ADAPTATION FUND

REGIONAL PROJECT/PROGRAMME PROPOSAL

PART I: PROJECT/PROGRAMME INFORMATION (Summary)

Title of Project/Programme:	Groundwater resources in the Greater Mekong Subregion: collaborative management to increase resilience
Countries:	Cambodia, Lao People's Democratic Republic, Myanmar, Thailand, Vietnam
Thematic Focal Area:	Transboundary water management
Type of Implementing Entity:	MIE
Implementing Entity:	UNESCO
Executing Entities:	National Agencies, CCOP-TS, IWMI, IGRAC
Amount of Financing Requested:	**US $ 4,898,775**

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Groundwater resources in the Greater Mekong Subregion: collaborative management to increase resilience

A collaboration of Vietnam, Lao People's Democratic Republic, Cambodia, Thailand and Myanmar to increase climate resilience in the greater Mekong Sub-region through improved GW management and transboundary cooperation

United Nations Educational, Scientific and Cultural Organization

International Hydrological Programme

COORDINATING COMMITTEE FOR GEOSCIENCE PROGRAMMES IN EAST AND SOUTHEAST ASIA (CCOP)

IWMI International Water Management Institute

IWMI is a member of the CGIAR Consortium and leads the:

CGIAR RESEARCH PROGRAM ON Water, Land and Ecosystems

igrac International Groundwater Resources Assessment Centre

Inside cover

Front cover pictures: courtesy IWMI team Lao PDR

Bangkok, July 2016

Content page

PART III: IMPLEMENTATION ARRANGEMENTS

Annexes

PART IV:

Abbreviations

ADB	Asian Development Bank
AF	Adaptation Fund
ASEAN	The Association of Southeast Asian Nations
AWP	Annual Work Plan
CA	Climate Adaptation
CCA	Climate Change Adaptation
CBDRM	Community-based Disaster Risk Management
CBNRM	Community-based Natural Resource Management
CBOs	Community Based Organizations
CCOP-TS	Coordinating Committee for Geoscience Programmes in East and Southeast Asia – Technical Secretariat
CoP	Community of Practice
DMH	Department of Meteorology and Hydrology
DNR-DGM	Department for Mineral Resources – Division for Groundwater Management
DRR	Disaster Risk Reduction
DWRPIS	Division for Water Resources Planning and Investigation in the South of Vietnam
GEF	Global Environment Facility
GGMN	Global Groundwater Monitoring Network
GGIS	Global Groundwater Information System
GMS	Greater Mekong Subregion
GW	Groundwater
IHP	International Hydrological Programme
IMS	Information Management System
INGO	International Non-governmental Organization
IGRAC	International Groundwater Resources Assessment Centre
IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
MAR	Managed Aquifer Recharge
M&E	Monitoring and Evaluation
MIE	Multilateral Implementing Entity
MONRE	Ministry of Natural Resources and Environment
MRC	Mekong River Commission
MSL	Mean Sea Level
QGIS	Quantum GIS – Geographic Information System
SDGs	Sustainable Development Goals
TA	Technical Assistance
TBA	Transboundary Aquifer
TWAP	Transboundary Water Assessment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
VP	Vientiane Plain (Lao PDR)
WASH	Water, Sanitation and Hygiene
WRUD	Water Resources Utilization Department (Myanmar)

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Groundwater resources in the Greater Mekong Subregion: collaborative management to increase resilience

PART I: PROJECT INFORMATION

1. Project background and context

Brief information on the problem the proposed project/programme is aiming to solve, including both the regional and the country perspective. Outline the economic social, development and environmental context in which the project would operate in those countries.

1.1 Resource Status: Groundwater in the Greater Mekong Subregion

The countries of the Greater Mekong Subregion (GMS – Cambodia, Lao People's Democratic Republic (Lao PDR), Thailand, Myanmar and Vietnam) have abundant surface water resources in the large rivers of the region – the Mekong alone discharges around 475 km³ annually, and the Ayeyarwady around 400 km³. Even though surface water is abundant, a significant contribution to overall water supply comes from GW (GW). GW use is common and widespread in the lowlands and plains and is especially used to cover water needs in the prolonged dry season. The GMS countries have a total population of about 240 million people; a considerable number are low-income groups and urban/rural communities that rely on easily accessible, reliable, good quality and low-cost GW for their domestic use and agrarian-based livelihoods. GW use has been increasing as water needs from different sectors are rising and drilling and pump costs have become more affordable. This trend is likely to continue in view of growing demand for food security and livelihood enhancement, meeting Sustainable Development Goals and adapting to climate change. The long term impacts from increased GW use on domestic and industrial supplies and the resource in general, including the ecosystems served, remain unclear.

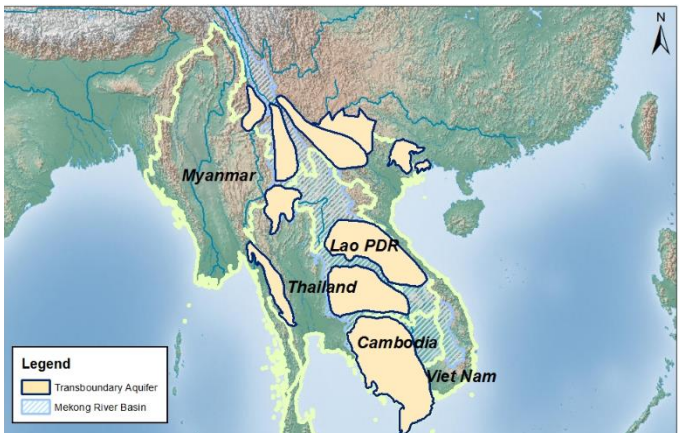


Figure 1: Overview of the main transboundary GW aquifers in the Greater Mekong Subregion; source IGRAC.

GW is an important resource in the highlands as well as the lowlands along the Mekong River in Lao PDR, in northeast Thailand, Cambodia, in the Mekong Delta in Vietnam and in Myanmar's Central Plain. Important transboundary aquifers straddle the border areas and highlight the need for bi- or tri-partisan cooperation for effective management of shared resources (Figure 1; see also Landon, 2011[1]). Throughout the GMS, complex relationships occur between upstream recharge areas and downstream aquifers. The total potential capacity of GW resources is estimated to be about 60 million m³/day. But GW resources of the GMS have not been investigated in detail, and only limited information about GW resource volumes, use, sustainability and quality is available. Recent studies (i.e. Erban, 2014[2]; Wagner et al., 2012[3]) illustrate the intensive use and economic significance of GW for both

[1] Landon. M., 2011; Preliminary compilation and review of current information on GW monitoring and resources in the Lower Mekong River Basin. USGS report to Mekong River Commission.
[2] Erban, L. S.M. Gorelick & H.A. Zebker, 2014; Groundwater extraction, land subsidence and sea-level rise in Mekong Delta, Environ.Res.Lett. 9.
[3] Frank Wagner, Vuong Bui Tran and Fabrice G. Renaud; Groundwater in the Mekong Delta: Availability, Utilization and Risks, in The Mekong Delta System, Interdisciplinary Analyses of a River Delta, Renaud and Kuenzer (eds.), Springer, 2012)

the Vietnamese and Cambodian part of the Mekong Delta. This also applies for the drought sensitive northeast of Thailand (the Isan region), adjacent parts of Lao PDR (Pavelic et al., 2014[4]; Vote et al., 2015[5]) and Myanmar's central plain (McCartney et al. 2013[6]). GW is also an extremely important resource for crop irrigation, food production (notably in Myanmar, Thailand and Vietnam), industry (e.g. food processing, mining) and domestic supply for urban and rural communities. Due to rapid economic and population growth, pressures on GW in the region are increasing fast. Climate variability creates a more uncertain dimension of stress, with, for example, the recent El Niño related drought in Thailand leading to emergency measures involving the drilling of 900 wells for irrigating parched rice fields with unknown longer term consequences (Bangkok Post, 23 June 2015). The threats of climate change impacts on the region's water supply are further discussed below.

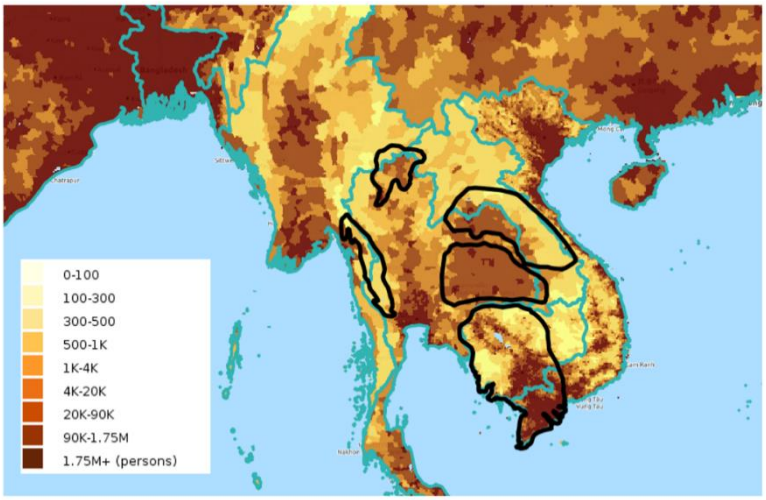


Figure 2. Main Transboundary aquifer (TBA) systems in the region and the population density in 2015 in the region (data: SEDAC: Socioeconomic Data and Applications Center).

Population densities (persons/sq. km) vary quite significantly throughout the region but it can be said that in more densely populated areas there is a significant dependency on GW for agricultural (irrigation) water needs, rural and urban water supply for domestic needs, especially in more frequent and prolonged droughts.

1.2 Groundwater resources users and increased vulnerabilities

In the recent past over-extraction of GW for production of high-value crops, such as coffee, has caused a severe drop in GW levels in parts of the Vietnamese highlands. Intensification of irrigation to meet the food demand of growing populations increases GW use while recharge diminishes. In some areas such as southern Cambodia, parts of Lao PDR and the Mekong and Ayeyarwady deltas, naturally occurring arsenic contamination will be exacerbated by increased GW use in a changed climate. GW supports valuable ecosystem services by feeding springs and baseflow to rivers and wetlands that are the habitats of fish and aquatic vegetation harvested by riparian communities.

Intrinsic linkages between surface water and GW exist, but are not always clear and must be taken into account in water allocation planning. Further expansion of irrigation, land use changes (deforestation) in the highland areas, increase of domestic and industrial use in expanding cities of the GMS may result in significant depletion of GW resources in the future, leading to reduced water availability, higher pumping costs, saltwater intrusion in coastal areas, and loss of ecosystem services. These effects will be exacerbated by the impacts of climate change (increasing demand, potentially reducing recharge) throughout the GMS. The full impacts of climate change on GW availability are likely to be complex and require further investigation.

[4] Pavelic.P., O. Xayviliya and O. Ongkeo., 2014; Pathways for effective GW governance in the least-developed-country context of Lao PDR., Water International; DOI 10.1080/02508060.2014.923971

[5] C Vote, J Newby, K Phouyyavong, T Inthavong and Eberbach, P. 2015; Trends and perceptions of rural household GW use and the implications for smallholder agriculture in rain-fed Southern Laos. International Journal of Water Resources Development, 02/2015; DOI:10.1080/07900627.2015.1015071

[6] McCartney, M.; Pavelic, P.; Lacombe, G.; Latt, K.; Zan, A.K.; Thein, K.; Douangsavanh, S.; Balasubramanya, S.; Rajah, A.; Myint, A.; Cho, C.; Johnston, R.; Sotoukee, T. 2013. Water resources assessment of the dry zone of Myanmar. [Project report of the Livelihoods and Food Security Trust Fund (LIFT) Dry Zone Program]. Vientiane, Laos: International Water Management Institute (IWMI); Yangon, Myanmar: National Engineering and Planning Services (NEPS). 52p.

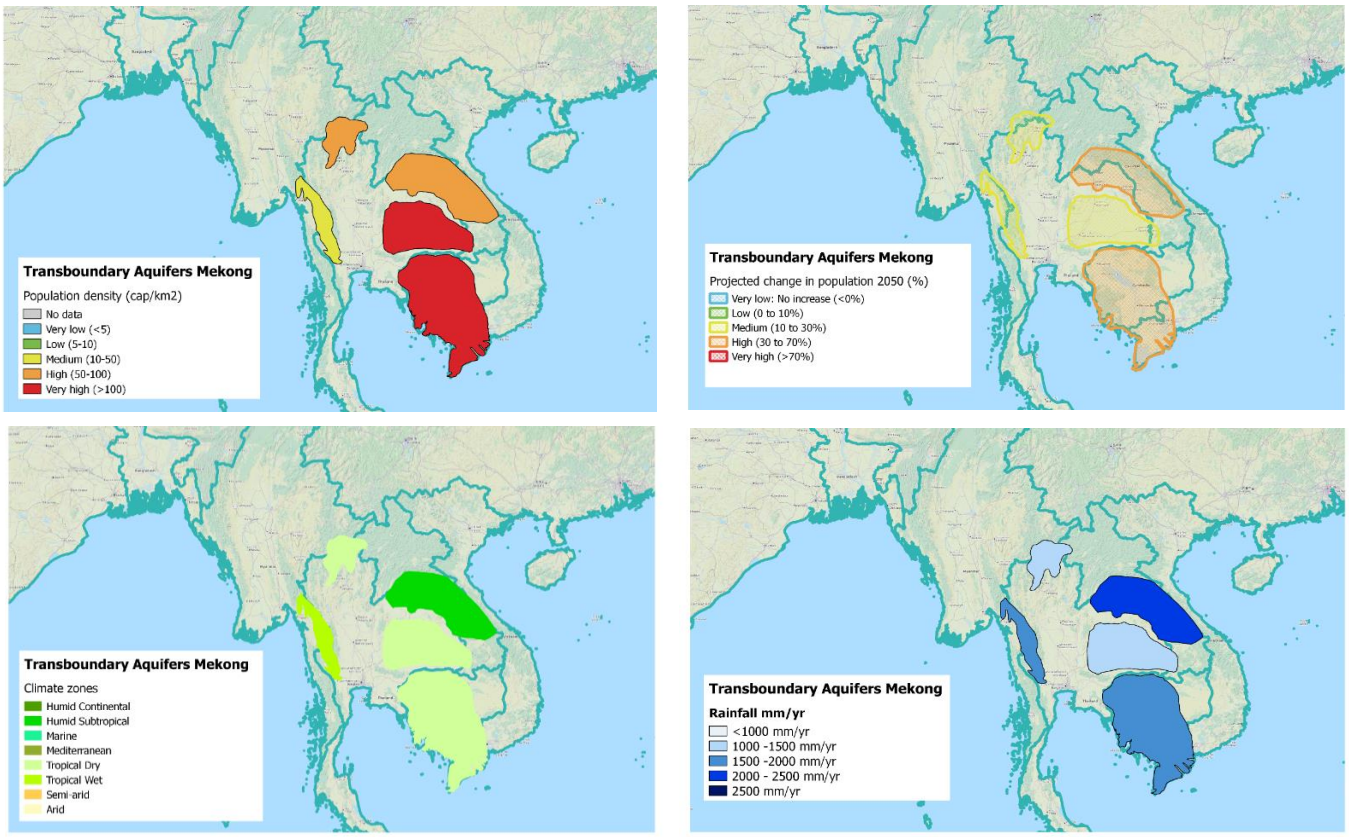


Figure 3: Overview of characteristics of the main TransBoundary Aquifers located in the GMS and shared by Myanmar, Thailand, Lao PDR, Cambodia and Vietnam. A. Population density; B. Projected change in population; C. Climate zones and D. Average annual precipitation. Data derived from the Transboundary Water Assessment Programme (TWAP), http://twapviewer.un-igrac.org).

Comprehensive GW management and specialized studies are a relatively new and underdeveloped domain, pertinently so in Lao PDR, Cambodia and Myanmar. In Thailand government departments DNR-DGM have, over the last decades, made substantial efforts to map GW resources (1:250.000 series hydrogeological maps / GW maps) throughout the country and conduct various regional and specialized studies. Besides major studies in the Bangkok metropolitan region important work also was done in the drier northeast of the country (Isan region) where agriculture relies heavily on GW. In a similar mode, systematic GW mapping and studies in Vietnam have progressed since early investigations in Red and Mekong river deltas and development of expertise and capacity in central government agencies under MONRE (Ministry of Natural Resources and Environment). GW is now a recognized component in studies for provincial and municipal water supply and there is growing awareness on long-term supply and water quality issues (arsenic, salinity intrusion, pollution in urban areas). Unfortunately, the situation is very different in Lao PDR and Cambodia where GW is a rather neglected resource. Only gradually it is considered in national water, environmental and natural resources management policies and slowly some capacity is being developed.

Monitoring

The status of GW resources needs to be monitored regularly to provide a basis for their assessment and to estimate quantities and quality. Without appropriate data collection and assessment there can be no effective GW management. GW is monitored in many parts of the world by measuring GW levels, GW abstraction rates, spring discharge and GW quality. GW level point measurements are often interpolated and combined with other data (e.g. remote sensing and modelling) to assess the state of GW resources over a larger area. Increasingly, there is active involvement in GW monitoring by stakeholders and users (crowdsourcing approaches to data collection, viz. Akvo Flow; http://akvo.org/products/akvoflow/); this is of particular interest for this project. There is however, a lack of

GW information at the regional and local scales, which hampers assessment and informed water management in general and the use and allocation of limited GW resources for specific purposes as intended in this project. Worldwide, organisations have taken up the challenge of setting up and supporting systematic collection of data and development of monitoring networks. One of these is the **Global Groundwater Monitoring Network** (GGMN) established and supported by IGRAC (www.un-igrac.org/ggmn) .

The GGMN is an easy to use and versatile tool that provides access to and analytical capabilities for GW monitoring data. GW level data and changes occurring in GW levels can be displayed on a regional scale. Additional data layers and information are available to understand the monitoring data in a broader water-related context. The web-based software application assists in the spatial and temporal analysis of monitoring data. The system is integrated with QGIS to process data offline. QGIS is an open source Geographic Information System that contains variety of functionalities to analyse the data and create spatially interpolated GW level maps (see for instance: www.un-igrac.org/qgis). The tool can be used and filled with data for any specific area, and data analysis, output, maps and charts can be derived in accordance with user needs.

Ongoing GW and hydrogeological studies in the five countries by themselves are not sufficient to address water scarcity and food production vulnerabilities; a paradigm shift in GW management is required to come to a concerted effort to develop resilience based on comprehensively supporting supply-demand issues, both from GW resources (Supply perspective, as well as from water user and stakeholder perspective (Demand). Much more than in the past, GW experts need to be aware of user needs and possibilities and constraints to sustainably use GW. At the same time, farmers, water supply managers, industrial plant managers and other users have to be informed and enabled about the (im)possibilities of GW use, surface and GW co-management practices and other measures to support development of more resilient irrigation, food production and water supply systems. This paradigm shift can be illustrated on different levels, from very basic to strategic policy-making levels, by the use of more appropriate information products. Traditionally, hydrogeological or GW potential maps do not provide very clear or pertinent information to water users in different sectors (agriculture, industry, domestic water supply) who develop and manage water supply. In order to use the resource more efficiently, in view of increasing demand and scarcity, this can be improved. On a higher level, GW resources are now more commonly seen as an intrinsic part of the water system and correctly so; GW resources are of strategic importance for national agriculture and food systems, energy systems, ecosystem services, rural and urban water supply and obviously, evolving climate change adaptation (CCA) strategies. Hence, appropriate GW information is of strategic importance on a (supra)national level and particularly also for transboundary water issues (as in the GMS). In this project focus will be on addressing water user needs in various sectors and jointly developing resilience measures, and on strengthening strategic GW management and transboundary cooperation.

Groundwater use

Across the GMS GW plays a major role to supply water for domestic, agricultural and industrial use, with a major share going to irrigation in rural areas and to industrial-domestic water supply in urban areas. Agricultural users commonly use surface water from streams and ponds as well as GW from shallow tube wells. GW is easily exploited by individual farmers due to general availability, quality and relative low development costs. Pavelic et al. (2015) describe different typologies of agricultural GW use in Myanmar Dry Zone; these are representative for the wider region.

- Deeper tube wells (larger farmers)
- Shallow tube wells and permanent (deeper) dug wells
- Seasonal dug wells in riverbeds
- Shallow dug wells and ponds for small extractions

Increasingly, GW is exploited, via deeper tube wells, in government-supported domestic water supply programmes for villages and smaller towns. These schemes are often hampered by poor management. Large scale irrigation schemes using GW have been developed with international technical assistance. Whereas normally large industrial water users would use surface water (sugar mills, cement factories), increasingly there are shifts to reliable, good quality GW.

1.3 Climate change scenarios and climate change impacts in the region

All GMS countries are vulnerable to the adverse effects of the existing climate and weather patterns; flooding and heavy monsoon rains are common but the region can also experience prolonged dry season droughts with pronounced and common water scarcity. Drought and water scarcity are the dominant climate-change related threats in Myanmar's Dry Zone (ADB, 2009), with major impacts on the regional and national food security. Rather similar patterns are known from north-eastern Thailand and the adjacent lowlands in Laos, and from southern lowland Vietnam. The tropical monsoon climate in the region is characterized by two major seasons. The monsoon occurs from May to October, with heavy rains, high humidity and strong winds. From November to April is the dry season, with little rain, low humidity and not much wind. Total rainfall across the region varies from extremely high (up to 5000 mm annually) to a mere 700 mm per year in the central Dry Zone of Myanmar. These recurrent dry spells constitute a constant threat to the livelihoods of the rural poor. The climate is influenced by the El Niño Southern Oscillation, which causes inter-annual variations, bringing warmer, drier winters in El Niño years and cooler than average summers in La Niña years. Temperature records show an increase in mean annual temperatures and the number of dry, hot days annually. Future projections suggest that these trends will continue, with the average annual temperature rising by 0.7-2.7°C by the 2060s and 1.4-4.3°C by the 2090s throughout the year (depending on the greenhouse gas emission scenario and the climate model used).

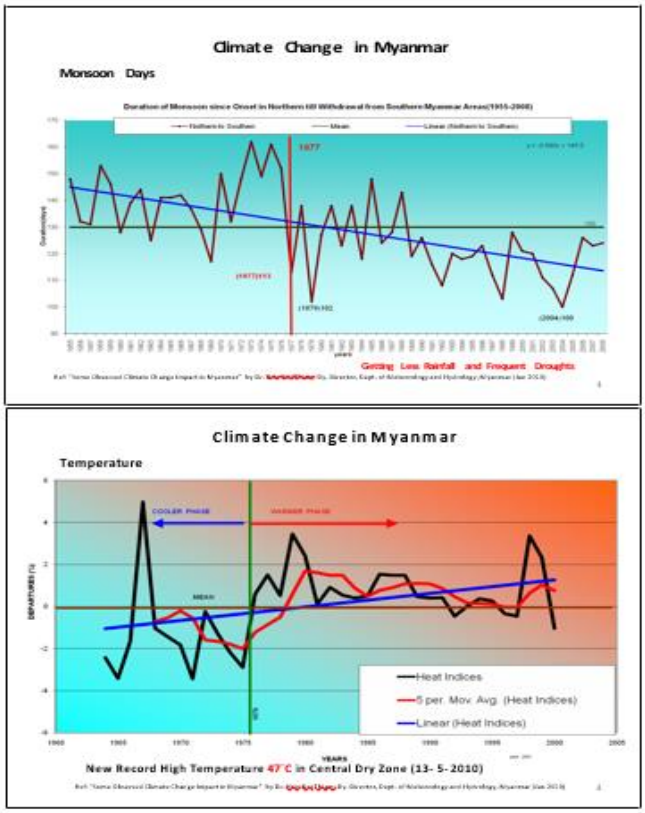


Figure 4: Climate change trends in Myanmar's Dry Zone: Rising dry season temperatures and shorter rainfall periods.

Climate models predict a minor increase in annual rainfall in the coming decades but with notable regional and seasonal differentiations. Generally speaking, it is expected that shorter and wetter rainy seasons and longer will occur, with longer and drier dry seasons, and more anomalous seasonal events, such as the occurrence of short droughts during the rainy seasons. Together, these impacts mean increased uncertainty in the availability of water for domestic and agricultural users. Given that the climate will be increasingly variable, with more pronounced extremes, the impacts of climate change will be evident primarily through extremes in the water system, which have significant implications for different sectors and water users. (Johnston *et al*., 2010).

1.4 Transboundary resource management and regional cooperation

Climate change and climate change vulnerabilities are not bounded by national borders. Likewise, GW resources are crossing state borders, including in the GMS. Accordingly, both climate change related vulnerabilities and resilience measures involving GW resources have to be assessed and managed at the appropriate (regional and at least aquifer-wide) scale. Besides assessment and characterization of GW resources, this should include environmental, socio-economic and policy/ institutional aspects. In the case of internationally shared aquifers and resources used on both sides of the international border, information management/sharing and international relationships are two additional very important aspects to be taken along in the assessment. In various ways, these aspects also affect resilience based on GW use; significant changes across the border (increased pumping, pollution, etc.) may increase vulnerabilities to changing climate. (Even when that it is not immediately evident, it should be proven by monitoring and assessment because of intrinsic sensitivities in international relationships.). Once the aquifer sharing states agree to jointly manage GW resources, they need to set up an international cooperation mechanism.

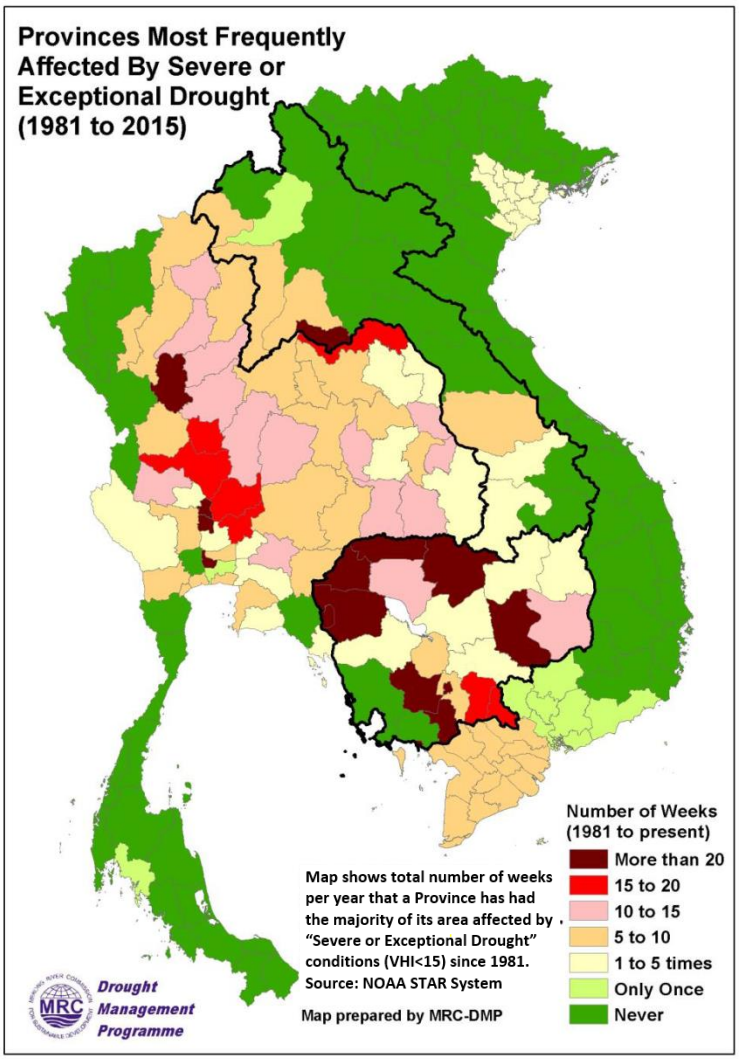


Figure 5: Regional impact of droughts (Source: MRC.org). The project proposes to work in three of the most vulnerable regions, viz. the Vientiane Plains (Lao-PDR-Thailand, bordering Mekong river, the border area between northwest Cambodia and Thailand, and the upper Mekong Delta region shared by Cambodia and Vietnam.

