The more farmland is cultivated, the less pieces of land submerged.

- The scope of the project's farming area, which had been used to estimate the number of water demand, was set upon the existing rice paddy farmlands at the time of the study. The farming area of the project was 72,000 rai that made up the number of total water demand volume of about 116.81 million cubic meters per crop (in the dry season).

- It was found that farmlands located at the lowest elevation level of this planned flood retention area could be used for farming eight weeks after the first plots of farmlands were cultivated.

- According to a graph of relationship between the volume of water demand and the decreased flood volume, the water demand in the area was found to be higher than the amount of flood water retained by about 58.63 million cubic meters. This shortage amount of water should be delivered from outside sources that would be from the Yom River (possibly being diverted from the Ping River Basin) and Khlong Bang Kaeo Canal (possibly being diverted from the Nan River Basin through Khlong Wang Khon, Khlong Mem Canals under operation of the Plai Chum Pol Project). The water diversion should be started at the ninth week of the farming season around the end of December till early January.

- The in-season rice cultivation would start from the mid of April. The rainfed cultivation technics would be applied. And the harvesting should be done before the mid of August when a large amount of runoff would flow into the area.

3.3 Project Elements Recommendations

1) Hydraulic structures to be utilized for controlling of water flow. It would manage the water inputs and outputs between the project area and main waterways outside as well as to manage the circulations and drainage of water within the project area. Details are including of;

- Drainage tunnels equipped with gates, nine facilities in total
- Floodgates, three facilities in total

2) The construction of levees to assist the hydraulic structures in controlling and maintaining water to be within the particular waterways. This element has been planning in the lowlands and the lower part of the project area (not for preventing the runoff or flood water flowing into the area) with total length of 15.60 kilometers.

4. Investment and Benefits

4.1 Investment Cost and Cost-Benefit Analysis

List of Analysis	Unit	Financial Value	Economic Value
Investment cost	million Baht	424.48	373.54
Maintenance and operation expense	million Baht/year	8.49	7.81
Yield of return	million Baht/ year	68.21	66.31
(NPV) Net Present Value (NPV)			
Opportunity cost of 8%	Million Baht	242.65	275.69
Opportunity cost of 10%	Milion Baht	116.57	151.24
Opportunity cost of 12%	Million Baht	32.23	67.71
Benefit/Cost ratio (B/C)			
Opportunity cost of 8%		1.52	1.66
Opportunity cost of 10%		1.26	1.39
Opportunity coat of 12%		1.08	1.18
Economic Internal Rate of Return (EIRR)	Percent	13.01	14.39

4.2 Expected Outcomes

- 1) The ability to drain water out of the project area would be increased during the middle of the rainy season when water level in the Yom River is not very high.
- 2) The capacity of water storage in the project area would be increased by 37.80 million cubic meters equivalent to water demand for 23,297 rai of rice cultivation in the dry season.
- 3) The ability to divert water from the Yom River or Khlong Mem Canal into the project area during the dry season would be increased (in case of having enough water volume in the waterway). While the development of the large reservoir of Mae Yom Dam project, located in the upper basin, which was recommended in the study, would increase water supply capacity and make the water diversion from the Yom River into the project area be more efficient.
- 4) The water distribution system capacity to farming area would be increased.
- 5) The flood level in the late rainy season would be decreased by 0.59 meter.
- 6) The area would be developed as a special zone of water management that utilizing water from the storage of flood water in the area along with outside sources of water, to be covering 72,000 rai of farmland.

5. Suggestions

- 1) The project area has been planned over a number of sub-district administrations that would possibly cause water disputes. It is needed to administrate the project under the special zone so water management would be done accordingly to the study plan. The project area would be proposed as a newly opened irrigated zone with rules and regulations to govern the water management as planned.
- 2) The feasibility study of the newly opened irrigated zone should be carried out. The survey into its geographical characteristics in details should be conducted to obtain the flood level information in various locations precisely that would be used for the planning on water storage and management. Public relation activities and local consultation meetings should be arranged considerably in order to create people understandings and involvements in water co-management and in setting up the regulations. These are essential elements for the success of the project.
- 3) All the construction for various project's elements shall be implemented under the same project plan, particularly for all hydrolic structures in the project's area, which must be elevated and lined up appropriately for their most effectiveness. The dredging of waterways should be included under the plan.
- 4) It is needed to rapidly materialize the large irrigation development project for the Yom River Basin in order to increase water supply volume for farmlands within the project area during the dry period. The study into water co-management among neighboring water basins should be carried out as well, the development plan of each basin must be taken into account.

Annex III: Indicative Timetable of Project/Programme Implementation

TASKS ¹²	2017		2018				2019				2020				2021				2022	
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
Output 1: Improved climate risk-informed planning in the water and agriculture sectors	X	X	X	X	X	X	X	X	X	X	X	X	X	X						
Output 2: Strengthened water management infrastructure for greater resilience to projected climate change				X	X	X	X	X	X	X	X	X	X	X						
Output 3: Increased resilience of agriculture livelihoods in drought and flood prone areas				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

¹² Activities are, at this point, indicative and may change as a result of further development and review at the proposal stage.