Common monitoring and assessment usually face the challenge of data harmonization, including reference systems, formats, classifications, languages and/or technologies. Harmonized data and information should preferably be stored in an on-line Information Management System (IMS) along with outcomes of assessment and possible management scenarios. An IMS supports collection, storage, processing, visualization and sharing of data and information. As such, it is a valuable tool in management and protection of internationally shared aquifers. Moreover, contemporary IMS can easily store and combine info from various web-based sources, allowing analysis of GW resilience in a broader context of climate change (i.e. including surface water, land use, demographic predictions, etc.).

Role of Mekong River Commission

The Mekong River Commission has built up a long track record in contributing to regional water resources management in support of broader socio-economic development and sustainable management of natural resources. MRC Basin Development Plans, the latest just released[7], provide a comprehensive, integrated water resources management based framework. Unfortunately, with respect to GW issues the role and mandate of the Mekong River Commission is less well documented. Logically, it could provide an initial platform for regional transboundary GW cooperation, for instance focusing on a number of priority issues, such as:

- Monitoring and data sharing
- Information sharing and a joint approach to deal with high arsenic concentrations
- Inclusion of GW resource assessments and potentials in future Basin Development Plans and other challenges that require dealing with surface and GW in a conjunctive manner

This project will develop the functionality and *modus operandi* that could, potentially, be transferred to MRC as a more permanent entity with a regional water resources advisory mandate in the GMS.

Integrated Water Resources Management-based

Basin Development Strategy 2016-2020

For the Lower Mekong Basin

Today, the LMB is home for 65 million people, 80% of whom live in rural areas dependent on agricultural livelihoods. Many are poor. All countries are expected to have reached middle-income status by 2030. The Mekong contributes significantly to this growth through the opportunities it provides, including water and wastewater services, energy, agriculture, fisheries, transport and trade, and ecosystems services. But without coordinated development and effective management, the Mekong can also threaten continued growth through the risks that it brings, including the risks of floods and droughts, the deterioration of water quality, the reduction of sediment loads, and the overall deterioration of ecosystem services and biodiversity. The BDS 2016-2020 recognizes these trends, takes a long-term outlook, and examines longer term water resources development needs. It is assessed that the current national water resources development plans are sub-optimal from a basin-wide perspective. These plans fall short in protecting key environmental assets and protecting millions of increasingly affluent people against major floods (and droughts). Finally, the distribution of the benefits, impacts and risks from planned basin development may not be viewed as equitably distributed.

Figure 6: The recently published Basin Development Strategy (MRC, 2016) focuses on Mekong river basin surface water resources, while there is increasing awareness that a significant share of water needs for irrigation agriculture, domestic and industrial water supply are met by supplies from GW sources. Obviously surface and GW systems are intricately linked, in particular when it comes to addressing the impacts of climate change. This project aims to develop explicit resilience potential on the basis of improved GW management, in conjunction with the regional development ambition.

Even where transboundary *cooperation in* surface water management (Mekong River and MRC) has progressed, there is no common approach or even modest recognition and cooperation for GW resources. The challenges in river management (resource sharing, impacts of river management and hydropower development, climate change, etc.) are equally valid for GW resources and their diverse users. The absence of a sizeable community and cooperative network of GW experts in the GMS severely hampers addressing these issues, in particular in Myanmar, Lao PDR and in Cambodia, where local capacity in hydrogeology is very limited. Regional cooperation in the ASEAN Economic Community offers an opportunity to tackle these challenges.

[7] Integrated Water Resources Management-based Basin Development Strategy 2016-2020 For the Lower Mekong Basin, MRC.; http://www.mrcmekong.org/assets/Publications/strategies-workprog/MRC-BDP-strategy-complete-final-02.16.pdf

Information Management Systems for Transboundary Groundwater

The Global Groundwater Information System (GGIS) is an interactive, web-based portal to GW-related information and knowledge. The main purpose of the system is to assist in collection and analysis of information on GW resources and the sharing of this information among water experts, decision makers and the public.

IGRAC has provided Information Management Systems (IMS) to a variety of GW projects. Those IMS are designed to store interpreted and processed data from the assessment of the GW resources in order to be used as a tool to support decision makers and to create transparency between the (international) stakeholders. The project IMS can be set up in such a way that they facilitate sharing of data between project partners only, and/or with the general public.

A new IMS can be developed as a stand-alone application or, if preferred, further integrated with existing modules available in the GGIS. In the last years, the GGIS has demonstrated its capacity in transboundary aquifer assessment projects. Shared information systems among countries have facilitated joint management and better GW governance focused on coordination, scientific knowledge, social redress and environmental sustainability.

GGIS Portal capabilities:

1. Store variables, thematic maps and documents.
2. Visualize geospatial data and information in a map viewer.
3. Share and analyse results in a protected environment before making it publicly available.
4. Add map layers from external sources via web map services (WMS).
5. Generate new pieces of information by creating overlays of thematic maps.

Meta Information Module (MIM)
Maps are an excellent tool to communicate spatial data and information, but metadata related to the map layers is of equal importance. Therefore the GGIS also contains a meta-information module (MIM) which allows uploading, storing and searching of additional information linked to the data presented in the system, like documents or references.

1.5 Knowledge and Information Gaps

There is limited and regionally incoherent information on GW resources of the GMS, in particular the kind of insight required to deal with pressing issues, such as:

- Extent and/or characteristics of superficial and confined aquifer systems, including useable resource volumes in aquifers systems in the GMS, existing and/or potential water quality threats.
- Current GW volumes being abstracted for various uses; future demand scenarios for irrigation, urban and rural water supply.
- Relationships between recharge in highland (upstream) areas and resource potential in lowland (downstream) areas. This includes the GW dynamics of several important transboundary systems. Climate change, land use changes and major interventions in the river systems (dam and reservoir construction, upstream water diversion and flow regulation) will affect these delicate balances in supply and demand.
- Sustainability (in view of increasing abstraction) and vulnerability of riparian GW resources to climate change induced changes in precipitation and changes in river flow regimes (natural or anthropogenic).

To understand better the resource and resilience potentials and vulnerabilities of GW systems of the GMS, detailed hydrogeological investigations are required. Crucial GW monitoring data are needed to keep track of resource status and detect possible critical depletion, for developing and using regional GW information systems and for understanding transboundary GW flows. These regional (transboundary) GW models and information tools will help manage and conserve resources. It is therefore also needed to:

- Visualize (in maps) regional and transboundary GW (recharge and extraction) systems and enable assessment of GW recharge rates from flooding and rainfall under the current and future climate conditions.
- Determine GW resource potential in shallow and deep aquifer systems (for different users) and demonstrate how this potential can be developed to increase resilience

1.6 Capacity building

The regional landscape of GW management capability and expertise is rather diverse. Especially in Lao PDR, Cambodia and Myanmar integrated and comprehensive GW management and specialized studies are rare, mainly due to a lack of well-trained and experienced practitioners. At the same time, the recognition of GW as a key natural resource is beginning to reach higher policy levels in government. Fortunately, the situation has been very different in Thailand and Vietnam where GW work took off decades ago and became part of natural resources and water agencies' mandates. Subsequently, also professional training and research activities took place. So in Thailand, there is a fairly good understanding of the most important national GW resource systems, such as those underlying the central-north Chao Praya plain and metropolitan Bangkok, and more diverse and problematic aquifer systems in the north-eastern Isan region. In this region, irrigated agriculture relies significantly on GW and now there is a considerable number of well-trained hydrogeologists and irrigation experts that know how to deal with GW. In Vietnam agricultural development work in Red and Mekong river deltas has resulted in a fair degree of capability in central government agencies in the north and south of the country. In a growing community of experts, there is growing awareness on the need to develop expertise on a number of challenging issues, like long-term urban water supply and water quality issues (arsenic, salinity intrusion) and, more recently, integrated water resources management to ensure the sustainability of the highly productive agricultural systems in both the Red River and Mekong River delta. Both from government and academe in Vietnam there is ongoing and high-level awareness to further develop human resources capacity through higher education and participation in national and international research. There is also a willingness to engage and collaborate with neighbouring countries.

This project will make use of the professional and political momentum (the processes that are part of the drive for ASEAN economic integration and cooperation) to build a GMS community of cooperation for capacity development in GW management. Strengthening of capabilities can take place throughout the region, but will be most explicit in the three countries most in need, i.e. Lao PDR, Cambodia and Myanmar. It will start with a verification and inventory of basic GW relevant skills and practical knowledge and general information on the size and qualifications of the practitioners, and their institutional context. Subsequently, capacity building efforts will be directed towards at least three generic issues:

1) Supporting capacity development of GW professionals towards better understanding and apprehension of new technologies that need to be engaged to ensure GW-based solutions and support for climate resilience. Examples are understanding and application of IWRM principles, GW governance, monitoring and information systems, issues of transboundary GW management, new concepts and technologies like managed aquifer recharge (MAR), co-management of surface and GW, stakeholder involvement for data collection.
2) Enhancing the skills and understanding of GW stakeholders. GW professionals should practice and be aware of the fact that many stakeholders use the resource: farmers need irrigation water, rural communities and towns need water supply for domestic use, industries and mining operations need process good quality water, and GW is intricately linked with valuable ecosystem services. Comprehensive and good GW studies and management should cater to all these interests and wide diversity of stakeholders. All these stakeholder groups can also develop climate resilience measures through responsible and forward-looking GW use. This will be explicitly addressed in Components 2 and 5 of the project.
3) In order for this approach to be successful, better awareness and understanding at higher policy levels is essential. First an assessment will be done to see if basic responsibilities and tasks for GW management as an important resource are in place at national government level. Second, the assessment will check whether policy development and linkages to other sectoral policies can be supported and broadened to explicitly include issues of climate resilience, sustainability and vulnerability reduction through more active GW management. Political awareness will be built up.

The project will engage the regional approach so that countries with a relatively advanced position (i.e., Thailand, Vietnam) can take a leading role, share experience and lessons learned. Additional international expert support will be provided. The project will organize and conduct a number of training workshops, with regional participation (Component 5: Training Activities: see Part II, Section A, Component 5). The degree in which national and/or regional specialized training are available will be assessed and collaboration opportunities set up. Where useful training courses are offered, project participants will be selected and invited to enroll.

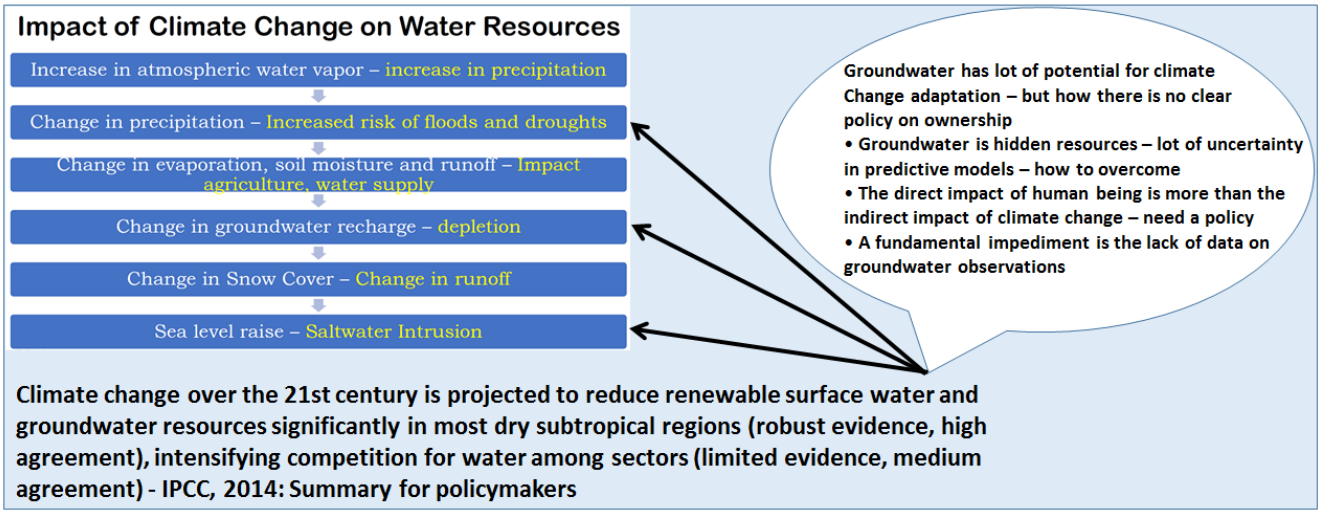
The project will generate important data, information, knowledge and linkages. It is intended to facilitate these functional linkages by means of an on-line knowledge management and information repository. First, the functionality will be built in to the project website, but gradually expanded to become a dedicated information and resources sharing tool.

Outlook

Overall, the project aims to enhance the resilience potential of improved and regionally coordinated GW management and demonstrate that it can provide effective tools and capacities to reduce vulnerability. To enhance adaptive capacity and reduce climate change vulnerability for specific target groups, the project will focus on implementing the following activities:

- Use the upgraded collective expertise and awareness of the GW community regarding CCA and resilience strategies to ensure that further work in the GW sector better supports the needs of vulnerable user groups.
- Demonstrate, further develop and ensure information is available on the 'resilience potential' of improved GW management and use (i.e. through collaborative transboundary aquifer management)
- Identify additional new vulnerability reduction options, develop these and share practices with relevant vulnerable groups (i.e. enhanced aquifer recharge practices that use wet season water surplus to create dry season reserves. These will be set up in cooperation with local stakeholder groups and under intraregional CCA initiatives).
- Ensure that new and innovative GW management information products specifically cater to the needs of the identified and targeted vulnerable groups (for instance using smart phone networks to distribute and collect information).
- Train a new generation of GW experts to think beyond the technical challenges of the physical GW system and ensure that they recognize and can respond to the multi-disciplinary and multi-sectoral nature of GW management, and are therefore able to engage with a wider range of stakeholder groups to resolve vulnerability issues and increase sustainable water use.

Figure 8: Earth and water resources systems are affected by the impacts of climate change. By virtue of its intrinsic properties the GW system has considerable resilience that can be developed and used to benefit water users and other stakeholders. This needs to be done with the utmost care, resource depletion following unsustainable use and mismanagement (because of a lack of guiding / monitoring data) are serious impediments.



2. Project Objectives and Outcomes

2.1 Project Objectives

The main project objective is based upon a combination of a number of relatively simple and straightforward concepts. In reverse hierarchy:

- There are excellent opportunities for regional cooperation and coordination to address climate resilience and mitigate threats from droughts and water shortages for food security and rural/urban livelihoods.
- GW (a "hidden resource") as an important component and integral part of the water system but not one that is sufficiently considered in general IWRM policies or in national climate adaption strategies
- National GW management expertise (from capable to very weak) that needs to be developed further. The national expert groups in some countries are not yet specifically oriented on the potential of GW to contribute to climate resilience and vulnerability reduction.
- The necessity to develop closer relationships between, on the one hand, GW users' groups and their urgent water needs for food production (irrigated agriculture), sustain rural water supply and other water demand, and on the other hand the GW community that can improve GW management and long-term sustainability and address priority needs from different end-user groups.

Bringing these considerations together, the following overall objective is obtained:

"Establish effective regional partnerships and network for sustainable use of GW resources as an adaptation response to protect people, livelihoods and ecosystems in the Greater Mekong Subregion (Vietnam, Lao PDR, Cambodia, Thailand, Myanmar)."

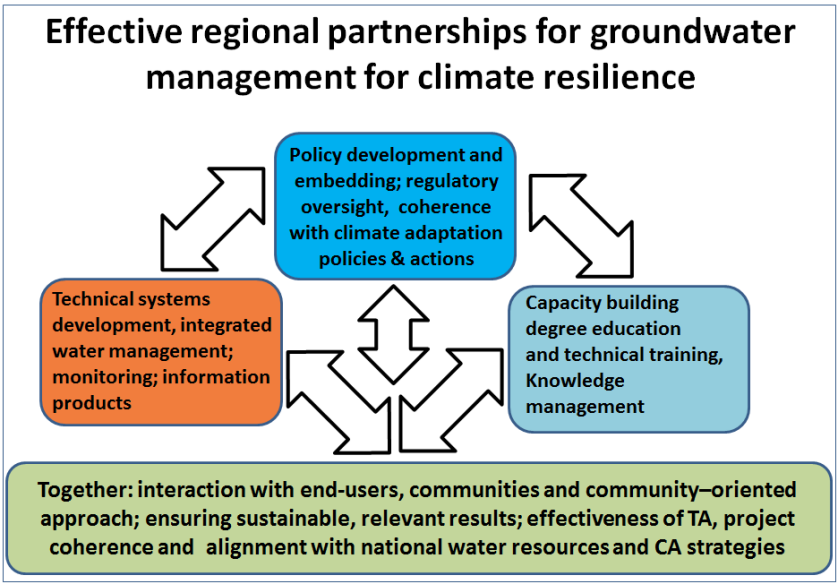


Figure 9: Departing from traditionally rather technical studies of the GW physical system (red box), with little awareness of the "demand" side (i.e. GW users), the project aims to connect GW professionals in the five countries with the current policy context of IWRM, integrated resource management, and resource use (blue box) to address sustainability issues and climate adaptation – vulnerability reduction. In the GMS there are excellent opportunities for collaborative capacity building and knowledge management (green box to the right). The foundation for a successful intervention lies in engagement with the GW end-users (bottom green box). Together with the different user groups (different users – different needs) climate resilience measures will be developed on the ground, and with recommendations for general guidelines and policy. Regional cooperation will also enable addressing transboundary issues.

Specific objectives are:

- Prepare an updated GW shared aquifer inventory for the GMS countries, develop resource management concepts and tools, and a monitoring network for GW systems.
- Understand GW recharge processes and formulate recommendations for protection and long-term sustainable management.
- Address issues of transboundary GW management also as an incentive to develop collaborative solutions
- Increase participation of stakeholders by implementing principles of GW governance through 1) dialogues with users to assess GW use scenarios for different sectors (agriculture, industry, rural and urban domestic water supply) and 2) develop and provide appropriate information to ensure sustainable use by different user groups (agriculture, industry, domestic water supply).
- Develop and implement targeted GW vulnerability reduction measures, GW quality improvement, identification and protection of strategic GW reserves. Cross-cutting objectives will be guiding the implementation of project activities in four pilot areas and jointly generate resilience deliverables on the ground.
- Capacity building and raising standards for GW practitioners across the GMS countries and initiating regional water cooperation (diplomacy).
- High level agreement on climate resilience through strategic planning for GW resources.

2.2 Project Outcomes

Project main outcomes are defined in conjunction with the five main components:

Outcome 1: Groundwater resource assessment and monitoring: A regional GMS approach to address challenges of climate change and resilience is created based on an information-based policy.

Outcome 2: Priority use and stakeholders: GW users in different economic sectors in the GMS have access to requisite information and guidelines and thus participate in GW management.

Outcome 3: Resource management, information tools and equipment: Climate resilience and GW use in pilot countries is increased, and low income and other vulnerable groups' needs are prioritized.

Outcome 4: Regional cooperation, coordination and information exchange: A regionally coherent policy for sustainable GW management in support of CCA is adopted based on a level playing field of all users in the GMS.

Outcome 5: Capacity building and training: GMS stakeholders capably use project tools on GW use for CCA and resilience.

These five outcomes will be achieved in the four pilot areas as a cross-cutting outcome that will significantly strengthen the local capacity of primary stakeholders to address climate resilience issues across the region.

3. Project Components and Activities

3.1 Overview

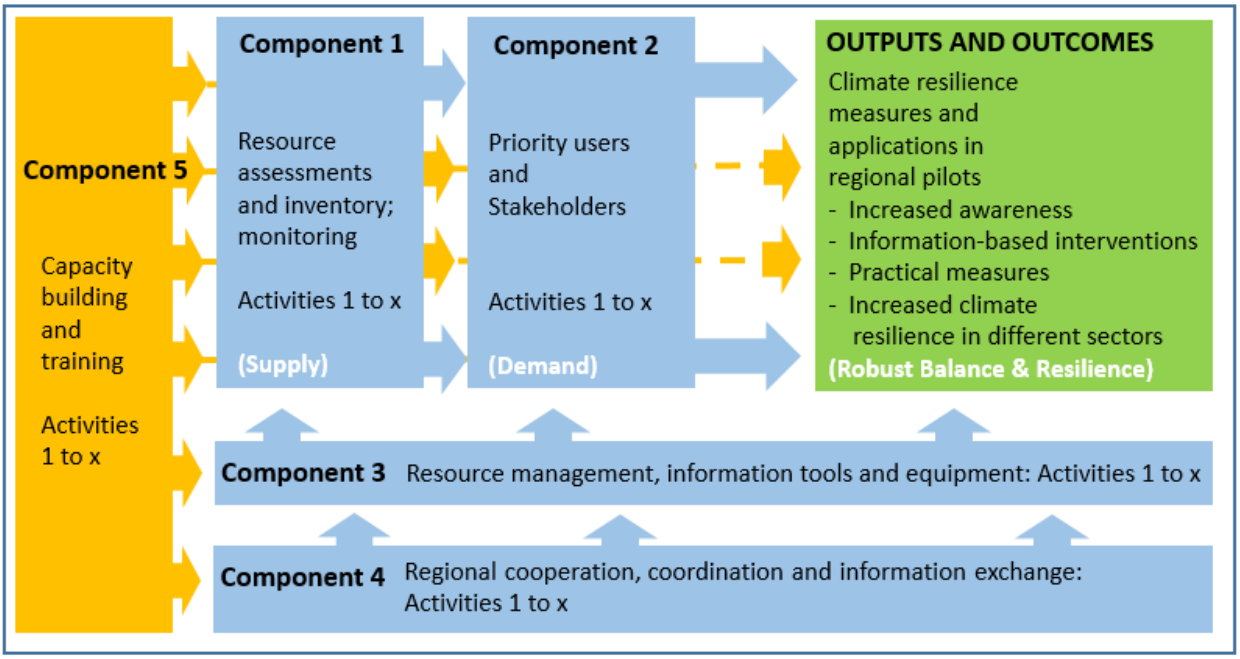


Figure 10: Schematic presentation of the project structure (four main "technical" components and one cross-cutting component for capacity building) and intervention strategy that will result in climate resilience in four regional pilots on the basis of a robust balance between GW supply and demand.

3.2 Regional pilots

The project activities as elaborated in the next sections will be centered and implemented in and associated with four regional pilots. In each pilot, the same activity format will be applied, but tailored to the local circumstances. The aim of the project is to achieve the climate resilience outcomes first in all pilot areas, and use these as examples that can multiplied across the region and used as case studies. This approach will result in efficiency gains (the effects of project resources will be multiplied) and it will also strengthen the multilateral cooperation. The following pilot areas are proposed:

1. Upper Mekong Delta Transboundary Aquifers (Vietnam + Cambodia). Mekong Delta aquifers in Vietnam are intensively used and contribute to the high productivity agri- and aquaculture systems in the entire Delta. It is assumed that major recharge takes place in the upper delta region in Cambodia, but this TBA system is poorly understood and there is little qualitative data.

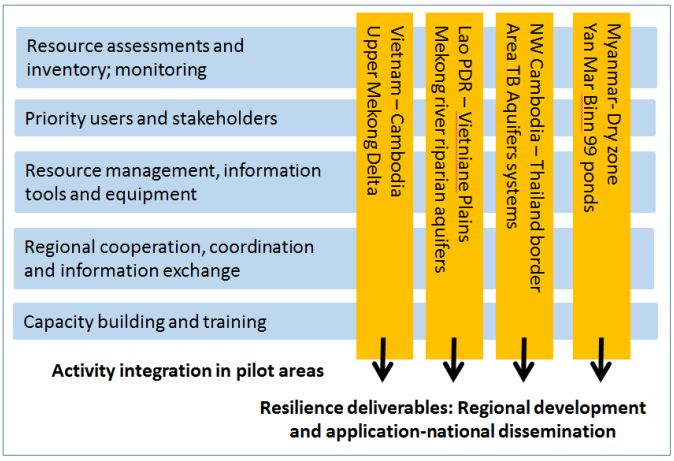


Figure 11: Project structure and activity integration in the proposed pilot areas.

2. Mekong river riparian aquifer systems (Laos, Thailand, and possibly Cambodia); The Vientiane Plains, Lao PDR and adjacent aquifers in Thailand will

be the preferred area. But also other areas like the Southern Lao PDR Pakse region (Laos – Thailand – Cambodia TBA) can be included.

3. Northwest Cambodia – Eastern Thailand border area; Transboundary aquifers in drought prone area with vulnerable rural population. GW potential supporting increased food security and rural water supply.

4. Myanmar: Central Myanmar Dry Zone, Yin Mar Bin – 99 Ponds area; The Dry Zone is one of Myanmar's most vulnerable areas to climate change. The selected area is characterized by intensive GW use, for both domestic and agricultural irrigation. There is increasing concern amongst farmers and water managers about availability of water, among others because of poor management.

All the pilots will follow the same approach and integrate activities from the five project components to generate resilience results.

Integration of all project activities in each pilot area will stimulate a balanced and output oriented way of working, without undue focus on specific studies or research.

In each of the pilot areas the project will generate specific and stakeholder-oriented, practical climate resilience measures, such as increased awareness, information on GW resource potential, GW system data and monitoring information results in order to be able to propose tailored and information-based interventions. Three of the four areas will include working in challenging transboundary aquifers systems and developing bilateral or multilateral cooperation. The available information from the different regions indicates the anticipated climate resilience measures can be targeted on different sectors. In all pilot regions, the stakeholder groups include a significant number of high-vulnerability groups.

3.3 Pilot areas description

The following section provides an overview of the characteristics and salient properties of the proposed pilot areas. The project will focus on the stakeholder groups in these areas; farmers, GW users in villages and small towns, small industries or other activities that rely on GW. Project activities are designed in such a way that vulnerabilities will be addressed and climate resilience strengthened.

A more comprehensive elaboration of the problem analysis and intervention logic for each of the four pilot regions is provided in **Annex I**

Table 1: Overview of pilot area characterization (see also Annex I).

	PILOT 1 Lao PDR-Thailand	PILOT 2 Vietnam-Cambodia	PILOT 3 Cambodia-Thailand	PILOT 4 Myanmar Dry Zone
Location	Vientiane Plain (area ~4,500 km^2)	Upper Mekong Delta, border provinces in Vietnam and Cambodia	Western Cambodia-Thai border area	Yin Mar Bin, Sagaing, Myanmar Dry Zone (area ~900 km^2)
Rainfall/Climate zone	2,000 mm/yr Tropical Dry	1700 mm/yr Humid Subtropical	1400-2000 mm/yr Tropical Dry	800-1100 mm/yr Tropical Dry
Population density and project growth	Average to high	Very high	Average	Average
Major land use	Paddy, vegetable crops, forest, urban	Paddy, vegetable crops, cities and villages	Paddy, vegetable crops, forest,	Paddy, vegetable crops (smallholders)
Aquifer type	Alluvium bounded by sandstone on margins and at depth	Alluvium, at depth older, semi-consolidated river deposits (sand and clay)	Thin alluvium, sandstones	Artesian system. Cemented sand and gravel overlain by sand to clay alluvium
Recharge rates	200-400 mm/yr (approx.)	Vietnam: 300 mm/yr Cambodia: not known	Thailand: 200 mm/yr Cambodia: not known	Not known
Interactions with surface water	GW drains to rivers which are affected by hydropower schemes; infiltration from small reservoirs and ponds	GW recharge from river channels with high/low seasonal flow; infiltration from small reservoirs and ponds	Recharge from small rivers, ponds, small reservoirs; GW drains to rivers and Tonle Sap lake	GW recharged from rainfall in ranges to west, and possibly seepage from Yama dam
Current abstraction	Relatively low	High to extremely high, deep tube wells and shallow wells	Low (Cambodia) and modest to high in Thailand	High – >1400 tube wells in area ~777 km^2
Major purposes for abstraction	Domestic, emerging agriculture, small industry (packaged water, salt production)	Irrigation, village supply, city water supply, minor industry	Small scale irrigation, village supply	Irrigation, village supply
Water quality	Salinity (natural), fecal pollution	Good, some concern about arsenic levels, pesticide etc. pollution from surface water	Good, some concern about arsenic levels, microbial pollution at GW points	Generally good (possibly some problems with salinity in the upper aquifer)
Transboundary issues	Recharge from Mekong river and connectivity with adjacent Thai aquifers	Integrated resource management by Cambodia – Vietnam authorities; recharge from Mekong river (floods); pollution threats	Contrast between Thailand and Cambodia regions in utilization of resource; very limited management in Cambodia	None
Major issues/threats GW for climate resilience	Expansion of GW use, for irrigation and domestic use, rapid urbanization, poor oversight of (possibly) large extractions	Overall volume of extractions, decreasing recharge; implications of extraction and lesser recharge for shallow domestic wells and downstream replenishment of aquifer	Non-sustainable use in Thailand; undervalued resource in Cambodia; management capabilities and better alignment with user needs	Drawdown and fluctuation of artesian water levels. Concern about wastage from free-flowing boreholes. Unregulated expansion of private wells.

4. Resource allocation and project finances

4.1 Resource Allocation

Table 2: Principle overview of the project

Project Components	Expected Outcomes	Expected Outputs	Country	Amount (US$)
1. GW Resource assessment and monitoring	Harmonised regional GW resource inventory supporting regional GMS approach to address challenges of climate change and resilience; information-based policy to manage resources and further develop new GW based resilience strategies and practical interventions.	Updated and harmonised regional GW resources and shared aquifer inventory; GW vulnerability and resilience potential assessment; common GW systems monitoring network, with community of experts and on-line information systems.	Lao PDR, Cambodia, Thailand, Myanmar, Vietnam	1,200,000
2. Priority use and stakeholders	Increased participation by GW users in different sectors who are aware of resource management issues and have access to information and guidelines that support more sustainable use region-wide.	Dialogues with GW users to assess GW use scenarios for different sectors and to develop and provide custom-made practical guidelines to attain sustainable use.	Lao PDR, Cambodia, Thailand, Myanmar, Vietnam	500,000
3. Resource management, information tools and equipment	Greater resilience and sustainable GW resource use, with protection of low income and vulnerable user groups. Transboundary GW policies more robust and climate change ready.	Adequate collaborative resource management methods and tools made available, enabling information sharing, cooperation and mutual support across the GMS region. Information-based measures to align GW management with broader climate change resilience measures and surface water management.	Lao PDR, Cambodia, Thailand, Myanmar, Vietnam	1,000,000
4. Regional cooperation, coordination and information exchange.	A regionally coherent policy for sustainable GW resource management in support of climate adaptation through a level playing field for all sectoral users in the region, efficiency gains of a common approach and the use of supporting information tools.	A regional cooperative network is established to exchange information and collaborate in addressing further challenges from information to policy to practice.	Lao PDR, Cambodia, Thailand, Myanmar, Vietnam	500,000

5. Capacity building and training	Internal capacity in the GMS region to develop CCA policy and practical resilience enhancing interventions, to use state-of-the-art tools and work with CoP, stakeholders and vulnerable groups.	A GW community-of-practice created and equipped with the knowledge and skills to ensure technical and policy capabilities. Expert groups can tackle acute problems, GMS cooperation.	Lao PDR, Cambodia, Thailand, Myanmar, Vietnam	1,000,000
6. Project/Programme Execution cost, 8.5 % (CCOP-TS)				357,000
7. Total Project/Programme Cost				4,557,000
8. Project Management Fee 7.5 % charged by the Implementing Entity (MIE, UNESCO)				341,775
Amount of Financing Requested				**4,898,775**

Resource Allocation: although there will be a limited number of generic project activities the majority of the inputs will be dedicated to develop and implement the project components in each of the four regional pilots.

A breakdown of cost items for activities versus project outcomes is presented in the detailed budget, Annex II.

4.2 Project Calendar

Table 3: The dates of important milestones for the proposed project are indicated.

Milestones	Expected Dates
Start of Project/Programme Implementation	Jan. 2017
Inception Phase	Jan.-May 2017
Start-up of four regional pilot programmes	June-Sept. 2017
Mid-term progress workshops of regional pilots	December 2018
Mid-term Review (with Steering Committee)	Jan-March 2019
Regional project Conference and field visit	May 2020
Project/Programme Closing	Dec. 2020
Terminal Evaluation	Sept. 2020

PART II: PROJECT JUSTIFICATION

Introduction
This section of the proposal covers all items **A to L of the AF proposal format** checklist. If necessary detailed info will be provided in Annexes. Unnecessary overlap with previous sections is avoided.

A. Overview of project components

The project will consist of five interlinked components. For each component we will define a limited number of specific activities with Results or Outputs. Outcomes (higher level results and/or impacts) as introduced in the previous section are defined at the component level. Under the five project components, each activity has a separate budget line and has inputs that include a number of cost items. Activities will be implemented at project level (generic, or GMS focus) or relate to project implementation in one of the four pilots in transboundary areas. The project is a collaborative effort of national GW agencies (and other contributing national parties) from the five participating countries with support from independent regional and international GW and climate change experts including IWMI and IGRAC.

Overall project implementation will be supported by CCOP-TS (project executive support), while project management, finance and administration. M&E, etc. are supported by the MIE UNESCO (Bangkok Office). Further details of project management are provided in Part III of this document.

The following is a summary introduction of the five main project components, with a first elaboration of the concrete activities. This project framework will form the basis for detailed workplans that will be developed at subregion level for each of the four pilots, during the Inception Phase of the project. This will be done in close collaboration with the national partners in each of the five countries.

Component 1: Groundwater resource assessment and monitoring

Outcomes: A regional GMS approach to address challenges of climate change and resilience is created based on an information-based policy.
Outputs: Updated and harmonised regional GW resources and shared aquifer inventory; GW vulnerability and resilience potential assessment; common GW systems monitoring network, with community of experts and on-line information systems.

Activities

1. **GW resources inventory** on basis of published data and maps, set up database and GIS tool modelled after IGRAC's tools or using CCOP GIS tool; not necessary all data in it, but especially common approach and methodology; start with countries with a lot of data (possibly existing tools, Cambodia and Lao PDR do not have much to insert.
2. **Monitoring resource status** (no data means no information and it is not possible to develop rational interventions); setting up minimum monitoring of selected aquifers (high potential, transboundary, vulnerable ones); Develop and agree on protocol to share monitoring data, select number of aquifer for active monitoring (should be active in year 2 to see trends year 2-3-4)).
3. **Aquifer status and vulnerability assessment;** exploitation history and trends, depletion indicators; document different examples from different countries, as examples.
4. **Resilience potential:** develop assessment framework, tentative resource classification in terms of resilience potential initially on basis of GW system properties. So where Activity 1-3 are fairly common GW resource studies in Activity 4 we make the step towards climate resilience concepts and tools. Results will show either resilience potential (use GW to help farmers and other users to build resilience) or vulnerability or negative resilience potential, i.e., the resource status is such that it does not offer much to strengthen resilience, on the contrary, existing GW use, supporting some form of resilience, could be threatened because of depletion, pollution or other factors. When developing resilience potential always remember, (positive) resource value is different for every user group, depending on their capability or need. What is positive resilience potential for large industrial users could be negative or neutral for small farmers.
5. **Geographical coverage:** Indicated Pilot areas; selected, preferably transboundary areas with very pertinent, practical and end-user oriented approach. These areas will also feature in the other components. On basis of results from Component 2 define information products, training and awareness activities, coaching and guidance (to farmers, or intermediaries) = Component 2. Ultimately generate improved resilience for these areas and their inhabitants, whilst working with stakeholders who may take the findings and enable scaling up in other areas.

GW resources inventory, organizing data collection, harmonization

Besides hydrogeological characterizations, GW assessment includes environmental, socio-economic and policy/institutional aspects. In the case of the internationally shared GW resources in the proposed pilot areas, information management and collaborative international work are two very important aspects to be taken up. Common monitoring and assessment usually face the challenge of data harmonization, including reference systems, formats, definitions, classifications, languages and/or use of different technologies. Therefore, one of the issues to enable collaborative management is to harmonize the hydrogeological information in the selected pilot areas. This will support a common regional view of the GW resources in the Mekong, providing a basis for collaborative actions, such as monitoring, pollution prevention and balanced use.

Aquifer status and vulnerability assessment

The transboundary aquifer assessment guidelines developed by IGRAC and UNESCO-IHP can be used for the GW inventory and aquifer vulnerability assessment process. The methodology covers hydrological, hydrogeological, socio-economic, environmental, legal and institutional aspects of the GW systems and transforms those into indicators. Indicators can be used to facilitate communication between parties with very diverse levels of

knowledge and professional backgrounds, one of the components towards collaborative management. The methodology also deals with challenges such as general lack of data, inaccessibility of GW information and harmonisation of data across borders. The assessment will provide the scientific and technical basis for actions and agreements, including to development of a specific action plan for the region. The methodology is based on a participatory approach to increase recognition, shared responsibility and transparency of the assessment processes. The collection, harmonization and analysis of the data on the transboundary aquifers should be carried out by a joint team of national experts from the involved countries. The joint assessment and fact-finding of the selected transboundary aquifers lay the first foundation for informed joint management.

Component 2: Priority use and stakeholders

Outcomes: GW users in different economic sectors in the GMS have access to requisite information and guidelines and thus participate in GW management.
Outputs: Dialogues conducted with GW users to assess GW use scenarios for different sectors and develop and provide custom-made practical guidelines to attain sustainable use.

Activities at the regional level (in the proposed four pilot areas)

1. Overview of most important GW user groups (user Typologies); understanding user perspectives; defining further work packages to think about targeting different users in different ways.
2. Information dissemination on vulnerability issues; challenges for users, most vulnerable groups
3. What GW experts can do to support users; here the results of Component 1 come in: resilience potential. How is it appreciated by different users?
4. **Resilience strengthening pilots** for different users in different locations, resilience development and demonstration. The following options will be considered:
   a. Pilot for agriculture/farmers, using small-scale MAR
   b. Pilot for regional water-supply companies that use GW information on GW management tools, making use of tools to manage resources and understand vulnerabilities and information-based resilience options; further develop resilience options
   c. Dialogues with national policymakers and experts on strategic importance of GW resources in the overall CCA discussion
      - Improve general understanding of the transboundary system
      - Clarify roles and responsibilities of local institutions
      - Information, participation and dialogue between stakeholders on both sides of the border
      - Involve local and regional authorities
5. **Geographic coverage:** Work package to distinguish different users, at different GW level in small pilots, but also national strategic level, focus on pertinent, practical and end-user oriented outputs (information products, training and awareness activities, coaching and guidance (to farmers, or intermediaries)
6. Give examples in workshop with different sectors, i.e. example of Vitens and client Water Supply companies on long-term strategy in Mekong Delta, i.e. how to ensure water supply in view of multiple threats, recharge depletion, salinity intrusion, pollution, etc.
7. **Resilience Agenda** for coming years; what do users need to do and consider (**Triple A** approach: **Agenda:** what are the issues, what has priority, when do we need to act: **Atlas/database**: where are our resources, location issues, protection, overlapping claims): **interAction** Who is going to do what, how do we interact - rules of the game, who will decide? who will pay?

Active interventions

In order to have a tangible impact on the ground, the project's activity plans for the four pilot regions will focus on co-development with GW users of suitable interventions in support of sustainable GW use and vulnerability reduction. Foremost among these is using the wet season rainfall surpluses to resupply GW buffers to overcome dry season droughts, in other words – enhancing GW recharge. A range of technical options are available for stimulating GW recharge. Direct surface methods are among the most widely used and simplest. Depending on local conditions, water is simply spread over fields to percolate into shallow aquifers. Other methods include digging

flooding pits or shafts; or 'injecting' water into aquifers through deep boreholes or tube wells from surface water bodies. GW recharge is often best accomplished as a by-product of integrated or 'conjunctive' management of reservoir and canal seepage, injection and infiltration of return flow from irrigation, enhanced infiltration of rainfall, or the simple leveling of fields or construction of small check dams. Technology aside, a managed recharge strategy strongly implies a shift to co-management of surface water and GW. These interactions are well understood in the scientific domain, but remain almost entirely separate domains in the day-to-day worlds of policy and water management authorities.

GW storage and replenishment offers a number of unique benefits, including potentially wider, more equitable access. GW (as long as there is a source of it) is accessible to anyone with the means to dig/ drill a well; an attractive option where surface water management is often highly politicized. As a CCA measure, aquifers respond to droughts and climate fluctuations much more slowly than surface storage structures, and are more resilient buffers during dry spells. The approach borrows from extensive and successful experiences elsewhere, among others in India (Table below; Source: Shah, 2009).

Table 1: Climate change and water storage alternatives.

	Small surface storage	Large surface reservoirs	Aquifer storage (BAU)	Managed aquifer storage
1. Make water available where needed (space utility)	↑↑↑	↑↑	↑↑↑↑	↑↑↑↑↑
2. Make water available when needed (time utility)	↑	↑↑	↑↑↑↑	↑↑↑↑↑
3. Level of water control offered (from utility)	↑	↑↑	↑↑↑↑	↑↑↑↑↑
4. Non-beneficial evaporation from storage	↓↓↓↓	↓↓	↓	↓
5. Non-beneficial evaporation from transport	↓↓	↓↓↓	↓	↓
6. Protection against mid-monsoon dry spell (2-8 weeks)	↑↑	↑↑↑	↑↑↑↑↑	↑↑↑↑↑
7. Protection against a single annual drought	↑	↑	↑↑↑	↑↑↑↑↑
8. Protection against two successive annual drought	↑	↑	↑↑	↑↑↑↑
9. Ease of storage recovery during a good monsoon	↑↑↑↑↑	↑↑↑↑	↑↑	↑↑↑
10. Social capital cost of water storage and transport and retrieval structure	↓↓	↓↓↓↓↓	↓↓	↓↓↓
11. Operation and maintenance social costs of storage, transport and retrieval structures	↓	↓↓	↓↓↓↓↓	↓↓↓
12. Carbon footprint of agricultural water use	↓	↓↓	↓↓↓↓↓	↓↓↓

Table 4: The overview shows four possible storage and improved GW management alternatives. The analysis assigns up to five benefits or five disbenefits to each of 12 resilience considerations. The first two options, small surface water storage facilities and large surface water reservoirs are quite well known, but provide little or negative resilience enhancement. The third option, aquifer storage, represents traditional GW use (Business as Usual – BAU), with mostly intensive exploitation (and depletion) of shallow aquifer storage, without any demand-side management or systematic strategy of enhancing aquifer recharge. The fourth option, managed aquifer storage, is not widely applied yet, and will require a radical shift in thinking. It recognizes that GW demand will and can increase, but, depending on a region's hydrology, aquifer storage can sustain this increase with proactive demand side management and a region-wide program of managed aquifer recharge.

Component 3: Resource management, information tools and equipment

Outcomes: Climate resilience and GW use in pilot countries is increased, and low income and other vulnerable groups' needs are prioritized.
Outputs: Adequate collaborative resource management methods and tools made available, enabling information sharing, cooperation and mutual support across the GMS. Information-based measures to align GW management with broader climate change resilience measures and surface water management.

Activities

1. Using the database and GIS tool; develop a number of specialised information products that can be derived from it.
2. Revisit resilience potential: what can user do with it; how to exploit this?
3. Pilots to confirm proper GW use is a resilience strengthening option (viz. Laos project IWMI, preferably in the identified transboundary aquifers
4. Co management of surface and GW
5. Resilience strengthening pilots: actual management interventions such as MAR
6. Monitoring schemes; minimum requirements prescribed for general monitoring; for selected aquifer locations defining and agreement on monitoring set up; installation and using the first results

The collected and harmonized data and information for the GMS in general and for the four pilot areas will be stored in an online Information Management System (IMS) along with outcomes of assessment and possible management scenarios. IGRAC can provide the IMS that can operate as a data and information sharing platform between the countries and the various water sector and climate resilience actors and stakeholders, covering issues like GW resource availability, monitoring of changes and more (pro)active management supporting climate resilience. A dedicated IMS will be set up for each pilot study, and later these will be integrated into one 'GW resources in GMS Portal'. Final output will be one information portal with an overview of the outcomes of the project and database on GW monitoring observations and other tailor-made tools.

Component 4: Regional cooperation, coordination and information exchange.

Outcomes: A regionally coherent policy for sustainable GW management in support of CCA is adopted based on a level playing field of all users in the GMS.
Outputs: A regional cooperative network is established to exchange information and collaborate in addressing further challenges from information to policy to practice.

Activities

1. Document for all five countries the GW policies and GW management activities; what is there to learn from each other, why is it done like it is done?
2. Focus on issue of transboundary aquifers: where, what? Are there common interests. Is it possible to set up a task force to bring transboundary aquifer (water resources) management to a higher level?
3. At least two follow up workshops, making use of the results produced in the other project components (database, joint monitoring, etc.).
4. Elaborate the four selected transboundary GW systems as cases (1. Vietnam-Cambodia: upper Mekong delta aquifer system; 2. Lao PDR-Thailand: riparian Mekong aquifers (Vientiane plains); 3; Eastern Thailand – NW Cambodia border region aquifers, 4. Myanmar Dry Zone aquifers).
5. A: Working group on sharing and co-development of tools; B: Working group on national policy and strategy.

Focus on issue of transboundary aquifers

Depending on the outcomes of the GW inventory, appropriate institutional setups and/or appropriate legal frameworks for their joint and sustainable management need to be developed. Once the interdependence of these countries has been recognized and accepted, the next step consists in establishing contact between them, both technical-regional as well as strategic-national (diplomatic) level. This step allows the exchange of viewpoints, the development of confidence and solidarity measures, the sharing of information, and the coherent, pragmatic and progressive implementation of the various operational tools. The involvement of UNESCO) will be helpful for assisting in this process, by providing their advice and assistance, and by encouraging the development and implementation of international consensus and guidelines concerning transboundary GW management.

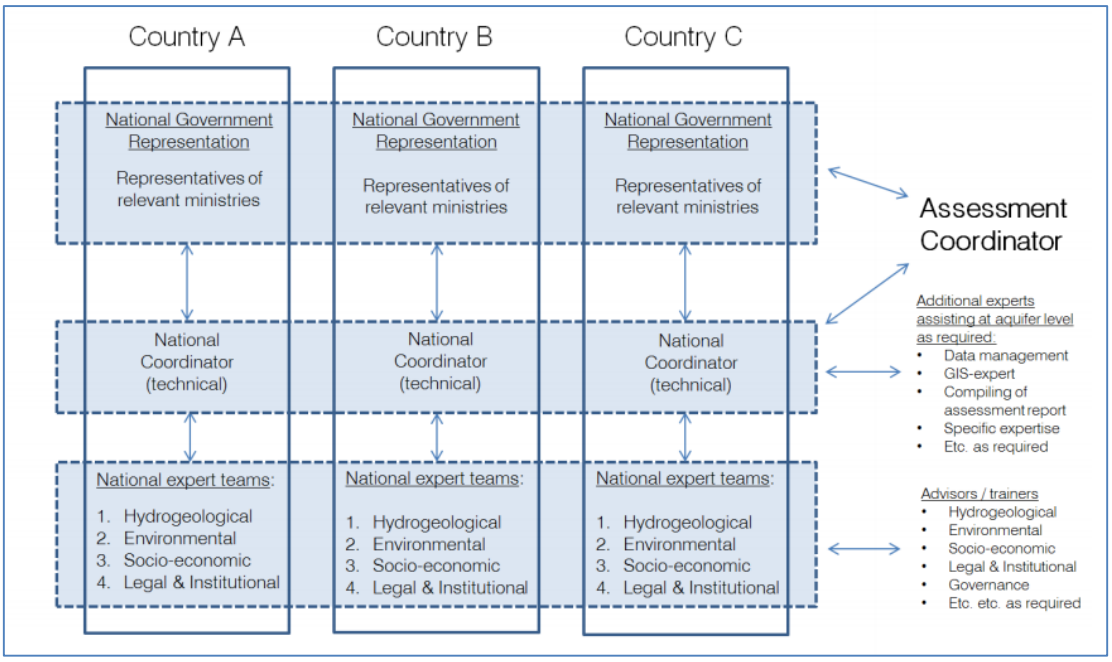


Figure 12: Example from the TBA Assessment Methodology. Executing a joint assessment will bring together experts from various regions and disciplines, one step towards joint cooperation mechanism. In this project, in order to improve the understanding of the shared aquifer systems as well as the collaborative management, the involved countries should progressively develop contacts. Preliminary technical contacts will be established by bringing officials together in regional workshops, focusing on the four pilot regions. Official meetings serve to create dialogues between the ministries from various countries to share knowledge, agree on common objectives, discuss stakes and (economic) benefits, ideas on collaborative actions and mechanisms and possibly financing issues. Source: IGRAC & UNESCO-IHP (2015).

Component 5: Capacity building and training

Outcomes: GMS stakeholders capably use project tools on GW use for CCA and resilience.
Outputs: A GW community-of-practice created and equipped with the knowledge and skills to ensure technical and policy capabilities. Expert groups can tackle acute problems, GMS cooperation.

Activities

Training programmes Subcomponent

1. Training workshops (Information on the tentative scope of the training courses provided in boxes below)
   a. MAR, ASR and other storage and GW potential strengthening techniques, connected to pilots
   b. Transboundary aquifer management; training programme (IGRAC)
   c. GGMN – the next level for the GMS; training and learning-by-doing (IGRAC)
   d. Co-management of surface and GW; training workshop with MRC experts
   e. GW monitoring, developing monitoring with support of GW users
2. **Support formal training programmes**: Support to existing and/or new formal training programmes at institutes in the region covering aspects of GW management for resilience
3. Information and resources sharing and cooperation on formal training programmes in institutes, recognition of each other certificates, etc.

Learning and knowledge management Subcomponent;

4. **Information repository and Sharepoint.** The Sharepoint facility will be a publicly accessible database (Data repository) where all available data and information is stored and can be accessed. It will support taking stock of the current levels of understanding, research focus and management of GW, to assess the status of GW policies with respect to the existing and further developing knowledge base (see for instance: www.kindraproject.eu)
5. **International Conference** to disseminate the results of the project

Figure 13: Myanmar: Discussion with farmers on the use of tube wells for irrigation water supply. The project will be working with GW experts at various levels, but will also focus on direct interaction with stakeholder groups to extend GW use practices for climate resilience.

Training courses and capacity building workshops

Workshop on transboundary aquifer management

The workshop on transboundary aquifer assessment and management will provide national experts with guidance and tools to execute the assessment in a systematic way. The workshop follows a participative approach in which the regional experts will start the joint–fact finding. Joint-fact finding assists in opening discussion, increased knowledge-sharing, and overall transparency of the assessment processes. These components are all important to reach a common understanding and to enable collaborative management. The training programme will specifically deal with and will be tailored to the selected transboundary aquifer system (one of the three pilot areas)

Content of the training

- Transboundary aquifers and their management
- Guidance for data collection and harmonization
- How to go from data to knowledge?
- Training to work with the Information Management System
- Transboundary Dialogue on GW issues and Joint cooperation mechanisms

Training on Advanced GW Monitoring and Analysis

The purpose of the 'Advanced GW Monitoring and Analysis' training course is to train a group of GW professionals on GW monitoring networks, setting up monitoring network, and basic information on processing of the information. The second part of the training is focusing to provide the local technical consultants/researchers with modern technical skills in the use of Global GW Monitoring Network (GGMN) and GW modelling tools. The GGMN provides an interactive portal for storage, processing and dissemination of GW data. The training participants will have the opportunity to acquire an active role in the GGMN Network and to continue to use the GGMN interactive portal.

Content of the training

- GW monitoring objectives and monitoring network types
- Procedures and methods of setting-up a GW monitoring network
- GW monitoring equipment
- Open source and freely available GW software tools
- GGMN Portal (Database and information management)
- Time series analysis
- Spatial interpolation in QGIS
- FREEWAT software (open source GW modelling tool in QGIS)

Co-management of surface and GW; training workshop with MRC / National Mekong Commission experts
IGRAC will provide content for this training targeted to staff from the Mekong River Commission and National Mekong Commission members with a focus on 'Integration of GW Management into Transboundary Basin Organizations'. The training course will be tailored for the GMS, and partly based on the manual on 'Integration of Groundwater Management into Transboundary Basin Organizations', developed in corporation with IGRAC, Cap-Net, BGR, IWMI, AGW-Net/UNDP and the former GW-MATE team of the World Bank. The manual is designed to help develop capacity within the river basin organizations to include and manage (transboundary) GW issues. A community of experts affiliated with the Mekong River Commission and National Commissions in the region provides an initial platform for transboundary GW cooperation.

B. Innovative solutions to climate adaptation

Describe how the project /programme would promote new and innovative solutions to climate change adaptation, such as new approaches, technologies and mechanisms.

1. Climate resilience and added value of regional approach, Greater Mekong Subregion transboundary collaboration

By introducing and stimulating robust methods for resource assessment and collaborative principles for sustainable GW use, valuable water resources can be more effectively allocated for strategic and emergency purposes, thereby enhancing resilience in water supply and food production. Climate resilience is based on a broader suite of options, including limited surface water and GW, and overall use efficiency is stimulated.The regional approach creates significant efficiency gains in development of resource management concepts, tools and supporting systems and in developing the required regional human resources capacity. By developing regional regulatory guidelines for appropriate GW use, unsustainable practices are prevented equally across the region (also creating a level playing field), instead of pushing communities to compete with each other.

2. Sustainability assessment of limited and valuable GW resources

To increase resilience and reduce vulnerability it is essential to: assess sustainable GW extraction rates under various current and future land use conditions; develop with users "low vulnerability" land use and identify solutions to overcome high vulnerability cases; assess impacts of the current and likely future climate change conditions on the GW resources; create awareness on the potential depletion of limited GW resources; and develop fall-back options and water use efficiency measures that have a direct impact on the ground.

3. Innovative solutions to climate change adaptation; a regional approach and cost-effectiveness

The development of GW MIS for the region will provide ample opportunities to introduce innovative ICT supported data collection, information sharing and training. Direly needed GW resources monitoring in collaboration with well owners and water users provides excellent opportunities for data collection through crowdsourcing, which also strengthens stakeholder involvement.

The programme connects to national priorities for CCA, i.e. GW conservation and sustainable use, as included in respective national Climate Change adaptation policy documents. The programme partners are already working on related studies in the region; this earlier and ongoing work will pave the way for this new and challenging regional project.

4. An IWRM approach including GW and focused on farmers perspectives and needs.

Unlike many other studies and projects dealing with water resources management this intervention will apply IWRM from a GW system perspective, based on the fact that farmers and other water users almost always use (complementary) GW to cover seasonal water needs. This applies to farmers producing food and market crops, but more strongly to a large number of rural water users for domestic purposes. GW is nearly always a reliable source for low-cost and relatively good quality water. In applying IWRM principles specific attention will be paid to user perspectives, matching needs from different user groups and developing insight in what ways GW can contribute to increased resilience. This is not only different as compared to integrated (surface) water studies, but also requires a bottom-up (from the users' side) perspective on GW resources, versus a more traditional top down (from the resource assessment side) perspective.

It is believed that especially this innovative approach will generate tangible and acceptable climate resilience support to primary stakeholders in the country side and rural towns.

C. Project economic, social and environmental benefits

Positive environmental and social impacts, a balanced intervention with sustainable results

The program will mitigate environmental impacts of droughts on agriculture and food production, and on rural and urban domestic water supply constraints. It will also mitigate social impacts on access to low-cost domestic water supply and on rural communities' access to irrigation water for self-reliance in food production. The funding requested is allocated in a balanced way to 1) technical studies and deepening of the knowledge base, 2) dissemination and interaction with stakeholders and 3) human resources development and creation of a regional community of experts of both sexes.

The project will have positive environmental and social impacts: it will stimulate sustainable use of valuable natural resources and increase awareness on vulnerability; it will support approaches to ensure equitable access to water for food production and domestic use. It will enable conservation of scarce water resources for low-income groups. By following a regional approach also an international level playing field is supported.

Low income rural population: Traditionally, GW is an important source for water supply for agricultural and domestic purposes for low-income rural population, not connected to piped water systems or irrigation schemes. This project will improve the availability and sustainability of GW supplies and will strengthen the awareness that GW can be an important fall-back option in case of prolonged drought. The project will also introduce training and guidelines to ensure that limited GW resources are not depleted by wasteful practices such as pumping large volumes of good quality GW if surface water could be used. If such practices can be prevented or reduced it will eliminate a major threat to sustainable water supply for vulnerable groups.

Gender considerations: From rural population groups, female stakeholders will be specifically targeted in accordance with their traditional roles in food production for households and domestic water use. Within the project and the five-country participants group a gender platform will be created with predominantly female members who will actively engage with this mission. Best practices from other successful projects will be adopted (for instance, see: Ofosu, E. A., E. Mapedza, B. van Koppen, P. van Der Zaag and R.E. Namara 2010. *Gendered access to shallow wells and riverine dugouts in the Upper East Region of Ghana*. Unpublished report.); https://cgspace.cgiar.org/bitstream/handle/ 10568/33613/8.5%20Gender%20issues.pdf? sequence=1

Among others IWMI experts[8] (partner in this project) have shown that gender-sensitive approaches to GW development and management help secure and protect GW access and use for women and the rural poor. Gendered water rights determine access and control over GW resources. Men and women differ in their needs and technological preferences for GW extraction and are affected differently when GW development interventions are introduced.

Reference is also made to UNESCO's (including IGRAC) support for gender equality in relation to GW management and use. See: http://GWportal.org/focal-area/gender

UNESCO-IHP (International Hydrological Programme) advocates for more equitable water resources management and human development opportunities for both women and men.

Gender equality is one of UNESCO's global priorities, with a commitment to promote equality between women and men across the Organization's mandate. Gender equality is not only a fundamental human right, but a necessary foundation for the creation of sustainable and peaceful societies.

Women represent at least half of the workforce in agriculture and food production, and often bear the daily burden of carrying water to their families. Although women play such a pivotal role in water resource management, sanitation and hygiene

[8] *IWMI training programme: Gender and Institutional Approaches to Groundwater Development Management, MODULE 6: GENDER MAINSTREAMING IN AGRICULTURAL WATER MANAGEMENT;* *http://publications.iwmi.org/pdf/H042180.pdf* , and *http://siteresources.worldbank.org/INTGENAGRLIVSOUBOOK/Resources/Module6.pdf*

(especially in rural areas), gendered water data are among the least available of national level indicators, and 45% of countries do not produce any gender statistics related to water. Climate change, inadequate access to water, and poor water quality negatively affect women's and girls' health, education, employment, income, and empowerment in ways that are distinct from their male counterparts There are corresponding risks to both local and global food production and the care of livestock. Additionally, in academia, women are under-represented in hydrogeology studies mainly because of the structure of academia and historically low numbers of women entering the field.

In the project gender proactive approach will be undertaken throughout the project implementation in the four pilot areas along the lines of these best practices and other examples.

Finally, project capacity building activities and support to the GW Community of Practice will seek a balanced attendance of female/male participants.

D. Cost Effectiveness

Cost effectiveness through national agency and stakeholder contributions
The project will be implemented in close partnership with national agencies mandated with GW management and involved in supportive GW studies. Through these, there will be substantial in-kind contributions and spin-off of regional collaboration (better exchange of information, sharing of experience, joint studies, etc.). The resilience pilots will be multiplied and extended across the national territories of the five countries. Furthermore, for various proposed pilots and implementation activities there will be contributions from stakeholders, communities and local government. Although this kind of operation is organisational complex there will be significant cost reductions and, importantly, increased ownership and awareness. For example, stakeholders and GW users will be invited to propose case studies and practical cases in which climate resilience measures will be applied and tested-demonstrated.

Cost effectiveness of technical assistance and leverage
The executive model set up for the project emphasizes regional (from the five participating countries) sourcing of many inputs for activities, and regional coordination and support from CCOP-TS. CCOP-TS has been able to organize and implement regional collaboration projects that have shown high cost-effectiveness by making use of technical support and contributions from national government agencies. Additionally, the use of peer-support and local experts from the different expert communities is foreseen.

It is anticipated that the project and its executive proponents CCOP-TS, IWMI and IGRAC will be able to leverage additional support from partners that are active in the region and the subject matter.

1. CCOP-TS has longstanding and active cooperation with Germany's Bundesanstalt for Geowissenschaften und Rohstoffe (**BGR**). There are currently activities in Vietnam, Lao PDR and Myanmar.
2. CCOP-TS has a long standing and active cooperation with **JICA** of Japan. Further cooperation in this project is envisaged.
3. There is active cooperation on GW management and climate adaptation with **KIGAM**, Republic of Korea (Korea Institute of Geoscience and Mineral Resources). Recently, and in preparation of this proposal, a workshop was convened with representatives of all partners from the region (*CCOP-KIGAM-UNESCO-MME Workshop on "Climate Change and Groundwater Resources in the Mekong River Basin", Sihanoukville, Cambodia, 1-4 June 2016).* An earlier workshop also served in preparation and inspiration for this proposal *(CCOP-KIGAM-UNESCO-DGR Workshop on Sustainable Groundwater Management in Mekong River Basin 19-20 May 2015, Bangkok, Thailand.* Further support from KIGAM is envisaged.

The component for hardware and equipment is relatively small, and the items purchased will be for long-term use; upon completion of the project ownership of equipment will be transferred to the national agencies.

Cost effectiveness in project operations
The project *modus operandi* will be 'implementation by the stakeholders, for the stakeholders'. This means limited technical assistance support will be mobilized to develop, organize and implement activities (especially in the pilot areas) with and for the primary stakeholder, the actual and potential GW users. This will be a very cost effective approach, as only overhead costs and only limited time inputs will be incurred.

A similar principle will be adopted for activities on higher policy and institutional levels as it is believed that the main objectives of the project will feed directly into the main policy and operational tasks of the involved national partner agencies. It is expected that the strategic support the project can offer will leverage internal resources and create a win-win situation for the project and the national contributors.

E. Consistency with national or sub-national sustainable development strategies

Describe how the project / programme is consistent with national or sub-national sustainable development strategies, including, where appropriate, national or sub-national development plans, poverty reduction strategies, national communications, or national adaptation programs of action, or other relevant instruments, where they exist. If applicable, please refer to relevant regional plans and strategies where they exist.

Economic growth and food security have been important objectives of the governments of Vietnam, Lao PDR, Cambodia, Thailand and Myanmar. Over the last decade water resources management policies also have evolved in the countries towards more integrated management and in awareness of making use of finite resources in support of achieving MDG'. In Vietnam, for instance, this has resulted in the adoption of a new Law on Water Resources (2009), recognition of IWRM principles and the setting up of River Basin Management approaches for the integrated management of surface and GW resources.

In Lao PDR donor support (ADB, DFAT/AusAid) and international cooperation (GIZ, IWMI) have supported development of IWRM based policies and capacity at policy and operational level (National IWRM Support Programme, ADB.DFAT and related programmes. Although these policies and operational practices are far from mature, there is growing awareness, understanding and political ambition to strengthen natural resources management including GW in support of societal needs and in recognition of vulnerabilities of low income groups like small farmers. There is also a firm understanding that the impacts of climate change are not to be underestimated. In the Lao PDR the **National Adaptation Programme of Action to Climate Change (2009)** includes two action points on GW. These are well aligned with this proposal.

For **Thailand**, the project will closely align its initiatives with the Ministry of Natural Resources and Environment and the Office of Climate Change Coordination, Office of National Resources and Environmental Policy and Planning (ONEP) as the focal point for the **Thailand Strategic Plan on Climate Change**. For the specific interventions it will coordinate with the sectoral agencies mandated to address CCA. The AF project is anticipated to contribute to the strategic objectives shown in Table 5.

Table 5: Thailand's Strategic Plan on Climate Change main strategies and anticipated AF project impact.

	Strategy	**AF project impact**
1	Build capacity to adapt and reduce vulnerabilities to climate change impacts	Focus on pilot areas to build capacity for stakeholders and institutional partners
2	Promote greenhouse gas mitigation activities based on sustainable development	Developing sustainable use of natural resources
3	Support research and development to better understand climate change, its impacts and adaptation and mitigation options	Resource assessments, study and inventories of transboundary GW systems, assessing potential for resilience measures
4	Raise awareness and promote public participation	Focus on pilot areas and preparation of targeted information products
5	Build capacity of relevant personnel and institutions and establish a framework of coordination and integration	Build capacity for institutional partners, stimulate intra-institutional cooperation (interaction MNRE – Agriculture)
6	Support international cooperation to achieve the common goal of climate change mitigation and sustainable development	Regional cooperation, information sharing, intra-regional capacity building

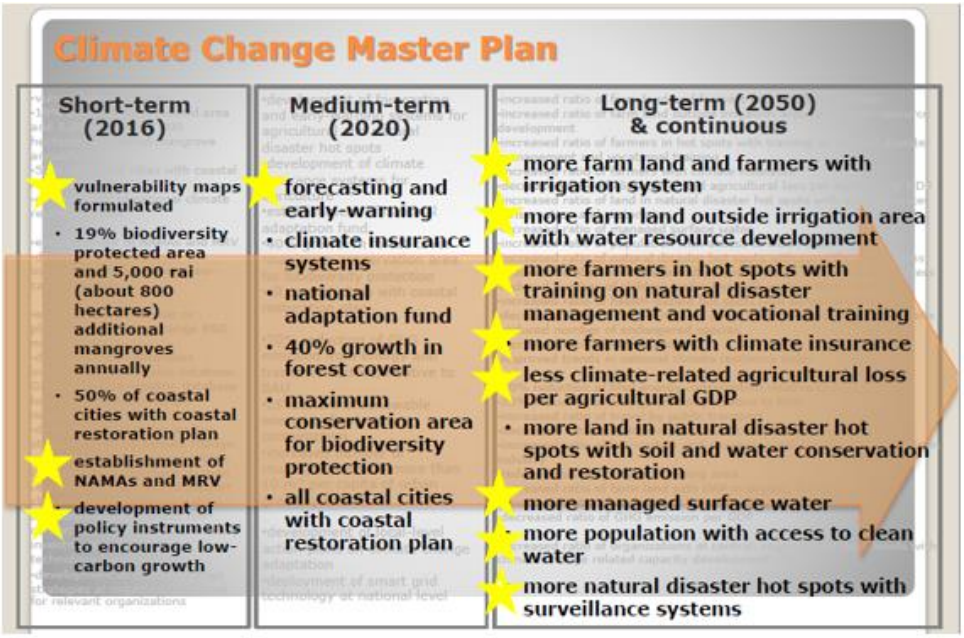


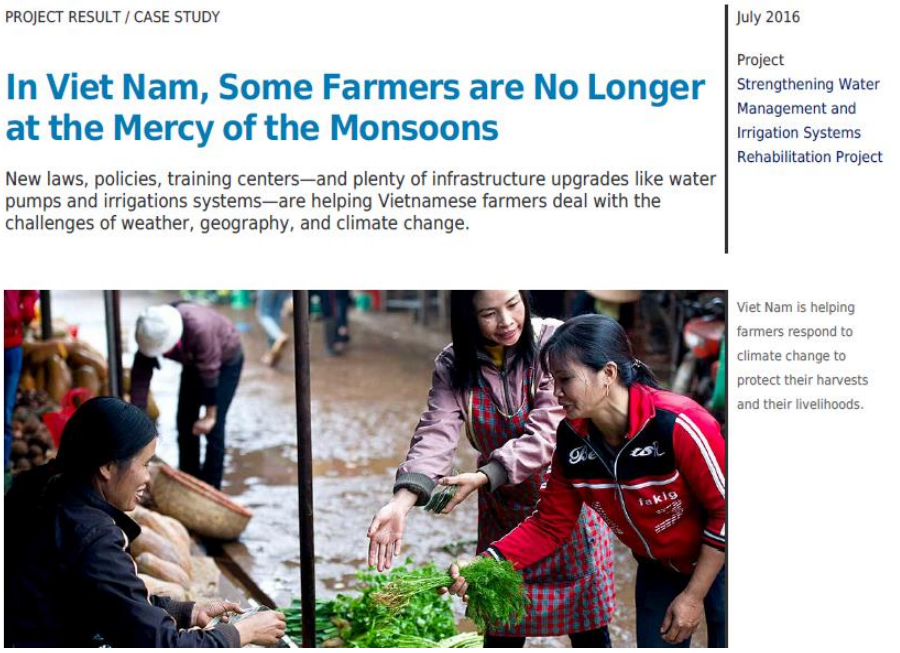
*Figure 15: Alignment of the AF project to **Thailand's Short. Medium and Long-term objectives of the Climate Change Master Plan**. The yellow stars mark the partial objectives on which the AF project will have an impact.*

For Vietnam we also refer to the national CCA agenda under its main proponent, MONRE, viz. **National Strategy on Climate Change**, period 2011-2020, (issued by Prime Minister Nguyen Tan Dung, 139/QĐ-TTg, December, 2011),
http://www.chinhphu.vn/portal/page/portal/English/strategies/strategiesdetails?categoryId=30&articleId=10051283

Its main policy objectives include prioritization of integrated water resources management to meet water needs on river basin level. Furthermore, the project closely aligns with strategic national development objectives as also supported by Vietnam's international development partners like ADB and Worldbank and for instance documented in ADB's **Environment and Climate Change Assessment for Vietnam (2013)**
http://www.adb.org/sites/default/files/institutional-document/33916/files/viet-nam-environment-climate-change.pdf

Further alignment with Vietnam's national policies and sectoral needs is documented in recent documentation on ADB's work in Vietnam.

The full story is proved as **Annex III**


PROJECT RESULT / CASE STUDY

July 2016

Project
Strengthening Water Management and Irrigation Systems Rehabilitation Project

In Viet Nam, Some Farmers are No Longer at the Mercy of the Monsoons

New laws, policies, training centers—and plenty of infrastructure upgrades like water pumps and irrigations systems—are helping Vietnamese farmers deal with the challenges of weather, geography, and climate change.

Viet Nam is helping farmers respond to climate change to protect their harvests and their livelihoods.

In Cambodia the Cambodia Climate Change Strategic Plan (CCCSP), 2014-2023 (2013; http://www.moe.gov.kh/userfiles/image/download/1445160472781.pdf) has laid the foundation for integration of climate change and climate resilience issues into national and sub-national level planning. The development of climate change strategies, action plans and financing frameworks are among the priority actions undertaken as defined in the National Strategic Development Plan Update (NSDP) 2009 – 2013. The development of the CCCSP was a significant step towards embedding climate change in the NSDP 2014 – 2018 and in sector development plans of all relevant ministries. The CCCSP will guide national entities and assist non-governmental organizations and development partners in developing concrete and appropriate measures and actions related to adaptation and greenhouse gas mitigation, which were the supportive pillars for the achievement of the Rectangular Strategy and Cambodia Millennium Development Goals.

This project, within its modest operational domain covering availability of water resources and sustainable use of strategic GW potential, will support these initiatives. Furthermore, it will connect directly to most of the eight strategic objectives of the CCCSP, as summarized in Table 6. The implementation schedule of this project will generate results that will directly feed into the medium-term implementation of the CCCSP, and further support its long-term (2021-2050) ambitions, in particular contributing to the following stated response measures

- Poverty alleviation; as more than 80% of the population depends largely on subsistence agriculture, floods and droughts could push large numbers of people below the poverty line;
- Management of water and fisheries is the lifeline of the Cambodian people. Changes in hydrology as a result of climate change may have adverse effects on water resources and fisheries;
- Expansion of capacity for provision of water and sanitation, particularly to rural areas.

*Table 6: Eight strategic objectives of **Cambodia Climate Change Strategic Plan**, 2014 – 2023 and alignment with this proposal.*

Eight strategic objectives of Cambodia Climate Change Strategic Plan, 2014 – 2023		**Connection with this AF proposal (+ = weak, +++ = strong**	**Potential Impact of this proposal to the strategic objective**
1	Promote climate resilience through improving food, water and energy security;	++	+++ : food, water security
2	Reduce sectoral, regional, gender vulnerability and health risks to climate change impacts	+	+ : working with low-income groups, water supply for domestic use
3	Ensure climate resilience of critical ecosystems (Tonle Sap Lake, Mekong River, coastal ecosystems, highlands, etc.), biodiversity, protected areas and cultural heritage sites;	++	++: sustainable management of GW in the pilot areas
4	Promote low-carbon planning and technologies to support sustainable development;	-	-
5	Improve capacities, knowledge and awareness for climate change responses;	++	+++: strong knowledge and capacity building impact, awareness and climate resilience measures
6	Promote adaptive social protection and participatory approaches in reducing loss and damage due to climate change;	+++	+++: working in 2 pilot areas, participatory approaches and climate resilience measures
7	Strengthen institutions and coordination frameworks for national climate change responses; and	+++	+++: Transfer of pilot area and regional experiences to

			institutions and coordinated efforts
8	Strengthen collaboration and active participation in regional and global climate change processes.	+++	+++: transboundary collaboration and dissemination of results, international TA support.

For Myanmar, the project connects to the five thematic areas from the **National Adaptation Programme of Action (NAPA),** namely (1) agriculture and forestry, (2) biodiversity, (3) water resources, (4) energy, transport and industry and (5) public health. Specifically, our project will support the stated need to *"climate-proof rural water management, safeguard agricultural output from flooding and drought, combat erosion, and rehabilitate degraded lands".*

In addition, the project is aligned with the National Sustainable Development Strategy (NSDS) (NCEA, 2009) which aims to achieve sustainable management of natural resources, integrated economic development, and sustainable social development. The NSDS proposes a number of actions that would improve the resilience of people vulnerable to climate change including increasing water availability by harnessing seasonal water flows and improving storage capacity and improved water application techniques at the farm level. In our project we will specifically develop the potential to use GW and develop underground storage to provide for dry season water needs. Our approach to develop a more water-user oriented groundwater management practice is also in line with Myanmar's National Action Plan (NAP) under the UN Convention to Combat Desertification (UNCCD, 2005) that states the ambitions to develop more sustainable environmental management "with full participation of the local people in order to achieve indirect benefit for their present and future generations", "increase seasonal income" and "transfer the technologies to the farmers". Specifically, it will help Myanmar to:

- Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources;
- Reduce the proportion of the population without sustainable access to safe drinking water and basic sanitation.

Institutionalization

Our strategy focuses on strengthening the capabilities and potential within the extended GW community to support CCA. The focus of the initiative will be on the national agencies and their networks (associated government entities and other ministries, the national policy level), and towards local managers and GW end users in different sectors (local to provincial; farmers and industry, water users). We aim for important institutionalization gains at 1) the higher policy levels ("Improved GW management is an important climate resilience tool)" and 2) at grassroots, end-user level, capabilities are embedded to use GW as a resilience enhancing strategy.

F. Compliance with relevant standards and with ESP of Adaptation Fund

Part 1: Describe how the project / programme meets relevant national technical standards, where applicable, such as standards for environmental assessment, building codes, etc., and Part 2: Compliance with the Environmental and Social Policy of the Adaptation Fund (see also guidelines document AF).

The implementation of the project at country level will rely on approval from and fall under responsibility of the respective line ministries. This concerns policy level issues and standards. At a more technical level, the ministries will rely on their line and technical agencies. All project activities and outputs will comply with the designated policy and technical standards at country level, firstly policy, and secondly technical, The project will work within this institutional, policy and technical framework. Through this construct, the ownership rest firmly within the five participating countries. Table 7 gives an overview of the relevant country ministries and technical agencies and departments from which relevant standards and guidelines will be used, and from which compliance will be obtained.

For capacity building and training, the project will work with the regional hubs for education and training. i.e., the leading national institutions as summarized below. The project's capacity building, training and knowledge transfer activities will be reviewed and endorsed by these institutions.

	Countries: Ministries (Policy level)	Country Agencies / Departments (Technical)	Educational / Capacity building
	Cambodia Water Resources and Meteorology; Mines and Energy; Agriculture, Forestry and Fisheries; Rural Development	**Cambodia** Department of Geology; Climate Change Department	**Cambodia** Royal University of Phnom Penh; Institute of Technology of Cambodia
	Lao PDR Natural Resources and Environment; Energy and Mines	**Lao PDR** Division for GW Management (DGM); Natural Resources and Environment Institute (NREI)	**Lao PDR** National University of Laos, Faculty of Water Resources
	Myanmar Agriculture and Irrigation Water Resources; Public Works	Myanmar Water Resources Utilization Department	**Myanmar** Yangon Technical University
	Thailand Natural Resources and Environment	**Thailand** Department of GW Resources (DGR) GW Research Centre	**Thailand** GW Research Centre, Khon Kaen University
	Vietnam Natural Resources and Environment Agriculture and Rural Development	**Vietnam** National Center for Water Resources Planning and Investigation (NAWAPI) , DWRPIS (Ho Chi Minh City)	**Vietnam** Hanoi University Water Resources; Vietnam National University - HCMC

Table 7: Overview of the relevant country ministries and technical agencies and departments from which relevant standards and guidelines will be used, and from which compliance will be obtained.

At a more technical level design, implementation and monitoring of project activities has and will involve technical agencies from the five participating countries and/or their local/provincial representatives in the four proposed pilot areas to ensure that project outputs meet relevant national technical standards in terms of design and execution.

Project component activities and outputs will meet the technical standards commonly prevailing in water and natural resources management.

For Myanmar, UN-Habitat has developed a manual on drought prevention with consultation of experts from government ministries, UN agencies, INGOs and NGOs. This manual, that certainly has relevance for the Myanmar Dry Zone pilot, will be followed as much as possible in the other pilot areas as well.

The challenge is not so much meeting the prevailing GW and natural resources management standards and regulations, as in Lao PDR. Myanmar and Cambodia these are fairly general and non-specific, or in several instances, not at all or poorly defined. The challenge will be much more first to develop practices and useful interventions for which subsequently and if proven useful, regulatory guidelines and standards have to be formulated and adopted by higher policy levels. This will be done in close collaboration with the project's stakeholders and national participating agencies (Table 7).

Also here the regional cooperation aspect of this project will provide guidance, as in Thailand and Vietnam regulations are more developed and application has penetrated further. Hence, the project will mobilize and use expertise from the more advanced GW management and extension centres in the region to ensure that relevant standards and guidelines are shared and applied in a similar way across the region. Both UNESCO and CCOP-TS can make us of a rich and diversified experience in other countries from which best-practices and relevant track record can be obtained.

Part 2: Compliance with the Environmental and Social Policy of the Adaptation Fund (see also guidelines document AF).

This issue is further discussed in Section 3 of Part III (Implementation Arrangements).

G. Duplication of other initiatives or ongoing projects

Describe if there is duplication of project / programme with other funding sources, if any.

The project is the result of an intensive regional consultation process, described under Section J (below) with participation of representatives from the five countries and international experts active in the region. The GW community is not too large, but the network includes experts with different affiliations (government organisations (different ministries, such as natural resources, agriculture, water, environment and climate change policy), R&D institutions, universities, etc.). In this setting there is a good oversight of comparable or related initiatives. There are national or more localized projects, targeting small and specific stakeholder groups, but to our knowledge there is no existing or planned regional and multifaceted programmes as described in this proposal.

To our knowledge there are currently no potentially overlapping initiatives.

Earlier initiatives with a somewhat comparable focus included a launch workshop in 2011 by the Asia Pacific Water Forum (APWF) for a regional knowledge hub for GW management, with support of the Institute for Global Environmental Strategies (IGES, Japan), ADB, Department of GW Resources (DGR), Thailand Asian Institute of Technology (AIT), and other knowledge hub partners (see: http://www.iges.or.jp/en/natural-resource/GW/knowledgehub_gw_20110602.html. The meeting had three main objectives:

- Discuss and explore ways to highlight and prioritize GW issues on main water agenda and identify feasible actions for sustainable development of GW resources;
- Clarify importance of GW in the time of global change to address food and water security and suggest ways to safeguard its strategic resource value from emerging challenges;
- Facilitate partnership with clients, partners and relevant organisation working in the field of GW and dig into opportunities to synergize efforts being taken in different corners of the region.

But this project lacked concrete interventions on the ground due to poor financial support and after the launch workshop there was no further follow-up.

A more successful example of a past initiative is TWAP http://twapviewer.un-igrac.org. This is now being set up as an independent project and is financially supported, but has no explicit Mekong Region focus.

About TWAP

Recognizing the value of transboundary water systems and the fact that many of them continue to be degraded and managed in fragmented ways, the Global Environment Facility Transboundary Water Assessment Programme (GEF TWAP) was developed. The Programme aims to provide a baseline assessment that identifies and evaluates changes in these water systems caused by human activities and natural processes, and the consequences such have on dependent human populations. The project is the first truly global comparative assessment for transboundary aquifers, lakes, rivers and large marine ecosystems, as well as a thematic evaluation of the open ocean, through institutional partnerships that hope to seed future global assessments. The project results are envisioned to assist the GEF and other international organizations in setting priorities for supporting the conservation of transboundary water systems. More information on TWAP including final reports can be found on www.geftwap.org

The portal gives access to the map based results from the GW component of the Transboundary Waters Assessment Programme.

The data shown in this portal have been made available by national experts from countries involved in the TWAP GW project. It also includes the results from scenario analyses using the global WaterGAP model (University of Frankfurt, Germany) and a study on GW systems of small island developing states, also called SIDS (Simon Frasier University, Canada). More information on TWAP GW, including reports on methodology and outcomes, can be found on www.twap.isarm.org

H. Learning and Knowledge Management

If applicable, describe the learning and knowledge management component to capture and disseminate lessons learned.

Learning and knowledge management is one of the key components of the project (under Component 5); capacity building, training and knowledge dissemination are firstly directed at the Community of Practice (CoP) of GW workers, who need to be better equipped with proper management tools and supported with relevant expertise, and secondly, at GW end-users and stakeholders who need to be more aware and supported with technologies and information to use GW to increase resilience. Hence, the learning and knowledge development and management outcomes for the project have been defined as:

''Internal capacity in the Greater Mekong Subregion to develop Climate Change Adaptation policy and practical resilience enhancing interventions, to use state-of-the-art tools and work with CoP, stakeholders and vulnerable groups ''

The proposed regional approach will ensure involvement and results for five countries and operational and resource efficiency. Activities to capture and disseminate lessons learned include (see also under Component 5, Part II, Section A):

- A series of training workshops with participants from the GW CoP from the five countries
- Dissemination of relevant expertise and skills to end-users in resilience pilots. In these practical, hands-on demonstrations we will exploit various learning tools, such as: news items in local media, public and school presentations, water management briefings with local community groups, awareness actions for private sector, short training workshops and courses on climate change. Information and supporting guidelines will be consolidated in policy briefs for national decision makers; and best practice guidance materials and tools.
- Collaboration with the training institutes in the countries to adapt and improve formal training programmes and promote increased participation by women in the sector.
- Setting up of a knowledge management repository and exchange facility (Sharepoint)
- International conference

A more detailed workplan for the proposed activities will be developed during the Inception phase of the project.

The first challenge of the learning and knowledge management component of the project is to address a number of knowledge and information gaps; it is of critical importance that knowledge and learning development starts from the correct foundations and proper understanding. The following are important and basic resource management concepts that need to be addressed: (between brackets the project component/activity in which the issue will be addressed):

- Extent and/or characteristics of superficial and confined aquifer systems, including resource volumes in aquifers systems in the selected pilot areas, existing and/or potential water quality threats (Component 1).
- Current GW volumes being abstracted for various uses; future demand scenarios for irrigation, urban and rural water supply (Component 2)
- Relationships between recharge in highland areas and resource potential in lowland areas. This includes several important transboundary systems. Climate change and land use changes will affect these delicate balances in supply and demand (Component 1).
- Sustainability (in view of increasing abstraction) and vulnerability of riparian GW resources to climate change induced changes in precipitation and changes in river flow regimes, be they natural or anthropogenic (Component 1).
- To understand better the resource and resilience potentials and vulnerabilities of GW systems of the region, detailed hydrogeological and geophysical investigations are required. A crucial GW monitoring network is needed to monitor resource status and critical depletion, and for developing and using regional GW information systems and GW flow models. These regional (transboundary) GW models and information tools will help manage resources. It is therefore also needed to visualize (in maps) regional and transboundary GW (recharge and extraction) systems and enable assessment of GW recharge rates from flooding and rainfall under the current and future climate conditions. (Component 3).

- Determine GW resource potential in shallow and deep aquifer systems (for different users) and demonstrate how this potential can be developed to increase resilience. (Components 1, 2 and 3).

Learning, knowledge development and sharing of expertise are key elements of the program; the more advanced groups (Thailand, Vietnam) will contribute to this process by helping their less advanced colleagues in Lao PDR, Myanmar and Cambodia. In comparison with isolated single-country interventions this is much more cost effective. The bulk of the technical support work can be done by regional experts.

Capacity building to form a regional community of experts and address societal needs: Sustainability aspects are highly dependent on the human resources capacity dimensions. With a strong focus on human resources development a new generation of better skilled and equipped GW experts will engage with pertinent challenges of the coming decades. They can do this better in a concerted manner, with common tools and data. Sustainability is also enhanced by closely linking GW resource studies to societal needs (in various sectors like food production, domestic water supply, industry, ecology/environment). A regional Community of Practice (CoP) will be fostered, building upon efforts previously undertaken by the project partners. This CoP will meet and share issues annually. The project will also provide an enabling environment and give support to postgraduate studies. The opportunities for regional cooperation are being greatly strengthened in readiness for the establishment of the ASEAN Economic Community later this year.

Finally, the project will benefit for proposed project partners' (IWMI and IGRAC) dedication to knowledge development and sharing, such as IWMI's global GRIPP initiative.

GRIPP: Groundwater Solutions for Policy and Practice

GRIPP is a global level, multi-partner initiative of the IWMI working closely with IGRAC and a host of other partners. Its aims are to '*secure GW resources for livelihoods, food security, climate resilience and economic growth while sustaining the resource for future generations*' by:

a) creating long-term partnerships
b) sharing lessons
c) scaling-up successes
d) filling knowledge gaps

Thus GRIPP brings in tested success stories, new technology, and innovative policy and institutional approaches for GW management in order to achieve the SDGs related to climate resilience, food security, and sustainable water management. As this global mandate conform closely with those of this regional project, it is anticipated that the inception phase of this project will enable close interactions and linkages to be developed to enable two-way feedback and learnings to better address these contemporary GW management challenges.
For further information visit: http://gripp.iwmi.org/

GRIPP
GROUNDWATER SOLUTIONS FOR POLICY & PRACTICE

I. Project consultation process

*Describe the consultative process, including the list of stakeholders consulted, undertaken during project / programme preparation, with particular reference to **vulnerable groups, including gender considerations**, in compliance with the Environmental and Social Policy of the Adaptation Fund.*

The consultation process for the preparation of the AF project has been guided by UNESCO and CCOP-TS with external support of IWMI and IGRAC, in close contact with national partners in the five countries. This responsibility underwrites the long-term engagement with the subject and, increasingly, also the awareness of significant vulnerabilities. Although the engagement of CCOP-TS and UNESCO with the GW CoP has been successful in its own right, the need is felt to raise the stakes and bring the challenge of CCA and supporting resilience to the forefront. In these project preparation workshops also a lot of discussions were dedicated to the challenge of how to interact with stakeholders in such a way that vulnerable groups and women are prioritised.

UNESCO coordination and consensus building role builds on established experience in diverse programmes on environment and natural resources management, both in and beyond the region. UNESCO, through its diplomatic and official network, has access to, and is able to mobilise high-level political and institutional offices and support in the region. In this way, UNESCO was able to muster support for this proposal and this will be the way UNESCO will support during implementation. On the one hand disseminating information on the project status, objectives and progress, and on the other hand seeking for confirmed political support, assistance (if needed) and promoting acceptance and embedding of verified project results.

CCOP-TS executive support: The CCOP-TS approach is such that progressively regional collaboration takes place without much external technical assistance; CCOP-TS has nearly 60 years of experience with keeping regional cooperative networks alive in this way.

In preparation of the proposal, important support was gathered in the following consultative meetings:

1. CCOP-KIGAM-UNESCO-DGR Workshop on Sustainable Groundwater Management in Mekong River Basin 19-20 May 2015, Bangkok, Thailand.

CCOP Technical Secretariat, in collaboration with the Korea Institute of Geoscience and Mineral Resources (KIGAM), the UNESCO Bangkok Office and the Department of GW Resources (DGR) of Thailand, co-organized the Workshop on Sustainable GW Management in Mekong River Basin on 19-20 May 2015 in Bangkok, Thailand. This meeting is within the framework of the five-year CCOP-KIGAM Project "Solution for GW problem in CCOP region" funded by KIGAM since 2013.

The meeting was attended by 26 participants (45 % female) from CCOP Member Countries, Cambodia, Republic of Korea, Lao PDR, Myanmar, Thailand, Vietnam, international resource persons and CCOP TS staff.

It was recognized from the presentation of country reports that Cambodia, Lao PDR and Myanmar have limited information available on GW resources and lack any mechanisms to regularly monitor GW for quality or quantity. On the other hand, Thailand and Viet Nam have adequate monitoring data at the national level. To address this dearth of information on GW and encourage collaboration in its management, a proposal was made during the workshop for the creation of a GW monitoring network and to provide technical support to countries in need of developing sustainable management plans for this resource.

Figure 15: Participants of the May 2015 workshop (not all shown in the picture)

2. UNESCO-IGRAC workshop, Bangkok, March 2016

UNESCO-IGRAC workshop GW Monitoring Workshop for South-East Asia; On 15-16 March 2016, the workshop 'GW Monitoring in Southeast Asia' was held in Bangkok Thailand. The workshop was organised by UNESCO Bangkok Office, Department of GW Resources Thailand (DGR) and the International GW Resources Assessment Centre (IGRAC) under the framework of the Global GW Monitoring Network (GGMN) programme. In total 45 GW specialists from six countries (Cambodia, Iran, Malaysia, Myanmar, Thailand and Vietnam) attended the workshop.

Workshop objectives
The purpose of the workshop was to bring together national and international GW experts to review the state of GW monitoring in the region, to introduce the Global GW Monitoring Network (GGMN) programme and its possible role in Southeast Asia. The workshop was also intended to build synergies and strengthen international water cooperation.

Results and Contributions
Presentations were given by country representatives to share experiences on the current state of GW monitoring, information management and future challenges. The Global GW Monitoring Network Programme was introduced followed by a live demonstration of the GGMN Portal. Participants explored the functionalities of the GGMN Portal to become familiar with the GGMN Programme and the GGMN Portal. There was an interactive session to identify the bottlenecks for proper GW monitoring and translate some of those into additional developments for the GGMN Programme.

Professor Yangxiao Zhou (UNESCO-IHE) provided a presentation on GW monitoring in the Netherlands and the use and application of time series analysis for GW monitoring data. Afterwards, participants learned how to work with the time series analysis tool available in the GGMN Portal and how to create spatially interpolated GW maps using the GGMN Portal. Sangam Shrestha (Asian Institute of Technology) presented the recently published book: 'GW Environment in Asian Cities: Concepts, Methods ad Case Studies'. Wytze Schuurmans and Nienke Ansems introduced the use of remotely sensed data for GW monitoring and the role of information technology and big data in GW research and management.

3. CCOP-KIGAM workshop Sihanoukville, Cambodia, June 2016

A workshop was convened in preparation of this proposal, with representatives of all partners from the region (*CCOP-KIGAM-UNESCO-MME Workshop on "Climate Change and Groundwater Resources in the Mekong River Basin", Sihanoukville, Cambodia, 1-4 June 2016).*

CCOP-KIGAM-UNESCO-MME Workshop
"Climate Change and Groundwater Resources in the Mekong River Basin"

Date: 1-2 June 2016
Venue: Sihanoukville, Cambodia
Host: CCOP, KIGAM, UNESCO, and MME
Participants: Vietnam, Lao PDR, Cambodia, Thailand, Myanmar, China, Republic of Korea and international experts

Background
GW is a valuable natural resource and one of the primary sources of water in Mekong River countries. Global climate change is expected to affect availability and sustainability of GW resources by altering hydrological cycles and GW recharge in the face of human activities (higher demand). Despite its importance, the impact of climate change on GW resources has received inadequate attention in Mekong river countries. The communication and collaboration between countries are required (1) to more urgently assess climate change effects on GW, and (2) to mitigate the impact of climate changes to the water resource supply in the Mekong River Basin.

Aims of the workshop
The objectives of this workshop were to promote sharing information and best practices among Mekong countries for assessing availability of GW resources under climate change and to support member countries to prepare for sustainable GW management. The key players of each country in the Mekong River Basin addressed major issues and status of GW management with changing environment. Strategies to enhance collaboration between neighbouring countries and to adapt to future climate change were discussed. The workshop provided opportunities to further understand the dynamic relationships between climate change and GW and to provide strategies for sustainable GW resource management in the lower Mekong River Basin.

In all, the sequence of regional meetings and workshops laid the foundation for the project concept and consensus on priorities and opportunities. The meetings were well attended by a regionally representative assemblage of GW experts, policy-makers and government officials responsible for natural resources management and CCA policies. The network has multiple important functions:

1. Share ideas and information on the status of GW resources management and alignment with national and regional government policies
2. Provide an opportunity to assess the status of national capabilities and mandates
3. Support regional cooperation, capacity building and knowledge exchange. The regional network is complemented and supported by international experts.
4. Identify opportunities and priorities for regional cooperation and increasing the impact of the sector.

It is believed that the series of workshop and bilateral meetings has resulted in a shared vision and ambition to use GW expertise and potential not just as an additional natural resource, but as a strategic asset, that, when used sustainably and responsibly, can make a significant contribution to climate resilience and livelihood improvement.

J. Justification of Funding

The project focuses on building climate resilience on the basis of "hidden" and poorly managed GW resources in particular for vulnerable rural communities, and other low-income users in cross-border regions of Lao PDR, Cambodia, Thailand, Myanmar and Vietnam.
The overall justification of the project lies in the potential to use GW, always a reliable and "safe" resource for low-income groups to provide water for food production, domestic use and production processes. This potential remains undeveloped in large parts of the GMS for a number of reasons. The project will address the following:

- Poor information on and confirmation of resource potential: The project will prepare an updated GW inventory of shared aquifers in border regions (four pilot areas), develop resource management concepts and tools, and set up a much needed monitoring network for GW systems.
- Regional collaboration will enhance understanding of GW recharge processes and formulate recommendations for protection and long-term sustainable management.
- In the general approach and in the pilot areas issues of transboundary GW management will be addressed. Taking up transboundary challenges will also form an incentive to develop collaborative solutions.
- In addition to making use of the available national capacities, the project will aim for intensive participation of local stakeholders by implementing principles of GW governance through 1) dialogues with users to assess GW use scenarios for different sectors (agriculture, industry, rural and urban domestic water supply) and 2) develop and provide appropriate information to ensure sustainable use by different user groups (agriculture, industry, domestic water supply).
- On the basis of improved information (supply/demand assessments, climate vulnerability profiles) the project will develop and implement targeted vulnerability reduction measures, GW supply quality improvement measures, and identification and protection of strategic GW reserves. Implementation of different project activities will be integrated in the four pilot areas and will generate resilience deliverables on the ground.
- On the medium and longer-term the investments in training, capacity building and raising standards for GW Community of Practice across the GMS and initiating regional water cooperation (diplomacy) will generate long-term benefits.
- Strategic planning for GW resources will support high level policy consensus and regional cooperation and make significant contributions to climate resilience of low income and rural population.

In the following summary, for each main project component a justification of the funding is given, followed by a concise reflection on Adaptation alternatives.

Component 1: GW resource assessment and monitoring: to obtain and use a harmonised regional GW resource inventory supporting a regional GMS approach to address challenges of climate change and resilience, and enables an information-based policy to manage resources and further develop new GW-based resilience strategies and practical interventions.			
Outcome: A regional GMS	**Baseline (without AF)**	**Additional (with AF)**	**Justification**

approach to address challenges of climate change and resilience is created based on an information-based policy.	Governments and user groups have incomplete to severely limited knowledge of GW resources and no consistent assessment.	A comprehensive overview of regional GW resources (quality, quantity) is included in a easily accessible inventory (GIS, database).	It is essential to prepare a thorough inventory of available GW resources. But this should not be an academic or stand-alone investment. The resource potential should be made in close connection with a comprehensive assessment of water user needs (for different sectors: rural food production/agriculture, domestic water needs and small town water supply). Without proper understanding of the resource availability GW can still be used as a resilience (as is done in many places), but issues of sustainability and depletion of scarce resources will crop up. By combining expertise from within the region with modest Technical Assistance support in a focused and coordinated intervention valuable and relevant resource availability information will be prepared and made available in formats that improve use by stakeholders and users. It will be possible to level regional differences **Adaptation Alternative?** Information on GW resources is available especially in Thailand and Vietnam, but much less so in Myanmar, Lao PDR and Cambodia. This unbalanced information base is not supportive to sustainable resource use and developing fair and equitable resilience measures, forms a challenge especially for proper management of transboundary aquifer systems. Existing GW information lacks detail and quality due to a low level or absence of monitoring, especially so with respect to GW management in border regions. So it would be difficult to work on the basis of existing information and not possible to achieve the set objectives.
	There is some GW-related info, but hardly used for this purpose.	GW information forms the basis for specific climate resilience measures.	
	GW seen as a static resources (basic inventories) and no to little data on temporal changes (or depletion)	Monitoring system and information operational and used for periodic updates.	
	Currently, GW information is hardly used.	Clear and consistent reference to GW in support of climate resilience development.	

Component 2: Priority use and Stakeholders: Stakeholders from different GW user sectors increasingly participate in decision-making on resource management issues and have access to information and guidelines that support more sustainable use region-wide.			
Outcome 2: GW users in different	**Baseline (without AF)**	**Additional (with AF)**	**Justification**

economic sectors in the GMS have access to requisite information and guidelines and thus participate in GW management.	Farmers and other users deplete GW resources regardless of CCA challenges.	Multiple users aware of and supported with resource management information and guidelines; support available in transboundary regions.	Due to the scientific and academic character of GW studies, also a somewhat neglected chapter not really part of water resources management and neither at the core of natural resources management, the results of GW studies were always a bit out of reach for many GW user groups. By addressing this, the project will deliver tangible results to different water users so that a) climate change resilience is strengthened, and b) limited but critical GW resources are not depleted. This will be done in close consultation with the stakeholders, in all parts of the proposed pilot areas. From the local pilots, the project will reach for higher institutional and policy levels, to ensure recognition of GW as a resource that can contribute to regional resilience. **Adaptation Alternative?** Working in the traditional manner will bring the risk of not reaching the target groups, or maintaining the mismatch and poor coordination between the GW CoP and the user sectors. The project workplan allows for flexibility and adaptation (to be used during the Inception Phase) to the specific requirements to generate results in the (different) pilot areas.
	Information on GW potential is not tangible enough to motivate users to adopt and apply.	Supporting national partners dedicated to provide users (in-country and transboundary) with adequate information.	
Component 3: Resource management, information tools and equipment: will support greater resilience and more sustainable GW resource use, with protection of low income and vulnerable user groups; resource management methodology support better transboundary GW policies that are more robust and climate change ready.			
Outcome 3: Climate resilience and GW use in pilot countries is increased, and low income and other vulnerable groups' needs are prioritized.	**Baseline (without AF)**	**Additional (with AF)**	**Justification**
	Next to basic resource inventories (GW maps) there is no tailored information to support sustainable resource use of specific measures to support resilience.	Greater resilience and sustainable GW resource use, enabling low income and vulnerable user groups to use GW resources optimally when needed.	On the basis of improved information (supply/demand assessments, climate vulnerability profiles) the project will develop and implement targeted vulnerability reduction measures, GW supply quality improvement measures, and identification and protection of strategic GW reserves. Implementation of different project activities will be integrated in the four pilot areas and this will generate resilience deliverables on the ground. The project will provide farmers and rural communities and village water user groups in the pilot areas with awareness, understanding and skills to manage limited GW resources to overcome climate-change induced perennial droughts and water shortages. **Adaptation Alternative?** One of the fundamental questions is the use of surface vs. GW. In principle, similar resilience levels could be reached with the use of surface water, commonly available in the proposed pilot areas (but not in drought periods). However, the investments needed to ensure availability of surface water and the complexities involved in management give low-income user and
	No transboundary cooperation, incompatible resource inventories, no communication.	Joint and coordinated efforts to use information and tools (monitoring) to develop and apply GW management	
	Only very basic, general information is available	Comprehensive information, tools and methods developed and applied	

			rural communities poor leverage and little influence. Surface water, originating outside the area, and destined for other users downstream, is not really an alternative for the "hidden" resource underground. Our approach complements other interventions that deal with surface water management.
Component 4: Regional cooperation, coordination and information exchange will result in the development of a regionally coherent policy for climate adaptation through sustainable GW resource management, a level playing field for GW users from all sectors throughout the region and efficiency gains through a common approach and collaborative support tools.			
Outcome 4: A regionally coherent policy for sustainable GW management in support of CCA is adopted based on a level playing field of all users in the GMS.	**Baseline (without AF)**	**Additional (with AF)**	**Justification**
	Despite common CCA challenges countries in the region do not optimally share practices, knowledge and resources	Regionally coordinated GW use contributes to regional, cross-border climate resilience for food production, rural water supply, etc.	In the provinces, when discussing GW resources for use in agriculture or for domestic purposes, few people realize the resource is not simple available from an underground (limitless) source, but forms part of a complex system with recharge areas, GW flow in complex aquifer systems, interaction with surface water and sometimes affected by large scale spatial and long-term temporal dynamics. A similar misunderstanding is encountered among higher policy levels. Our approach for regional and transboundary, joint development is aimed at overcoming these misunderstandings. This justifies a fair amount of bilateral and five-country meetings and workshops, to create a joint understanding, both on advanced technical levels, as well as on policy coordination and complex cross-border cooperation. **Adaptation Alternative?** From a GW management perspective, there is no real alternative; if there is no real cross-border coordination resource depletion will take place in the medium- to long-term, and communities on both sides of the border will suffer.
	Vulnerable groups in the region and cross-border suffer from detrimental impact of resource depletion and increasing climate change vulnerabilities.	Collaborative transboundary approach to protect limited resources and support vulnerable groups.	

Component 5: Capacity building and training will enhance the internal capacity of the GW community of experts in the GMS region to develop and contribute to Climate Change Adaptation policy and practical resilience enhancing interventions, to use state-of-the-art tools and work with stakeholders and vulnerable groups.			
Outcome 5: GMS stakeholders	**Baseline (without AF)**	**Additional (with AF)**	**Justification**

capably use project tools on GW use for CCA and resilience.	Within the region different national groups work on rather different knowledge levels and there is little bi- or multilateral cooperation.	Community of Practice of GW experts is able to contribute to CCA policy and practical resilience enhancing interventions.	The project investments in training, capacity building and raising standards for GW Community of Practice will use within-the-region training. There is a high (double) return on investment as both the participants as well as the host institutions will benefit. The programme will offer fertile training grounds for a new generation of experts, in a learning-by-doing approach that will cover practical, on-the-ground issues in the pilot areas, but also higher policy levels. New and innovative subject matter and policy context will be injected to give more relevance to the sector. The project will be implemented with limited international TA and build on existing networks. **Adaptation Alternative?** The direction of development is really set for further ASEAN cooperation for and coordination of important policies in the region. It is an option to implement the project with experts from advanced countries in the GMS region (Thailand, Vietnam). But this will lead to unsustainable results in the priority areas and for priority low income groups in Myanmar, Lao PDR and Cambodia. The underdeveloped GW management capacity in these countries is a challenge and an opportunity to develop greater climate resilience. Bringing in more international TA will substantially raise the interventions costs, as would training in leading institutions outside the region.
	Although there are regional network meetings there is little coordinated effort to improve overall impact level.	Through regional cooperation GW experts have reached a higher and collaborative knowledge and impact level	
		GW CoP is regionally active and able to contribute effectively to different GW system, sustainability or CCA challenges.	

K. Sustainability of outcomes

Describe how the sustainability of the project / programme outcomes has been taken into account when designing the project / programme.

Sustainability aspects are highly dependent on the human resources capacity dimensions. With a strong focus on human resources development a new generation of better skilled and equipped male and female GW experts will engage with pertinent challenges of the coming decades. They can do this better in a concerted manner, with common tools and data. Sustainability is also enhanced by closely linking GW resource studies to societal needs (in various sectors like food production, domestic water supply, industry, ecology/environment). A regional Community of Practice (CoP) will be fostered, building upon efforts previously undertaken by the project partners. This CoP will meet and share issues annually. The project will also provide an enabling environment and give support to postgraduate studies. The opportunities for regional cooperation are being greatly strengthened in readiness for the establishment of the ASEAN Economic Community later this year.

The proposed implementation partnership, with UNESCO (Bangkok Office), CCOP-TS as executive partner and technical support from IWMI and IGRAC will form a solid foundation for outcome sustainability. All partners have a long time presence in the region and are dedicated to continue their activities, in close cooperation with the national partners.

Project outcomes will be shared and made available for uptake by relevant regional organisations such as MRC and Climate Change coordination focal points under ASEAN. On the national level, national Mekong River Commissions will be engaged.

L. Environmental and social impacts and risks

Provide an overview of the environmental and social impacts and risks identified as being relevant to the project / programme.

As further elaborated in project management section 3, the proposed project seeks to fully align with the Adaptation Fund's Environmental and Social Policy (ESP). Table 8 (in Section 3 below) summarizes the initial analysis that has been carried out to evaluate environmental and social impacts of the project versus the AF policy. Also, it indicates where steps will be taken and where further assessment is needed (in those domains were positive impacts are anticipated). This will be done as part of the project monitoring and evaluation effort.

Activities under Component 1 to 5 are in general all "soft" activities. According to the Adaptation Fund's Environmental and Social Policy, "Those projects/programmes with no adverse environmental or social impacts should be categorized as Category C" (Source: Adaptation Fund Environmental and Social Policy document.) No negative environmental and social impacts, whether direct, indirect or cumulative are envisaged to arrive as a result of any of the soft activities under Components 1 to 5. Despite this, however, utmost care will be taken to ensure that no detrimental environmental or social impacts can occur.

As elaborated throughout the proposal the project specifically aims to deliver positive transboundary impacts.

The miscellaneous field activities that will be formulated in detail for the implementation of the designated pilot areas need to be scrutinized more closely. Some of these may be considered 'hard' activities, and as such have the potential, without environmental and social safeguarding and mitigation measures, to have minor negative environmental and social impacts. However, in our assessment, none of the proposed activities is expected to be in Category A or B of the Adaptation Fund's impact classification. This is because this project proposes potentially 'hard' activities that are small scale and very localized, and co-managed by local communities where possible, who have a stake in avoiding negative environmental and social impacts. This means that the potential for direct impacts is small and localized, that there can be few indirect impacts, Given this, cascading or cumulative negative impacts are also unlikely.

Section 2 of the Management Part below deals with potential risks. The project did not, at this stage, identify explicit or implicit environmental and/or social risks other than the ones discussed in that Section.

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PART III: IMPLEMENTATION ARRANGEMENTS

1. PROJECT MANAGEMENT
2. PROJECT AND FINANCIAL RISK MANAGEMENT
3. PROJECT ENVIRONMENTAL AND SOCIAL POLICY
4. MONITORING AND EVALUATION
5. PROJECT RESULTS FRAMEWORK (LOGICAL FRAMEWORK): MILESTONES, TARGETS AND INDICATORS
6. ALIGNMENT WITH ADAPTATION FUND RESULTS FRAMEWORK

7. Budget (Excel sheets, also provided as Annex IV)
   Sheet 1: Summary project budget
   Sheet 2: Breakdown of the project execution costs (CCOP-TS)
   Sheet 3: Implementing Entity (MIE) management fee (UNESCO)
   Sheet 4: Budget disbursement schedule with time-bound milestones.
   Sheet 5: Detailed project budget, Excel format (Annex)

1. PROJECT MANAGEMENT

1.1 Introduction

The arrangements for effective and efficient project implementation and management are introduced. First, project 'ownership' arrangements at overall project level are presented, including coordination arrangements by UNESCO (MIE) and CCOP-TS (Executive Entity). Regional and national coordination within countries is also clarified. Actual and prospective partnership arrangements with national institutions are discussed and it is elaborated how national and regional partners as National Implementing Entities (NIE) will play a role in project implementation and management.

On the basis of this application and following project preparatory consultations and arrangements, the following entities will support project implementation and management.

Who is Who: Beneficiaries and stakeholders – NIEs

1. Government of Cambodia, Ministry of Water Resources and Meteorology and Ministry of Mines and Energy deal with GW issues in Cambodia.

2. Government of Lao PDR, Ministry of Natural Resources and Environment (MoNRE), and its subsidiary Department for Water Resources (DWR) including the GW Management Division. Furthermore, the Natural Resources and Environment Institute (NREI) has an executive role in GW management.

3. Government of Myanmar, Ministry of Agriculture and Irrigation and within the Ministry of Water Resources the Utilization Department (WRUD) has the role of implementing agency.

4. Government of Thailand, Ministry of Natural Resources and Environment; within the Ministry the Department of GW Resources has the responsibilities in planning, assessment, resource conservation, and regulations.

5. Government of Vietnam, MoNRE as the coordinating Ministry for water resources management, is implementing river basin water resources management plans on a national scale that include GW. The National Center for Water Resources Planning and Investigation (NAWAPI), has an executive role.

6. Universities, research institutions and local NGOs in the GMS and specifically active in the proposed pilot areas and in a position to contribute to capacity building on GW. A specific role is envisaged for the Mekong River Commission and the National Mekong Commissions in the respective riparian countries.

The collaboration will be supported by:

UNESCO: as MIE, it will provide all technical backstopping, facilitation with member States and processes with the Adaptation Fund.

Technical Secretariat of CCOP (CCOP-TS): Coordinating Committee for Geosciences Programmes (in East and Southeast Asia): CCOP-TS, as Executive Entity (EE) will provide technical expertise and coordinate and support implementation along with the national partners.

International Water Management Institute (IWMI): has been at the forefront of research aimed at exploring opportunities for improved GW development and management for poverty alleviation and improving GW governance across SE Asia. IWMI will be one of the implementing partners.

International GW Resources Assessment Centre (IGRAC): is UNESCO's and WMO's GW expertise and resources centre that facilitates and promotes information and knowledge sharing required for sustainable development, management and governance of transboundary GW.

Multilateral Implementing Entity (MIE)
As endorsed by the signatories from the five participating countries, UNESCO-Bangkok Office will be the MIE for the project. Firstly, a short overview of UNESCO's track record in the subject matter is presented. Secondly, it is elaborated in what way UNESCO, as MIE, will manage the project

UNESCO and water management, including of GW
UNESCO works to build the scientific knowledge base to help countries manage their water resources in a sustainable way through the International Hydrological Programme (IHP), through leading the UN-wide World Water Development Programme, through the UNESCO-IHE Institute for Water Education in Delft in the Netherlands, through over 20 affiliated research centres on water around the world and through a series of water-related UNESCO Chairs.

The IHP is the only intergovernmental programme of the UN system devoted to water research, water resources management, and education and capacity building. Since its inception in 1975, IHP has evolved from an internationally coordinated hydrological research programme into an encompassing, holistic programme to facilitate education and capacity building, and enhance water resources management and governance. IHP facilitates an interdisciplinary and integrated approach to watershed and aquifer management, which incorporates the social dimension of water resources, and promotes and develops international research in hydrological and freshwater sciences. UNESCO's International Hydrological Programme, founded in 1975 and implemented in six-year programmatic time intervals or phases, is entering its eighth phase to be implemented during the period 2014-2021. IHP-VIII will bring innovative methods, tools and approaches into play by capitalizing on advances in water sciences, as well as building competences to meet the challenges of today's global water challenges.

Under IHP VIII GW is one of the main key area where IHP is continuing its pioneering work to learn more about the complexity of aquifer systems, the increasing global risk to GW depletion, quality deterioration and pollution, and the resilience of communities and populations dependent on GW sources.

Objectives include promoting measures addressing the principles of sustainable management of GW resources, addressing methods for the sound development, exploitation and protection of GW resources, developing new GW resource maps, and strengthening GW governance policy and water user rights in emergency situations. These challenges call for comprehensive research, implementation of new science-based methodologies and the endorsement of principles of integrated management, and environmentally-sound protection of GW resources.

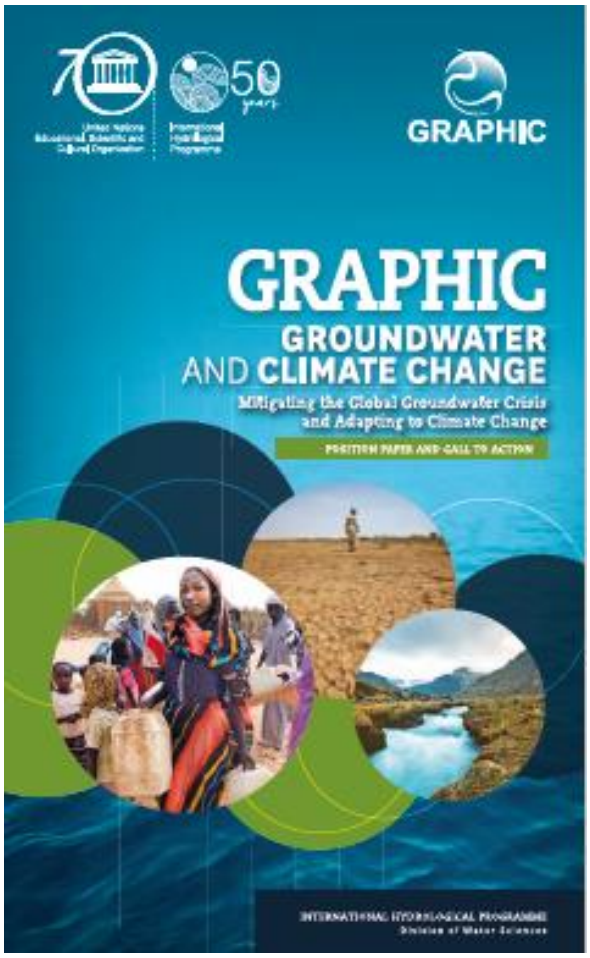
Focal Areas of IHP VIII GW
Focal area 2.1 - Enhancing sustainable GW resources management
Focal area 2.2 - Addressing strategies for management of aquifers recharge
Focal area 2.3 - Adapting to the impacts of climate change on aquifer systems
Focal area 2.4 - Promoting GW quality protection
Focal area 2.5 - Promoting management of transboundary aquifers

Ongoing main Initiatives under UNESCO-IHP:

GRAPHIC (Groundwater Resources Assessment under the Pressures of Humanity and Climate Change) is a UNESCO-IHP project, seeking to improve our understanding of how GW interacts within the global water cycle, how it supports ecosystems and humankind and, in turn, responds to complex and coupled pressures of human activity and climate change. GRAPHIC was developed to successfully achieve these objectives within a global context and represents a collaborative effort that serves as an umbrella for international research and education.

Through a variety of regional working groups and case studies, GRAPHIC outlines areas of international research, covering major geographical regions, GW resource topics, and methods to help advance the knowledge required to address both the scientific and social aspects of this field. Comprehensive information is provided in:
http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SC/pdf/2015_GRAPHIC_GWandCC.pdf

The full documentation on the highly relevant GRAPHIC programme is provided as **Annex III.**



The **worldwide ISARM (Internationally Shared Aquifer Resources Management)** Initiative is an UNESCO and IAH led multi-agency effort aimed at improving the understanding of scientific, socio-economic, legal, institutional and environmental issues related to the management of transboundary aquifers (http://isarm.org/).

The issue of shared international waters is as old as the national borders that make those waters international. During the last century, a significant progress has been made in regulation of joint management of surface watercourses; many international river-, lake- or basin commissions have been set up and the legal treaties signed. Although some of these activities address "a GW component" as well, major comparable efforts related to the invisible GW have started just a several years ago with the ISARM Programme.

Since its start in 2002, ISARM has launched a number of global and regional initiatives. These are designed to delineate and analyse transboundary aquifer systems and to encourage riparian states to work cooperatively toward mutually beneficial and sustainable aquifer development. Comprehensive information is provided in: (http://en.unesco.org/themes/water-security/hydrology/programmes/isarm/general-information).

The World-wide Hydrogeological Mapping and Assessment Programme (WHYMAP) was created in 1999 in order to contribute to worldwide efforts towards better managing the Earth's water resources, particularly GW. It is a joint programme of the United Nations Educational, Scientific and Cultural Organization (UNESCO), the Commission for the Geological Map of the World (CGMW), the International Association of Hydrogeologists (IAH), the International Atomic Energy Agency (IAEA) and the German Federal Institute for Geosciences and Natural Resources (BGR). General information is provided at: http://en.unesco.org/themes/water-security/hydrology/programmes/whymap/resources

'GW for Emergency Situations' (GWES). The aim of the GWES project is to consider natural catastrophic events that could adversely influence human health and life and to identify in advance emergency GW resources resistant to natural and man-made disasters that could replace damaged public and domestic drinking water supplies. A very important aspect of the GWES project, in drawing the attention of governments, organizations and individuals to the concept of preparedness for establishing alternative drinking water supplies, is empowerment. Very often a local population is rendered helpless following a disaster, cut off from its traditional water supplies and faced with delays in aid from outside. This may lead to destabilization and demoralization at a time when people need to rebuild their lives (http://unesdoc.unesco.org/images/0019/001921/192182e.pdf).

UNESCO Bangkok Office:
Since 1961, UNESCO Bangkok Office, the Asia-Pacific Regional Bureau for Education and Cluster Office for the six "Mekong" countries, Thailand, Myanmar, Lao PDR, and Singapore, and indirectly through UNESCO country offices in Hanoi and Phnom Penh, promotes peace and human development through education, sciences, culture, communication and information.

As Cluster Office for the "Mekong" countries and Singapore, UNESCO Bangkok covers all UNESCO's fields of competence: education, sciences, culture, communication and information. It is responsible for UNESCO's action

directly in Thailand, Myanmar, Lao PDR and Singapore, and indirectly in support of UNESCO Country Offices in Hanoi and Phnom Penh.

While UNESCO's work within the cluster generally emanates from Bangkok Office, this office is cognizant of the importance of relying on staff and partnerships in every cluster country. Across the different cluster countries this takes various forms. UNESCO Bangkok works closely with the National Commissions of all of these countries to ensure a strong working partnership, and as a means of maintaining close relationships with governments and civil society. In Thailand, UNESCO Bangkok acts as country office and coordinates all UNESCO's sectorial activities in the country. In Vietnam and Cambodia, UNESCO has established country offices. The Bangkok Office has a supporting role, with the majority of UNESCO's work going through the country offices. In Myanmar, UNESCO Bangkok has a Project Office in place, with eight temporary staff working under the supervision of a Head of Project Office, and with coordination from Bangkok. In Lao PDR, while UNESCO's work is coordinated through Bangkok, there are a number of professional staff travelling to the country, and one staff resident in Vientiane, who ensures the smooth implementation of projects in the countries.

The Natural Sciences Sector portfolio was created at UNESCO Bangkok Office in response to increased demands for regional cooperation and international attention to issues pertaining to the Mekong Cluster Natural Sciences Sector. The Natural Sciences Sector serves Mekong Cluster countries in areas including: Water Sciences – International Hydrological Programme (IHP); Ecological Sciences – Man and Biosphere Programme; Science Policy for Sustainable Development; UNESCO Engineering Initiative; cross-cutting issues such as climate change; as well as disaster risk reduction. The Bangkok office will also act as an adviser for Asia and Pacific on the International Geosciences Programme and Geoparks Initiative.

Complementing the work carried out by the UNESCO Natural Sciences Sector, Bangkok Unit, will be the IOC Regional Secretariat (Office) for the Sub-Commission for the Western Pacific (WESTPAC), established in 1994 and currently hosted by the Government of Thailand through its Ministry of Natural Resources and Environment.

MIE Management tasks

The following implementation support under the MIE modality will be provided by UNESCO for the project:

- Overall coordination and management of UNESCO's MIE functions and responsibilities, and the facilitation of interactions with the AF Board and related stakeholders;
- Oversight of project implementation through close interaction with the project
- Executive Entity CCOP-TS and with the Project Steering Committee and reporting to AF on progress and on budget performance;
- Quality assurance and accountability for outputs and deliverables during project implementation and upon completion;
- Receipt, management and disbursement of AF funds in accordance with the financial standards of the AF;

UNESCO as MIE and as part of its project management responsibility will appoint through an open competition a **Project Manager** (**PM**) who will oversee the implementation of the project along the tasks outlined above. There will be close cooperation between the Project Manager (part-time position, filled by UNESCO Bangkok Office) and the project executive and operational levels (i.e., with Project Director, Coordinating Technical Advisor CTA and CCOP-TS support staff). Through the official network of UNESCO Bangkok Office in the five participating countries and its Head Office UNESCO as MIE and its Project Manager will be a able to actively support project implementation and have regular contact with the Executing Agency (CCOP-TS, also in Bangkok) over the course of the AF project implementation.

Project Execution

In accordance with its standards and procedures, UNESCO will enter into a contractual agreement with the coordinating executing partner, CCOP-TS, towards the execution of the AF project activities and delivery of the proposed outputs.

The **Project Director (PD)** will be responsible for the overall management of the AF project. The PD (a part-time position taken by CCOP-TS Executive Director will ensure that the project is run transparently and effectively in

accordance with AF and UNESCO's guidelines and approved workplans and budgets. The PD will receive project support from the CCOP-TS project finances manager as well as additional staff members within CCOP-TS. The key functions of the PD will be:

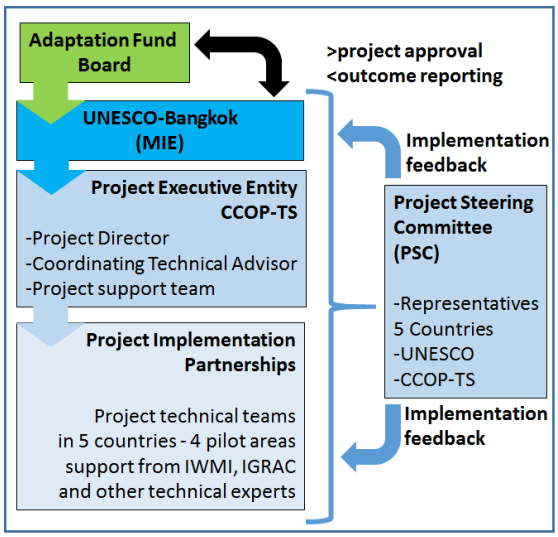
- Facilitating the day-to-day functioning of the project support staff;
- Managing human and financial resources in consultation with UNESCO and the project CTA to achieve results in line with the outputs and activities outlined in the project document;
- Ensure gender analysis and gender monitoring are undertaken by experts;
- Leading the preparation and implementation of annual results-based workplans and logical frameworks as endorsed by the management of UNESCO;
- Monitoring project activities, including financial matters, and preparing monthly and quarterly progress reports, and organising monthly and quarterly progress reviews;
- Together with UNESCO Bangkok Office, organizing PSC meetings;
- Regular reporting and providing feedback on project strategies, activities, progress, and barriers to UNESCO, PSC and project partners; and
- Managing relationships with project stakeholders including donors, NGOs and government agencies

A **Coordinating Technical Advisor (CTA)** will be hired by CCOP-TS to assist the PD and provide technical guidance and support for the implementation of the project. The CTA will:

- Prepare Annual Workplans, TORs for technical consultancies and supervision of consultants' work;
- Assist in monitoring the technical quality of project M&E systems, including annual workplans, indicators and targets;
- provide advice on suitable approaches and methodologies for achieving project targets and objectives;
- provide a technical supervisory function to the work carried out by any other technical consultants hired by the project; and
- assist in knowledge management, communications and awareness raising.

The CTA position will be filled through a transparent and competitive recruitment process that will commence as soon as the Full Project Proposal is approved.

Figure 16: AF project management arrangements.



Step-by-step implementation strategy

- Organise an executive project team consisting of national experts from the five partner countries, and experts from the supporting Technical Assistance partners (CCOP-TS, IWMI, IGRAC). As MIE, UNESCO will convene a project Steering Committee.
- Develop a common view and understanding of the role that improved GW management shall play in strengthening climate resilience in multiple sectors; identify additional opportunities through transboundary collaboration; sharing information, expertise and collaborative policies for climate resilience.
- Resource assessment: common methodology to be adopted and approach to data collection/sharing; agree on protocols for sharing available data on transboundary aquifers.
- Compile various maps / information services and products available from countries/organisations and further demarcate the recharge and extraction zones and consider transboundary issues.
- Identify data gaps and need for new data; collaborative monitoring approach, initiate base-level monitoring.
- Common approach for GW resources management information system, basic functions and operations, training expert users, dissemination to end-users in the five countries.
- Raise stakeholder and public awareness on GW vulnerability through development of tailored information

for sectoral users and multi-media awareness for urban and rural populations.

- Build capacity of local GW management professionals, planners and policy makers in the pertinent national government organisations.
- Consult stakeholders and develop a process of ongoing engagement with the specific actors with and interest in GW from government, donors, NGOs and the private sector.

These activities collectively serve to create the environment needed to achieve positive change on the ground throughout the GMS by reducing vulnerability and increasing adaptive capacity to the impacts of climate change, including climate variability. Clear indicators to track and demonstrate these outcomes will be developed at an early project stage and monitored by the Project Steering Committee and activities adjusted as needed.

Terms of Reference for Project Steering Committee (PSC)

The PSC will be formed to keep abreast of the project progress and to facilitate the implementation of the project, while direct implementation of the project and decisions regarding the allocation of resources and assistance under the project will be taken by UNESCO as the implementing agency and CCOP-TS as EE. The PSC will:

- Facilitate the implementation of the project to achieve progress on time, on scope and on budget
- Review progress reports submitted by the Project Team
- Support the broader dissemination of the project's results, especially towards government entities and policy-makers.

PSC Members: One Steering Committee member from each participating country will be invited through the appropriate governance channels. Hence, the SC will have five (country) members. Chair will rotate every year. UNESCO as MIE and CCOP-TS will attend, as well as CTA.

PSC Meetings: The Steering Committee will meet quarterly throughout the lifetime of the project and may meet more often as required. A calendar of meetings will be developed at the project inception workshop. Whether virtual meetings can serve after at least two successful in-person meetings have been held will be assessed.

Secretariat function: CCOP-TS as Executing entity will provide secretariat services for the PSC by coordinating meetings, producing documentation and meeting minutes, managing correspondence, information management/ dissemination and related tasks.

Documents will be made available to Steering Committee members at least one month prior to the meetings. Minutes of the meetings will be prepared by UNESCO & CCOP-TS. Members of the Steering Committee will share information with non-member stakeholders.

CCOP-TS for project execution

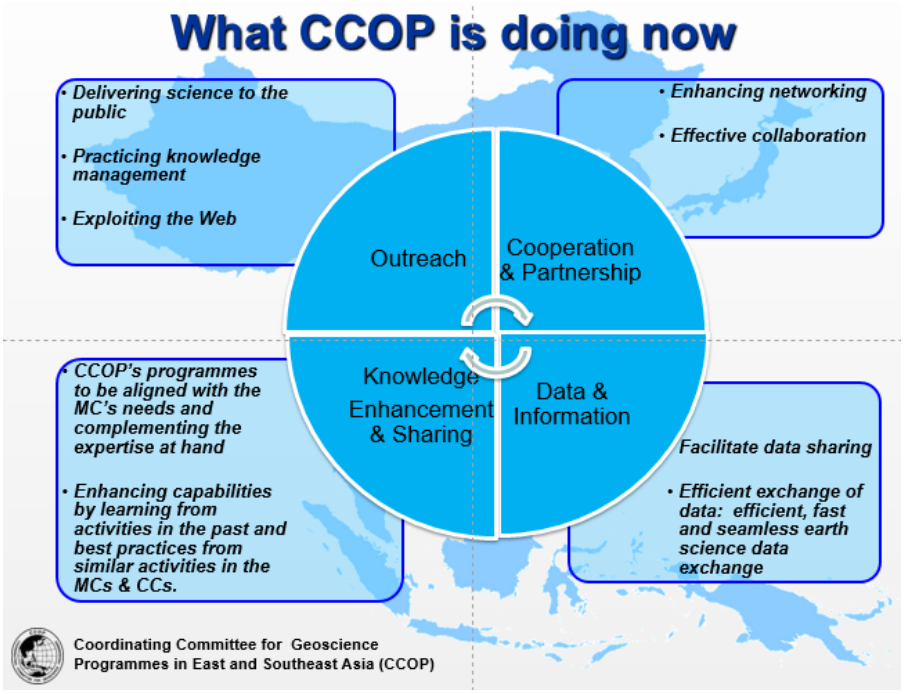
For this project CCOP-TS is the designated project EE. Below, CCOP-TS is briefly introduced and its project management and coordination qualifications highlighted. For a useful introduction and overview, please also consult www.ccop.or.th

CCOP, established in 1966, is one of the oldest intergovernmental organisations in East and Southeast Asia. Its mission is to contribute significantly to the economic development and sustainable management of the environment of the quality of life of its Member countries by the application of Earth sciences knowledge. Its focus is on:

- **Outreach**: to enhance influence with decision-makers, investors and the general public through the provision of relevant earth system science information and to develop appropriate skills to communicate effectively with CCOP stakeholders.
- **Cooperation and partnerships**: to enhance the internal and external partnerships to improve the quality, reach, application and impact of earth sciences information and knowledge
- **Knowledge enhancement and sharing**: to manage, promote, share and exploit the region's earth sciences information and skills
- **Data and information:** to advance sharing of data and information and integrate earth sciences data across national boundaries

- CCOP's primary network consists of the 14 member countries: Cambodia, China, Indonesia, Japan, Republic of Korea, Lao PDR, Malaysia, Myanmar, Papua New Guinea, Philippines, Singapore, Thailand, Timor-Leste and Vietnam. Additionally, it maintains close ties with a considerable number of Cooperating Countries and Cooperating Organisations. The management and organization structure of CCOP and CCOP-TS is presented below. At the beginning of 2016 CCOP-TS had 10 permanent staff, including four earth science experts and six support staff.

Technical cooperation and tasks of CCOP-TS



In response to the requests of the member countries CCOP-TS has organized, coordinated and supported a number of capacity building and technical cooperation workshops, training courses and case studies in three technical sectors, geo-resources, geo-environment and geo-information. Most of these activities have multilateral participation and support, and often include attention for transboundary issues (resource management, data and information sharing, harmonization). CCOP-TS also supports specific bilateral technical cooperation. For instance, in 2014 there were 26 training/ workshop activities were carried out that were attended by over 890 participants from all member countries. One of the tasks of CCOP-TS is to ensure workshop results and deliverables are prepared and disseminated (reports, books, database content, website, etc.). CCOP-TS also prepares a regular Newsletter.

CCOP-TS Director and senior experts have the responsibility to continuously liaise with member countries and organisations, ensure donor support and prepare technical meetings. CCOP-TS budget derives mainly from membership fees, income from project execution and support and occasional grants, while its expenditure consists of personnel expenses and operational costs. Its offices are provided by the Royal Thai Government through an arrangement with MoENR and include office workspace and facilities, meeting rooms and services.

CCOP-TS capabilities as a network organization are complemented with thorough and high-level expertise in the subject matter. As part of the 'Geo-Resources' CCOP-TS and its partners have worked on sustainable management of GW for a considerable time. There is also relevant expertise in the 'Geo-Information' programme. In all, CCOP-TS is well placed to be tasked with execution of the proposed project.

CCOP-TS GW related project involvement (since 2004)

1. **General GW resources**
   CCOP-GSJ/AIST GW Project (2004-2015)
   - Phase I: GW Assessment along Great River Basins in East and Southeast Asia (2004-2009)
   - Phase II: GW Assessment and Control in the CCOP Region (2010-2014)
   - Phase III: As a GW component of the CCOP-GSJ Project "Development of Geo-Information sharing infrastructure for ASEAN/CCOP countries" (started 2015)
   - Project: "Development of Renewable Energy for Ground-Coupled Heat Pump system in CCOP Regions"
   - GW and Bottled water market

- CCOP-BGR-NAWAPI, Vietnam Workshop, Integrated water resource management in coastal zones with a focus on GW – Experiences in East and Southeast Asia Countries, Can Tho, Vietnam, 19-21 January 2016
- CCOP-KIGAM Workshop (Sihanoukville, Cambodia), 1-4 June 2016 GW management and CCA in Lower Mekong Basin

2. GW – Environmental and Geohazard issues

- CCOP-KIGAM Project "Solution for GW problems in CCOP region" (2013-2017)
- CCOP-Panya Consultant-DGR Land Subsidence Monitoring System Design Project Workshop/Meeting, 16-22 January 2011, Bangkok, Thailand
- The 6th JPDC-KIGAM-CCOP Jeju Water Forum on 6-9 October 2014 in Jeju, Korea
- BGR – CCOP Workshop "Integrated water resource management in coastal zones with a focus on GW – experiences in East and Southeast Asia countries"

3. Deep GW programme

- PETRONAS-PETRAD-INSTOCK-CCOP Deepwater Subsea tie-back in Kuching, Malaysia on 24-26 Janury 2011
- Deep GW Resources (project proposal under development)

2. Project and financial risk management

A number of potential project and financial risks have been considered and analyzed in the process leading up to this AF proposal. These are summarized in Table 8 below. The risk management strategy of this AF project will be further fine-tuned during the project Inception phase.

No	Risk	Classification	Impact/ Probability 1: Low 5: High	Mitigation Measure
1	National policy and institutional practices undermine the development of concrete resilience measures in the pilot areas	Institutional	Impact: 4 Probability: 1	The project will work on different intervention levels, from national natural resources management and CCA policy in the five countries (national ministerial level), as well as on regional (responsible agencies and subministerial) level and stakeholder group organisations, to local level through direct interaction with primary stakeholder groups.
2	Data availability and consistency is inadequate to design trusted and acceptable resilience measures.	Environmental	Impact: 3 Probability: 3	The project will follow a step-by-step approach, with simple and low-threshold initiatives first, and then gradually develop more complex and higher impact practices.
3	Resilience measures increase inequity in communities	Environmental and Social	Impact: 3 Probability: 2	Local level implementation through farmer and other GW user groups will ensure that resilience measures are demonstrated on the basis of participative processes which are gender-sensitive and enable participation of vulnerable and marginalized groups.
4	Political and safety situation is not supportive of field visits and working with stakeholders in pilot areas	Social, Political	Impact: 4 Probability: 1	Pilot areas have been selected with this in mind. Different pilot areas can be selected, but only if this has to be done early on in the project.
5	Technical support capabilities and budgets from the project are inadequate.	Institutional	Impact: 3 Probability: 2	The project is relying on a participative approach through its engagement with national partners and local stakeholders in the pilot areas. This will stimulate ownership and allow for collaboration with local initiatives and will muster support from national and international partners.

Table 8: Project risks and mitigation measures.

3. Project Environmental and Social Policy

The proposed project seeks to fully align with the Adaptation Fund's Environmental and Social Policy (ESP). Summarized below is the initial analysis that has been carried out to evaluate environmental and social impacts of the project versus the AF policy. Also, it indicates where steps will be taken and where further assessment is needed.

Activities under Component 1 to 5 are in general all "soft" activities. According to the Adaptation Fund's Environmental and Social Policy, "Those projects/programmes with no adverse environmental or social impacts should be categorized as Category C" (Source: Adaptation Fund Environmental and Social Policy document.) No negative environmental and social impacts, whether direct, indirect or cumulative are envisaged to arrive as a result of any of the soft activities under Components 1 to 5. Despite this, however, utmost care will be taken to ensure that no detrimental environmental or social impacts can occur.

As elaborated throughout the proposal the project specifically aims to deliver positive transboundary impacts.

The miscellaneous field activities that will be formulated in detail for the implementation of the designated pilot areas need to be scrutinized more closely. Some of these may be considered 'hard' activities, and as such have the potential, without environmental and social safeguarding and mitigation measures, to have minor negative environmental and social impacts. However, in our assessment, none of the proposed activities is expected to be in Category A or B of the Adaptation Fund's impact classification. This is because this project proposes potentially 'hard' activities that are small scale and very localized, and co-managed by local communities where possible, who have a stake in avoiding negative environmental and social impacts. This means that the potential for direct impacts is small and localized, that there can be few indirect impacts, Given this, cascading or cumulative negative impacts are also unlikely.

The checklist provided in the Adaptation Fund guidelines for project funding document has been scrutinized and is provided below.

	Checklist of environmental and social principles	No further assessment required for compliance	Potential impacts and risks – further assessment and management attention to be considered.
1	Compliance with the Law; Projects/programmes supported by the Fund shall be in compliance with all applicable domestic and international law.	X	The project's intervention and impact domain does not touch upon this principle. It will operate within the prevailing laws and regulations of the partner countries and potentially applicable international laws.
2	Access and Equity; Projects/programmes supported by the Fund shall provide fair and equitable access to benefits in a manner that is inclusive and does not impede access to basic health services, clean water and sanitation, energy, education, housing, safe and decent working conditions, and land rights. Projects/ programmes should not exacerbate existing inequities, particularly with respect to marginalized or vulnerable groups.	X √	The project's intervention and impact domain does directly touch upon this principle; Access to low-cost and stable water supply for primary livelihood and WASH purposes will be supported for all on an equal basis but priority will be given to vulnerable and low-income groups.
3	Marginalized and Vulnerable Groups: Projects/programmes supported by the Fund shall avoid imposing any disproportionate adverse impacts on marginalized and vulnerable groups including children, women and girls, the elderly, indigenous people, tribal groups, displaced people, refugees, people living with disabilities, and people living with HIV/AIDS. In screening any proposed project/programme, the implementing entities shall assess and consider particular impacts on marginalized and vulnerable groups.	X√	The project's intervention and impact domain does indirectly touch upon this principle; Vulnerable groups will be supported in their access to low-cost and stable water supply.

4	Human Rights: Projects/programmes supported by the Fund shall respect and where applicable promote international human rights.	X√	The project's intervention and impact domain does indirectly touch upon this principle; the fundamental right to water as a source for basic livelihood will be strengthened.
5	Gender Equity and Women's Empowerment: Projects/programmes supported by the Fund shall be designed and implemented in such a way that both women and men (a) have equal opportunities to participate as per the Fund gender policy; (b) receive comparable social and economic benefits; (c) receive comparable social and economic benefits; and (b) do not suffer disproportionate adverse effects during the development process.	X√	The project's intervention and impact domain will touch upon this principle; it will positively pursue and support gender equity and women's involvement through its core approach for direct stakeholder involvement in resource management.
6	Core Labour Rights; Projects/programmes supported by the Fund shall meet the core labour standards as identified by the International Labor Organization.	X	The project's intervention and impact domain does not touch upon this principle.
7	Indigenous Peoples: The Fund shall not support projects/programmes that are inconsistent with the rights and responsibilities set forth in the UN Declaration on the Rights of Indigenous Peoples and other applicable international instruments relating to indigenous peoples.	X	The project's intervention and impact domain does not touch upon this principle.
8	Involuntary Resettlement; Projects/programmes supported by the Fund shall be designed and implemented in a way that avoids or minimizes the need for involuntary resettlement. When limited involuntary resettlement is unavoidable, due process should be observed so that displaced persons shall be informed of their rights, consulted on their options, and offered technically, economically, and socially feasible resettlement alternatives or fair and adequate compensation.	X	The project's intervention and impact domain does not touch upon this principle.
9	Protection of Natural Habitats: The Fund shall not support projects/programmes that would involve unjustified conversion or degradation of critical natural habitats, including those that are (a) legally protected; (b) officially proposed for protection; (c) recognized by authoritative sources for their high conservation value, including as critical habitat; or (d) recognized as protected by traditional or indigenous local communities.	X√	The project's intervention and impact domain does indirectly touch upon this principle; the project will prioritize conservation of natural habitats when these contribute to GW recharge processes and storage (ecosystem services).
10	Conservation of Biological Diversity: Projects/programmes supported by the Fund shall be designed and implemented in a way that avoids any significant or unjustified reduction or loss of biological diversity or the introduction of known invasive species.	X	The project's intervention and impact domain does not touch upon this principle.
11	Climate Change: Projects/programmes supported by the Fund shall not result in any significant or unjustified increase in greenhouse gas emissions or other drivers of climate change.	X√	The project's intervention and impact domain does indirectly touch upon this principle;
12	Pollution Prevention and Resource Efficiency; Projects/programmes supported by the Fund shall be designed and implemented in a way that meets applicable international standards for maximizing energy efficiency and minimizing material resource use, the production of wastes, and the release of pollutants.	X√	The project's intervention and impact domain does indirectly touch upon this principle; Resource use and aquifer recharge will be developed in an energy-efficient manner and by taking utmost care for protecting existing resources from pollution.
13	Public Health: Projects/programmes supported by the Fund shall be designed and implemented in a way that avoids potentially significant negative impacts on public health.	X√	The project's intervention and impact domain does indirectly touch upon this principle; Access to low-cost and stable water supply for primary livelihood and WASH purposes will be supported.

14	Physical and Cultural Heritage; Projects/programmes supported by the Fund shall be designed and implemented in a way that avoids the alteration, damage, or removal of any physical cultural resources, cultural sites, and sites with unique natural values recognized as such at the community, national or international level. Projects/ programmes should also not permanently interfere with existing access and use of such physical and cultural resources.	X	The project's intervention and impact domain does not touch upon this principle.
15	Lands and Soil Conservation; Projects/programmes supported by the Fund shall be designed and implemented in a way that promotes soil conservation and avoids degradation or conversion of productive lands or land that provides valuable ecosystem services.	X√	The project's intervention and impact domain does directly touch upon this principle; the overall aim of the project is to support the conservation of soil and lands that provide valuable ecosystem services, such as GW recharge.

Table 9: Checklist of project's potential impacts conform guidance document for Implementing Entities on compliance with the Adaptation Fund Environmental and Social Policy.

√ = *The project is expected to generate positive impacts in this marked domain. Once the detailed workplans have been developed, in particular for the direct interventions in the four pilot areas. the project management, monitoring and evaluation approach will be updated to include verification and assessment of the anticipated positive impacts.*

4. Monitoring and Evaluation

The monitoring and evaluation (M&E) scheme of the project will be applied in accordance with established UNESCO procedures throughout the project lifetime. As MIE UNESCO Bangkok Office will ensure timeliness and quality of project implementation. The M&E plan will be implemented as summarized in Table 10. Integral management and oversight will be provided by the UNESCO project holder and the CCOP-TS project team.
The following are a number of essential ingredients for project M&E.

Project Inception: A Project Inception Workshop will be held within the first three months of project and with participation of all persons and organizations that have been assigned roles and responsibilities in the project organization. Representatives from the National Agencies, technical advisors and stakeholders from the region will contribute to the Inception Workshop. The Inception Workshop is crucial to generate momentum for project implementation and to develop the workplan for the first year of the project.

The Inception Workshop will address a number of key issues including:

a. Assist all national partners to fully understand and take ownership of the project;
b. Specify the roles, support services and complementary responsibilities of the project team and the national partners in the five countries;
c. Discuss the roles, functions, and responsibilities within the project's decision-making structures, including reporting and communication lines, and conflict resolution mechanisms;
d. Confirm the procedures and arrangement to engage project staff;
e. Based on the proposed project results framework, review and finalize the first annual workplan;
f. Verify and agree on project indicators, targets and their means of verification, and recheck assumptions and risks;
g. Provide a detailed overview of reporting, as well as M&E requirements. The M&E workplan and budget should be agreed and scheduled;
h. Discuss financial reporting procedures and obligations, and arrangements for audits; (i) Plan and schedule Project Steering Committee meetings.
i. Roles and responsibilities of all project organization structures will be clarified and meetings planned. The first Project Steering Committee meeting will be scheduled directly following the Inception Workshop.

Following the Inception Workshop, an Inception Report will be prepared as a key reference document. The Inception Report will serve as an Annex to the signed project document and shared with participants to formalize various agreements and plans decided during the meeting.

Quarterly reporting: Quarterly project progress will be monitored by UNESCO on the basis of concise project progress reports.

Comprehensive Annual Reports: Annual Project Progress Reports are comprehensive key reports which are prepared to monitor progress made since project start and in particular for the previous reporting period. The annual progress reports will include at least the following: (a) Progress made toward project objective and project outcomes - each with indicators, baseline data and end-of- project targets (cumulative); (b) Project outputs delivered per project outcome (annual); (c) Lesson learned/good practice; (d) Annual workplan and other activity and expenditure reports; (e) Risk and adaptive management. UNESCO will assess the quality of annual progress reports for completeness, comprehensiveness, analytical rigor and lessons learned.

Periodic Monitoring through site visits: UNESCO and CCOP-TS will participate in project work visit and activities on location (activities as in the agreed schedule in the project's Inception Report and Annual Work Plan) to assess first hand project progress. Members of the Project Steering Committee and Technical Advisory Group may join these visits incidentally. A Field/Activity Visit Report will be prepared by CCOP-TS for circulation no less than one month after the visit to the project team and PSC members.

Mid-term of project cycle: The project will undergo an independent Mid-Term Evaluation at the mid-point of project implementation. The Mid-Term Evaluation will determine progress being made toward the achievement of outcomes and will identify course correction if needed. It will focus on the effectiveness, efficiency and timeliness

of project implementation; will highlight issues requiring decisions and actions; and will present initial lessons learned about project design, implementation and management. Findings of this review will be incorporated as recommendations for enhanced implementation during the final half of the project's term. The organization, terms of reference and timing of the mid-term evaluation will be decided after consultation between the parties to the project document. The Terms of Reference for the Mid-term evaluation will be prepared by the UNESCO based on guidelines from the AF and in line with UNESCO's evaluation policy as updated in 2016 which calls for a minimum of 3% of project costs to be allocated to the evaluation function.

External Final Project Evaluation: An external final project evaluation will take place three months prior to the final PSC meeting. The final evaluation will focus on the delivery of the project's results as initially planned (and as corrected after the mid-term evaluation, if any such correction took place). The final evaluation will look at impact and sustainability of results, including the contribution to capacity development and the achievement of global environmental benefits/goals. The Terms of Reference for this evaluation will be prepared by UNESCO and the project management based on AF programme guidelines and in line with UNESCO's evaluation policy as updated in 2016.

Financial Audit: Project audits will follow UNESCO's financial regulations and rules and applicable audit policies. A final certified and audited financial statement will be sent to the AFB once the project is completed. The external financial audit will be conducted in line with the financial regulations, rules and directives of UNESCO.

Project Final Reports: During the last three months of the project, CCOP-TS and the implementation team will prepare the Project Final Report. This comprehensive report will summarize the results achieved (Objectives, Outcomes, Outputs), lessons learned, problems met and areas where results may not have been achieved. It will also lay out recommendations for any further steps that may need to be taken to ensure sustainability and replicability of the project's results.

Description	Responsible party	Budget (tentative) excluding staff time	Time frame
Project Inception Workshop	Project management team	15,000	Project start
Inception Report	Project management team		Two weeks after the Inception workshop
Periodic status/ progress reports	Project management team		Quarterly
Meetings of Project Steering Committee	Project management team, MIE	40,000	Two times in every year of the project
Annual Progress Reports	Project management team, MIE		End of each year
Mid-Term Evaluation	External evaluation team	36,700	End of year two
External Audit	External auditor	20,000	At project closing
External Final Evaluation	External evaluation team	110,300	Three months before the end of the project
Project final reports	Project management team and MIE		Final concept one months before the end of the project

Table 10: Project reporting and M&E arrangements. The indicative budget reservations are part of the Executive and Implementing Entity reservations. These will be reviewed during the Inception Phase.

5. PROJECT RESULTS FRAMEWORK (LOGICAL FRAMEWORK)

Program Strategy	Objectively verifiable indicators				
	Indicator	**Baseline**	**Target**	**Sources of verification**	**Assumptions and Risks**
Component 1: GW resource assessment and monitoring: to obtain and use a harmonised regional GW resource inventory supporting a regional GMS approach to address challenges of climate change and resilience, and enable an information-based policy to manage resources and further develop new GW-based resilience strategies and practical interventions.					
Outcome: A regional GMS approach to address challenges of climate change and resilience is created based on an information-based policy.	**Indicator**	**Baseline**	**Target**	**Sources of verification**	**Assumptions and Risks**
	Governments and GW expert community and users refer to this GW inventory and use it.	Governments and user groups have incomplete to severely limited knowledge of GW resources and no consistent assessment. exists	A comprehensive overview of regional GW resources (quality, quantity) is included in a neasily accessible inventory (GIS, database).	GW resources inventory tool (database and GIS) with content.	National partners are willing to provide data to be included in database.
	GW information (reports, maps, monitoring data) are used in strategies for climate resilience.	There is some GW-related data, but it is hardly used for this purpose.	GW information forms the basis for specific climate resilience measures.	Documentation and evidence for resilience measures application in the pilots.	GW system might not be suitable to support adequate measures (limited quantity, quality issues).
	Monitoring system in place and data being collected in support of operational tool.	GW seen as a static resource (basic inventories) and little or no data on temporal changes exists.	Monitoring system and information is operational and used for periodic updates.	Hard- and software, data files	Expense of periodic data collection might be too high.
	GW resources information supports further climate adaption policy at high policy levels.	Currently, GW information is hardly used.	Clear and consistent reference to GW in support of climate resilience development.	CCA policy documents with reference to GW; GW experts involved in CCA issues.	Project is able to generate tangible results with clear evidence on the ground.
Component 2: Priority use and Stakeholders: Stakeholders from different GW user sectors increasingly participate in decision-making on resource management issues and have access to information and guidelines that support more sustainable use region-wide.					
Outcome 2: GW users in different economic sectors in the GMS have access to requisite information and	**Indicator**	**Baseline**	**Target**	**Sources of verification**	**Assumptions and Risks**
	Complete pilot area demonstrations with GW users supported	Farmers and other users deplete GW resources regardless of CCA challenges.	Multiple users aware of and supported with resource management information and	Attendance of users in resource management meetings/training; guidelines for different	GW users sufficiently aware of CCA challenges.

guidelines and thus participate in GW management.	with information to strengthen adaptation options without depleting limited resources.		guidelines; support available in transboundary regions.	water use sectors documented with breakout by sex.	
	GW information is regionally coherent and sufficient to attract interest from users	Information on GW potential is not tangible enough to motivate users to adopt and apply it.	Supporting national partners dedicated to provide users (in-country and transboundary) with adequate information.	Information products and guidelines published and circulated.	National partners sufficiently enabled to achieve the objectives and targets for the transboundary aquifer system.
Component 3: Resource management, information tools and equipment: will support greater resilience and more sustainable GW resource use, with protection of low income and vulnerable user groups; resource management methodology supports better transboundary GW policies that are more robust and climate change ready.					
Outcome 3: Climate resilience and GW use in pilot countries is increased, and low income and other vulnerable groups' needs are prioritized.	**Indicator**	**Baseline**	**Target**	**Sources of verification**	**Assumptions and Risks**
	Low income and vulnerable groups apply GW based resilience measures.	Next to basic resource inventories (GW maps) there is no tailored information to support sustainable resource use or specific measures to support resilience.	Greater resilience and sustainable GW resource use, enabling low income and vulnerable user groups to use GW resources optimally when needed.	Practices of farmers and other user groups that apply resilience measures	Differences in quality of GW system management may be too large to solve within the timeframe of the project.
	Improved exchange of information on transboundary GW management issues.	No transboundary cooperation, incompatible resource inventories, no communication.	Joint and coordinated efforts to use information and tools for monitoring to develop and apply GW management	Database, multi-language information products, shared management tools.	Investments in monitoring equipment may be too costly
	Suite of tools, methods etc. have been prepared		Comprehensive information, tools and methods developed and applied		Underlying data availability may be insufficient to develop useful information products.

Component 4: Regional cooperation, coordination and information exchange will result in the development of a regionally coherent policy for climate adaptation through sustainable GW resource management, a level playing field for GW users from all sectors throughout the region and efficiency gains through a common approach and collaborative support tools.					
Outcome 4: A regionally coherent policy for sustainable GW management in support of CCA is adopted based on a level playing field of all users in the GMS.	**Indicator**	**Baseline**	**Target**	**Sources of verification**	**Assumptions and Risks**
	Multi-country or bilateral arrangements to support and oversee GW management in support of climate resilience objectives.	Despite common CCA challenges countries in the region do not optimally share practices, knowledge and resources	Regionally coordinated GW use contributes to regional, cross-border climate resilience for food production, rural water supply, etc.	Multi-country or bilateral consensus documented in policy documents and similarities in approach.	Bilateral relations or specific resource conflicts may be too serious to overcome.
	Regional coordination recognizes different vulnerabilities and needs of different users.	Vulnerable groups in the region and suffer from detrimental impact of resource depletion and increasing climate change vulnerabilities.	Collaborative transboundary approach to protect limited resources and support vulnerable groups.	Database, multi-language information products, shared management tools.	Project is able to transfer the results of regional pilots to higher policy levels.
Component 5: Capacity building and training will enhance the internal capacity of the GW community of experts in the GMS region to develop and contribute to CCA policy and practical resilience enhancing interventions, to use state-of-the-art tools and work with stakeholders and vulnerable groups.					
Outcome 5: GMS stakeholders capably use project tools on GW use for CCA and resilience.	**Indicator**	**Baseline**	**Target**	**Sources of verification**	**Assumptions and Risks**
	A CoP on user-oriented GW management is active	Within the region different national groups work on rather different knowledge levels and there is little bi- or multilateral cooperation.	CoP of GW experts is able to contribute to CCA policy and practical resilience enhancing interventions.	Proceedings of meetings and collaborative products, joint statements.	proposed interaction may not evolve to a higher, more effective level.
	GW experts participate in regular capacity building and knowledge transfer activities.	Although there are regional network meetings there is little coordinated effort to	Through regional cooperation GW experts have reached a higher and collaborative knowledge and impact level.	General academic level within CoP is raised significantly (more PhDs, more MScs).	There is sufficient support and funding within the region to sustain the envisaged regional collaboration.

	GW CoP is actively engaged with different stakeholder groups and provides tailored information.	improve overall impact level. As above	GW CoP is regionally active and able to contribute effectively to different GW system, sustainability or CCA challenges.	CoP is visible with contributions and input in the regional CCA debate and multilateral coordination processes.	Risk: The regional CCA debate may be dominated by other groups.

6. ALIGNMENT WITH ADAPTATION FUND RESULTS FRAMEWORK

Groundwater resources in the Greater Mekong Sub-region: Collaborative management to increase resilience

A collaboration of Vietnam, Lao PDR, Cambodia, Thailand and Myanmar to increase climate resilience in the greater Mekong Sub-region through improved GW management and transboundary cooperation

Alignment of Project Objectives/Outcomes with Adaptation Fund Results Framework

Project Objective(s)[9]	Project Objective Indicator(s)	AF Fund Outcome	AF Fund Outcome Indicator	Grant Amount (USD-indicative)
GW resources management is improved, thus increasing the CCA and resilience of GMS countries to protect people, livelihoods and ecosystems.	Over 25 partnerships and active collaboration set up to support GW management capabilities that strengthen resilience and reduce detrimental climate change impacts. Over 50 regional experts support institutional capacity in 5 countries (male/female = 60/40). Over 250 participants have increased awareness and skills on climate related impacts (male/female = 60/40).	**Outcome 2:** Strengthened institutional capacity to reduce risks associated with climate-induced socioeconomic and environmental losses.	2.1.1. Number of staff trained to respond to, and mitigate impacts of, climate-related events (by gender). 2.1.2 Number of targeted institutions with increased capacity to minimize exposure to climate variability risks (by type, sector and scale).	2,500,000
GW users in different economic sectors in the GMS have access to requisite information and guidelines and thus participate in GW management.	In four pilot areas at least two different local GW users' groups are capacitated to use ground-water sustainably for adaptation and climate risk reduction measures. Higher management is also aware and involved.	**Outcome 3:** Strengthened awareness and ownership of adaptation and climate risk reduction processes at local level.	3.1. Percentage of targeted population aware of predicted adverse impacts of climate change, and of appropriate responses. 3.2. Percentage of targeted population applying appropriate adaptation responses.	2,400,000
Project Outcome(s)	**Project Outcome Indicator(s)**	**Fund Output**	**Fund Output Indicator**	**Grant Amount (USD-indicative)**

[9] The AF used OECD/DAC terminology for its results framework. Project proponents may use different terminology but the overall principle should still apply

A regional GMS approach to address challenges of climate change and resilience is created based on an information-based policy.	Greater GW management services made more responsive through improved resource assessments, management capability and information tools and human resources capacity in the sector. Greater water and specifically GW management services and supporting hard and soft infrastructure (policy and guidelines, database, monitoring systems, MAR systems) have been improved towards higher adaptive capacity.	**Outcome 4:** Increased adaptive capacity within relevant development sector services and infrastructure assets.	4.1. Responsiveness of development sector services to evolving needs from changing and variable climate. 4.1.1. Number and type of development sector services modified to respond to new conditions resulting from climate variability and change (by sector and scale).	1,000,000
Climate resilience and GW use in pilot countries is increased, and low income and other vulnerable groups' needs are prioritized.	Vulnerable people in four pilot areas and five countries will be able to rely on improved water management in support of livelihoods and other water needs.	**Outcome 6:** Diversified and strengthened livelihoods and sources of income for vulnerable people in targeted areas	6.1 Percentage of households and communities having more secure access to livelihood assets. 6.2. Percentage of targeted population with sustained climate-resilient alternative livelihoods.	1,000,000 800,000
A regionally coherent policy for sustainable GW management in support of CCA is adopted based on a level playing field of all users in the GMS.	Local interventions and guidelines (at least 3 in each pilot area) support resilience measures that are upscaled to national policies and guidelines. Regional (5 countries) and transboundary cooperation in pilots will generate at least 15 risk policies/guidelines.	**Outcome 7:** Improved policies and regulations that promote and enforce resilience measures.	7.1. Number of policies introduced or adjusted to address climate change risks (by sector).	500,000
Project Outcome(s)	**Project Outcome Indicator(s)**	**Fund Output**	**Fund Output Indicator**	**Grant Amount (USD-indicative)**

GMS stakeholders capably use project tools on GW use for CCA and resilience.	Number of partnerships and active collaboration set up to support GW management capabilities that strengthen resilience and reduce detrimental climate change impacts.	**Outcome 1:** Reduced exposure to climate-related hazards and threats.	1.1 Number of projects/ programmes that conduct and update risk and vulnerability assessments by sector and scale.	800,000
	Over 50 regional experts support institutional capacity in 5 countries (male/female = 60/40). Over 250 participants have increased awareness and skills on climate related impacts (male/female = 60/40).	**Outcome 2:** Strengthened institutional capacity to reduce risks associated with climate-induced socioeconomic and environmental losses.	2.1.1. Number of staff trained to respond to, and mitigate impacts of, climate-related events (by gender). 2.1.2 Number of targeted institutions with increased capacity to minimize exposure to climate variability risks (by type, sector and scale).	

7. Project budget

This technical project proposal is accompanied by a comprehensive budget proposal, following Adaptation Fund guidelines. The budget is available in **Annex II** (Excel format). Soft copies can be provided on request.

Project budgets (Excel sheets annexed)
Sheet 1: Summary project budget
Sheet 2: Breakdown of the project execution costs (CCOP-TS)
Sheet 3: Implementing Entity (MIE) management fee (UNESCO)
Sheet 4: Budget disbursement schedule with time-bound milestones.
Sheet 5: Detailed project budget, Excel format (Annex)

In this main document we present summaries of the different budget sheets

Sheet 1: Summary project budget

No.	Description	Budget (US $)
1.	Programmatic costs, Component 1 - 5	4,200,000
2.	Execution Costs (CCOP-TS) @ 8.5 %	357,000
3.	Subtotal	4,557,000
4.	Management fee MIE @ 7.5 % of Subtotal	341,775
5.	**Total Project budget**	**4,898,775**

Sheet 2: Breakdown of the Project Execution Costs (CCOP-TS)

No.	Description	Budget (US $)
1.	Project Coordinating Technical Advisor	180,000
2.	CCOP-TS Support staff	90,000
3.	Operational costs	40,000
4.	Project related regional travel	26,000
5.	External services (website, accountant)	21,000
	Total	**357,000**

Sheet 3: Budget for the Implementing Entity (MIE, UNESCO) management fee.

No.	Description	Budget (US $)
1.	General programme implementation support	224,000
2.	Finance, budget and treasury support	46,000
3.	Reporting to Adaptation Fund, M&E	210,000
4.	Project related regional travel	25,687
5.	Operational costs, publications costs	26,866
6.	External services (procurement, accountant)	21,222
	Total	**592,775**

Sheet 4: Budget disbursement schedule with time-bound milestones.

	Upon Agreement signature	One Year after Project Start[a/]	Year 2[b/]	Year 3	Year 4	**Total (US $)**
Scheduled Date	15-02-2017	15-02-2018	15-02-2019	15-02-2020	15-01-2021	
Project Funds	25 %	25 %	20 %	20 %	10 %	100 %
Implementing Entity Fee	30%	20 %	20 %	20 %	10 %	100 %
Total	**1,241,782**	**1,207.605**	**979,755**	**979,755**	**489,878**	**4,898,775**

[a/]Use projected start date to approximate first year disbursement
[b/]Subsequent dates will follow the year anniversary of project start
[c/]Add columns for years as needed

PART IV: ENDORSEMENT BY GOVERNMENTS AND CERTIFICATION BY THE IMPLEMENTING ENTITY

A. Record of endorsement on behalf of the government:

Cambodia: Mr. Tin Ponlok, Secretary General, NCSD/Ministry of Environment	Date*: 6 June 2016*
Lao PDR: Mr. Syamphone Sengchandala Department of Disaster Management and Climate Change (DDMCC), Ministry of Natural Resources and Environment	Date*: 14 July 2016*
Myanmar: H.E Ohn Winn U Win Tun, Union Minister, Ministry of Natural Resources and Environmental Conservation and Forestry and Chairman of the Environmental Conservation Committee	Date*: 31 May 2016*
Thailand: Mr. Kasemsun Chinnavaso, Permanent Secretary, Ministry of Natural Resources and Environment	Date*: awaiting for letter*
Viet Nam: Dr. Tran Hong Ha, Deputy Minister Ministry of Natural Resources and Environment	Date*: July 2016*

B. Implementing Entity certification

I certify that this proposal has been prepared in accordance with guidelines provided by the Adaptation Fund Board, and prevailing National Development and Adaptation Plans (Lao PDR and Vietnam) and subject to the approval by the Adaptation Fund Board, commit to implementing the project/programme in compliance with the Environmental and Social Policy of the Adaptation Fund and on the understanding that the Implementing Entity will be fully (legally and financially) responsible for the implementation of this project/programme.	
Name and Signature Implementing Entity Coordinator: **GWANG-JO KIM** DIRECTOR UNESCO BANGKOK	
Date: **1 August 2016**	Tel. and email:+66-3918474; gj.kim@unesco.org
Project Contact Person: **RAMASAMY JAYAKUMAR**	
Tel. and Email: +66-2-3910577 X 163 ; r.jayakumar@unesco.org	

KINGDOM OF CAMBODIA
Nation Religion King

Ministry of Environment
N° : 615 MoE

Phnom Penh, 6 June 2016

Letter of Endorsement by Government

To: The Adaptation Fund Board
c/o Adaptation Fund Board Secretariat
Email: Secretariat@Adaptation-Fund.org
Fax: 202 522 3240/5

Subject: **Endorsement for Groundwater resources in the Greater Mekong Subregion; collaborative resource management to increase resilience**

In my capacity as designated authority for the Adaptation Fund in Cambodia, I confirm that the above regional project proposal is in accordance with the Royal Government of Cambodia national priorities in implementing adaptation activities to reduce adverse impacts of, and risks, posed by climate change in Cambodia.

Accordingly, I am pleased to endorse the above project proposal with support from the Adaptation Fund. If approved, the project/programme will be implemented by UNESCO and executed by relevant country agencies, namely the Ministry of Water Resources and Meteorology and the Ministry of Mines and Energy with technical support and coordination from Coordinating Committee for Geosciences Programme (in East and Southeast Asia)-CCOP, International Water Management Institute (IWMI), and International Groundwater Resources Assessment Centre (IGRAC).

Sincerely,

Tin Ponlok
Secretary General,
NCSD/Ministry of Environment

The Lao's People Democratic Republic
Peace Independent Democratic Unity Prosperity

Ministry of Natural Resources and Environment
Department of Disaster Management and Climate Change (DDMCC)

Vientiane Capital, Date..14.. July 16

To: The Adaptation Fund Board
c/o Adaptation Fund Board Secretariat
Email: Secretariat@Adaptation-Fund.org
Fax: 202 522 3240/5

Subject: **Endorsement for Groundwater resources in Greater Mekong Sub-region: Collaborative management to increase resilience**

In my capacity as designated authority for the Adaptation Fund in Lao PDR, I confirm that the above regional project proposal is in accordance with the Government of Lao PDR national priorities in implementing adaptation activities to reduce adverse impacts of, and risks, posed by climate change in Lao PDR.

Accordingly, I am pleased to endorse the above project/programme proposal with support from the Adaptation Fund. If approved, the project/programme will be implemented by UNESCO and executed by relevant country agencies, namely the Ministry of Natural Resources and Environment (MoNRE) through the Natural Resources and Environment Institute (NREI), with technical support and coordination from Coordinating Committee for Geosciences Programme (in East and Southeast Asia) – CCOP, International Water Management Institute (IWMI), and Internaitonal Groundwater Resources Assessment Centre (IGRAC).

Yours sincerely,

Mr.Syamphone SENGCHANDALA

Designed Authority for the Adaptation Fund of Lao PDR

THE REPUBLIC OF THE UNION OF MYANMAR
MINISTRY OF NATURAL RESOURCES AND ENVIRONMENTAL CONSERVATION

Ref No. (F)6(1)/01(I)/(1826 / 2016)
Date 31st May, 2016

To

The Adaptation Fund Board
c/o Adaptation Fund Board Secretariat
Email: Secretariat@Adaptation-Fund.org
Fax: 202 522 3240/5

Subject: **Endorsement for Groundwater Resources in the Greater Mekong Sub-region: Collaborative Resource Management to Increase Resilience Proposal**

In my capacity as designated authority for the Adaptation Fund in the Republic of the Union of Myanmar, I confirm that the above national project proposal is in accordance with the government's national priorities in implementing adaptation activities to reduce adverse impacts of, and risks, posed by climate change in the country.

Accordingly, I am pleased to endorse the above project proposal with support from the Adaptation Fund. If approved, the project will be implemented by the Ministry of Agriculture, Livestock and Irrigation and executed by Irrigation and Water Utilization Management Department of Myanmar's Ministry of Agriculture, Livestock and Irrigation.

Sincerely,

Ohn Winn
Union Minister
Ministry of Natural Resources and Environmental Conservation
Chairman of the Environmental Conservation Committee
Building No. 28
Nay Pyi Taw, Myanmar

SOCIALIST REPUBLIC OF VIET NAM
MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT

Ha Noi, ... July 2016

The Adaptation Fund Board
c/o Adaptation Fund Board Secretariat
Email: Secretariat@Adaptation-Fund.org

Subject: Endorsement for the Project Proposal on "Groundwater resources in the Greater Mekong Sub-region: collaborative management to increase resilience"

In my capacity as Designated Authority for the Adaptation Fund in the Socialist Republic of Viet Nam, I confirm that the above regional project proposal is in accordance with the government's priorities in implementing adaptation activities to reduce adverse impacts of, and risks, posed by climate change in the Socialist Republic of Viet Nam, which is part of the Greater Mekong Sub-region.

Accordingly, I am pleased to endorse the above project proposal with support from the Adaptation Fund. If approved, the project will be implemented by UNESCO and executed by National Centre for Water Resources Planning and Investigation - Ministry of Natural Resources and Environment of Viet Nam.

Yours sincerely,

Dr. Tran Hong Ha
Minister of Natural Resources and Environment
Socialist Republic of Viet Nam

Address: 10 Ton That Thuyet street, South Tu Liem district, Ha Noi, Viet Nam
Tel: +84 4 37956868, Fax: +84 4 38359221, E-mail: icd-monre@monre.gov.vn, Website: http://www.monre.gov.vn

Annexes

Annex I: Comprehensive characterization of the proposed four pilot areas

Annex II: ADB case study brochure on improved water management and climate change in Vietnam

Annex III: Background information on UNESCO’s GRAPHIC programme (Groundwater Resources Assessment under the Pressures of Humanity and Climate Change)

Annex IV: Detailed budget and budget Excel sheets

URGENT

No. 1006.3/ 1905

Ministry of Natural Resources and Environment
92 Soi Phahol Yothin 7, Phahol Yothin Road,
Samsen-Nai, Phayathai, Bangkok 10400
THAILAND

29 July B.E. 2559 (2016)

To Adaptation Fund Board,

Subject: Endorsement for Groundwater Resources in the Greater Mekong Subregion: Collaborative Resource Management to increase Resilience

In my capacity as designated authority for the Adaptation Fund in Thailand, I confirm that the above regional project proposal, a collaboration of Cambodia, Lao PDR, Myanmar, Thailand and Vietnam is in accordance with the government's national and subregional priorities in implementing adaptation activities to reduce adverse impacts of, and risks, posed by climate change in the Mekong Region. This project would like to receive the financial support of USD 4,898,775 for 4 years.

Accordingly, I am pleased to endorse the above project proposal with support from the Adaptation Fund. If approved, the proposal will be coordinated and implemented by UNESCO and executed by Department of Groundwater Resources with technical support and coordination from Coordinating Committee for Geosciences Programme in East and Southeast Asia (CCOP) International Water Management Institute (IWMI) and International Groundwater Resources Assessment Center (IGRAC).

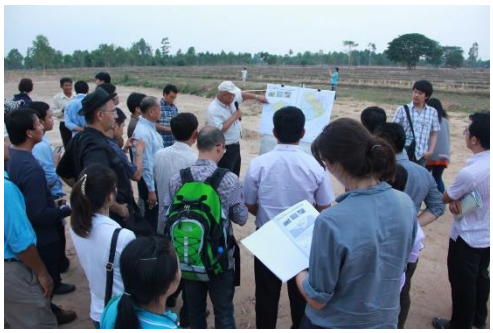
Yours Sincerely,

(Kasemsun Chinnavaso Ph.D.)
Permanent Secretary
Ministry of Natural Resources and Environment

c/o Adaptation Fund Board Secretariat
1818 H Street NW, Washington DC 20433, USA
Email: Secretariat@Adaptation-Fund.org
Fax: 202 522 3240/5

Groundwater resources in Greater Mekong Sub-region: Collaborative management to increase resilience

A collaboration of Vietnam, Lao PDR, Cambodia, Thailand and Myanmar to increase climate resilience in the greater Mekong Sub-region through improved groundwater management and transboundary cooperation

United Nations Educational, Scientific and Cultural Organization

International Hydrological Programme

COORDINATING COMMITTEE FOR GEOSCIENCE PROGRAMMES IN EAST AND SOUTHEAST ASIA (CCOP)

IWMI International Water Management Institute

IWMI is a member of the CGIAR Consortium and leads the:

CGIAR RESEARCH PROGRAM ON Water, Land and Ecosystems

igrac International Groundwater Resources Assessment Centre

Annexes

Annex I: Comprehensive characterization of the proposed four pilot areas

Annex II: ADB case study brochure on improved water management and climate change in Vietnam

Annex III: An overview of UNESCO water related project references (recent projects)

Annex IV: Background information on UNESCO's GRAPHIC programme (Groundwater Resources Assessment under the Pressures of Humanity and Climate Change)

Annex V: Detailed budget and budget Excel sheets

Groundwater resources in the Greater Mekong Sub-region: Collaborative management to increase resilience

A collaboration between Vietnam, Lao Peoples' Democratic Republic, Cambodia, Thailand and Myanmar to increase climate resilience in the greater Mekong Sub-region through improved groundwater management and transboundary cooperation

Annex I: Comprehensive characterization of the proposed four pilot areas

Table 1: Overview with summary data on four proposed pilot areas

	PILOT SITE 1 Lao PDR-Thailand	PILOT SITE 2 Vietnam-Cambodia	PILOT SITE 3 Cambodia-Thailand	PILOT SITE 4 Myanmar Dry Zone
Location	Vientiane Plain (VP) (area ~4,500 km^2)	Upper Mekong Delta, border provinces in Vietnam and Cambodia	Western Cambodia-Thai border area	Yinmabin, Sagaing, Myanmar Dry Zone (area ~900 km^2)
Rainfall/Climate zone	2,000 mm/yr Tropical Dry	1700 mm/yr Humid Subtropical	1400-2000 mm/yr Tropical Dry	800-1100 mm/yr Tropical Dry
Population density and projected growth	Average to high	Very high	Average	Average
Major land use	Paddy, vegetable crops, forest, urban	Paddy, vegetable crops, cities and villages	Paddy, vegetable crops, forest,	Paddy, vegetable crops (smallholders)
Aquifer type	Alluvium bounded by sandstone on margins and at depth	Alluvium, at depth older, semi-consolidated river deposits (sand and clay)	Thin alluvium, sandstones	Artesian system. Poorly cemented sand and gravel overlain by sand to clay alluvium
Recharge rates	200-400 mm/yr (approx.)	Vietnam: 300 mm/yr Cambodia: not known	Thailand: 200 mm/yr Cambodia: not known	Not known
Interactions with surface water	GW drains to rivers which are affected by hydropower operations; infiltration from small reservoirs and ponds	GW recharge from river channels with high/low seasonal flow; infiltration from small reservoirs and ponds	Recharge from small rivers, ponds, small reservoirs; GW drains to rivers and Tonle Sap lake	GW recharged from rainfall in ranges to west, and possibly seepage from Yama dam
Current abstraction	Relatively low	High to extremely high, deep tube wells and shallow wells	Low (Cambodia) and modest to high in Thailand	High – >1400 tube wells in area ~300 sq miles
Major purposes for abstraction	Domestic, emerging agriculture, small industry (packaged water, salt production)	Irrigation, village supply, city water supply, minor industry	Small scale irrigation, village supply	Irrigation, village supply
Water quality	Salinity (natural), fecal contamination	Good, some concern about arsenic levels, pesticide etc. pollution from surface water	Good, some concern about arsenic levels, microbial pollution at GW points	Generally good (possibly some problems with salinity in the upper aquifer)
Transboundary issues	Recharge from Mekong River and connectivity with adjacent Thai aquifers	Integrated resource management by Cambodia – Vietnam authorities; recharge from Mekong River (floods); pollution threats	Contrast between Thailand and Cambodia regions in utilization of resource; very limited management in Cambodia	None
Major issues/threats GW for climate resilience	Expansion of GW use, for irrigation and domestic use, rapid urbanization, poor oversight of potential large extractions	Overall volume of extractions, decreasing recharge; implications of extraction and lower recharge for shallow domestic wells and downstream replenishment of aquifer	Non-sustainable use in Thailand; undervalued resource in Cambodia; management capabilities and better alignment with user needs	Drawdown and fluctuation of artesian water levels. Concern about wastage from free-flowing boreholes. Unregulated expansion of private wells.

Pilot area 1: Mekong River riparian and transboundary aquifers-Vientiane Plains, Lao PDR

Proposed pilot area location:
Vientiane Plain (VP), 4,500 km^2 area extending across all or parts of Vientiane Capital, Vientiane and Bolikhamxay provinces, population around 800,000 people. The area directly borders the Mekong river.

Site characteristics:
Vientiane Plain is underlain by alluvial infill overlying sandstone/siltstone with outcropping or buried rocksalt (part of the Khorat Plateau system in adjacent Thailand with very similar aquifers). Groundwater serves domestic purposes (most villages and some urban residential), agriculture (small scale irrigation and livestock), industry (packaged water drinking suppliers, and limited harvesting of rocksalt from saline reserves). Transboundary implications of deep GW systems are poorly understood, and not considered for management (unlikely for phreatic aquifer). The same may be said of interaction of GW systems with Mekong River surface water.

Rationale for selection:
This is one of the larger and perhaps most economically important lowland plains in Lao PDR, and the most intensively studied GW resource in the country. A rudimentary monitoring network was set up in 2014; the areas is easily accessible from Vientiane.

GW activities carried out in the Vientiane Plain to date:
GW resources have been studied by various means: regional drilling investigations, resistivity surveys, recharge and discharge estimation studies, water quality assessments, GW use perception study, participatory management study, community GW irrigation scheme setup and evaluated, GW model constructed, GW Management for upper Vientiane Plain was initiated.

Proposed partnerships and roles:
Natural Resources and Environment Institute (NREI) – GW model development and scenario testing:
Department of Water Resources, Groundwater Management Divisions (DWR-GMD) – management plan formulation including stakeholder engagement
National University of Laos, Faculty of Water Resources (NUOL-FWR) – local scale resource assessments and modelling
National University of Laos, Faculties of Sciences, Engineering and of Environmental Sciences with graduate student project on GW related topics.

Linkages to current capacity building efforts

1) New PhD project on recharge estimation for lower Nam Ngum sub-basin starting in 2017 (NGRTC)
2) MSc study at Hiroshima University by Lao PDR, MONRE, Department of Water Resources Management staff on village level GW quality due for completion before end of year
3) Australia's AVID support to further develop curriculum in IWRM and Groundwater at National University of Laos, Faculty of Water Resources

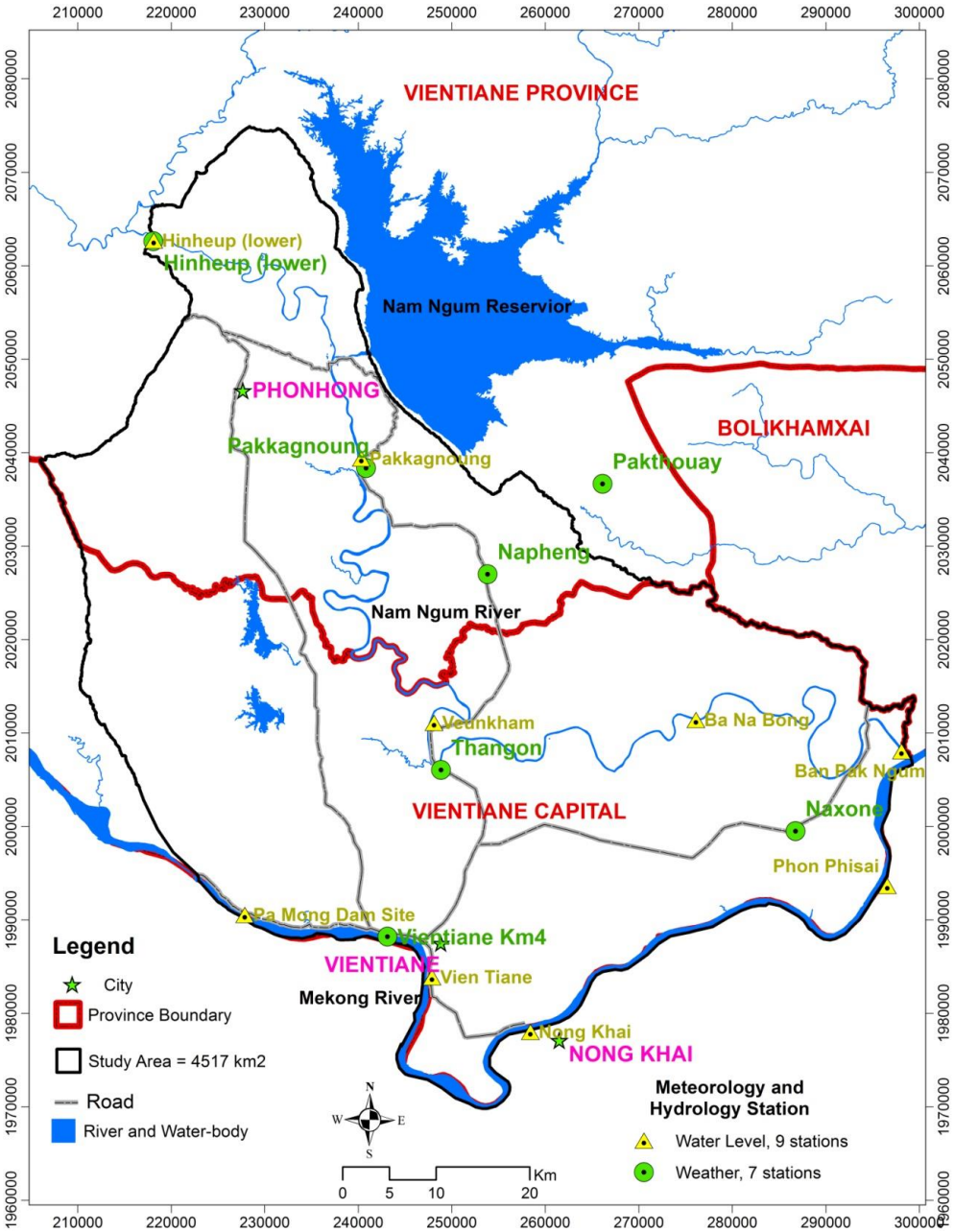
Publications and other resources

1. http://gw-laos.iwmi.org/
2. Suhardiman, D., Pavelic, P., Giordano, M. and Keovilignavong, O. (forthcoming) Agricultural groundwater use in the Vientiane Plains: Farmers' perceptions of opportunities and constraints. Human Ecology J.

Proposed Activities
In addition to the proposed and described project activities several focused activities will be carried out by the AF project consortium, in collaboration with local partners.

No.	Topic	Partners
1	GW management planning (GW use inventory, stakeholder consultations, tailoring GW regulations, decision support tool development, awareness raising).	DWR supported by IWMI & NREI
2	GW planning tool refinement and scenario testing	NREI supported by IWMI or KKU
3	Participatory GW management in alluvial areas	IWMI supported by DWR

Overview of the area



Pilot area 2: Upper Mekong Delta Transboundary Aquifers (Vietnam + Cambodia)

Proposed pilot area location:
Upper Mekong Delta region in Vietnam and adjacent lowlands adjacent to Mekong river in Cambodia, 12,000 km^2 area with a population of an estimated four million people. The area is part of major aquifers fed by the Mekong River system.

Site characteristics:
Subtropical lowland river plain with main channels of Bassac and Mekong Rivers, intensively used for paddy rice and food crop cultivation. Mekong and Bassac River waters intensively used for irrigation and water supply, but in the dry season increasing use of shallow and deep GW from dug wells, shallow and intermediate boreholes. Seasonal floods play a crucial role in natural replenishment of Cambodia and Vietnam Mekong Delta aquifers, but the flooding patterns are strongly affected by changing climate and upstream river developments. At the same time, dependency on reliable and good water supply for food production and domestic use is increasing.

Transboundary implications of deep GW systems are poorly understood, and not considered for management (unlikely for phreatic aquifer). The same may be said of interaction of GW systems with Mekong river surface water.

Rationale for selection:
This one of the largest and perhaps most economically important transboundary aquifer systems in the Lower Mekong Sub-region. The importance of long-term supply of GW (quantity and quality) for food production, both in Cambodia and in southern Vietnam, cannot be overemphasized. The dynamics of the system are explicitly transboundary, while also the effects of regional developments (such as dam construction, flood control and diversion of Mekong River waters and the development of the Ton Le Sap basin) are complex and most likely considerable.

Groundwater activities carried out in the upper Mekong Delta to date:
Groundwater resources are being exploited and studied quite intensively by provincial government organisations on both sides of the border. In Vietnam this is partly executed and supported by DWRPIS. In Cambodia government policy on GW is not very well developed and there is very limited capacity to engage in active and focused interventions.

Proposed partnerships and roles:
Vietnam's NAWAPI (MONRE) institute and its southern branch, the Division for Water Resources Planning and Investigation in the South of Vietnam (DWRPIS). In view of the situation in Cambodia, the execution of the activities in this pilot area will need substantial support from international experts.

Linkages to current capacity building efforts
There is an unique opportunity to apply and learn from the well-developed GW system knowledge and data management in the Vietnamese provinces for the rather poorly monitored and studied Cambodian aquifers. The Vietnamese experience includes the ongoing efforts to develop IWRM-based approaches to address climate change threats and long-term water supply strategies. The project is a first to address GW oriented resource management issues in the transboundary area with inclusion of knowledge transfer, capacity building and regional cooperation.

Publications and other resources
Various DWRPIS reports and publications by DWRPIS

1. Erban, L. S.M. Gorelick & H.A. Zebker, 2014; Groundwater extraction, land subsidence and sea-level rise in Mekong Delta, Environ. Res. Lett. 9.
2. The Mekong Delta System: Interdisciplinary Analysis of a River Delta, F.G. Renaud and Claudia Kuenzer (eds.), Springer 2012, pp. 463; incl.: Frank Wagner, Vuong Bui Tran and F.G. Renaud; Groundwater Resources in the Mekong Delta: Availability, Utilization and Risks, pp. 201-220.
3. Climate Change Adaptation Planning for Urban Water Supply in Soc Trang Province, Dierks, R, 2016, Conference paper

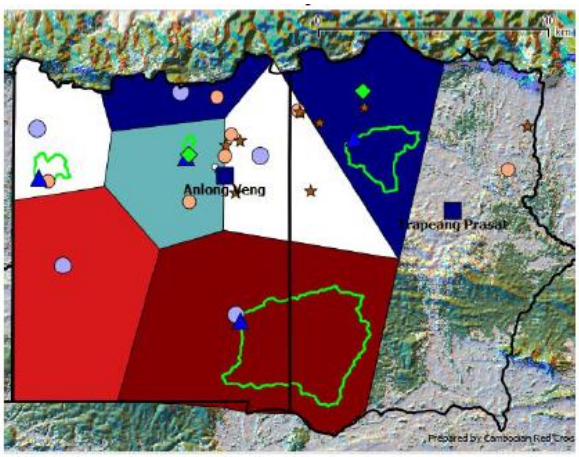
Proposed activities within the overall project approach
In addition to the proposed and described project activities several focused activities will be carried out by the AF project consortium, in collaboration with local partners.

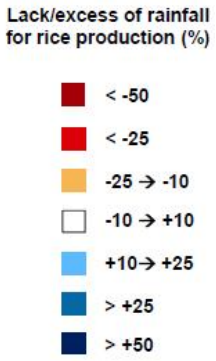
No.	Topic	Partners
1	Setting up a system of joint GW monitoring; supporting the GW monitoring capabilities in Cambodia	Project, with support of DWRPIS, Vietnam, Cambodia partners
2	Inventory and quantification of GW abstractions and use by different sectors; starting dialogue with main stakeholders	Project, with support of DWRPIS, Vietnam, Cambodia partners
3	Preliminary orientation on resilience enhancing measures in the framework of integrated surface-GW management	Project, with support of DWRPIS, Vietnam, Cambodia partners

Pilot area 3: NW Cambodia – Eastern Thailand border area

Proposed pilot area location:

Site characteristics:
The area is characterized by modest rainfall and a distinct dry season. Increasingly, due to climate change effects, monsoonal rains are late and come in the form of intensive cloudbursts, leading to flooding. Groundwater system are poorly studied, but it is well known that GW use for domestic and agriculture irrigation purposes is widespread. There is a significant water deficiency in the second half of the dry season, increasing pressures on GW use. Measures for recharge and storage are considered.





Regional water deficiencies occur in parts of northwest Cambodia (May 2013 situation). At the same time there is a water surplus in upstream catchments. Integrated surface-GW management and GW recharge can significantly contribute to climate resilient rural land use.

Rationale for selection:
Vulnerability of rural population; potential to increase sustainable GW use in support of rural livelihoods, food production and rural domestic water supply; significant potential to increase climate change resilience on the basis of improved and more sustainable GW management

Groundwater activities carried out in the area to date
Experts of Khon Kaen Groundwater Research Centre (Thailand**)** compiled the hydrogeologic units of Changwat Province and Sakaeo Province that forms a part of the Siem Reap hydrologic basin (see overview map). Inventories were also made of drill well locations in the border area, on the basis of several data bases from Thai Government offices. For the Thailand side, there is rather comprehensive information regarding surface- and GW resources and wells as shown in the map as well as other relevant data, e.g. land use, soils, communities, etc. Mostly rural population in the border area and the rural districts down to Ton Le Sap rely on GW resources (with several water wells in every village). The aquifer is meta-sedimentary aquifer, but with a rather variable GW potential across the region. It is assumed that similar

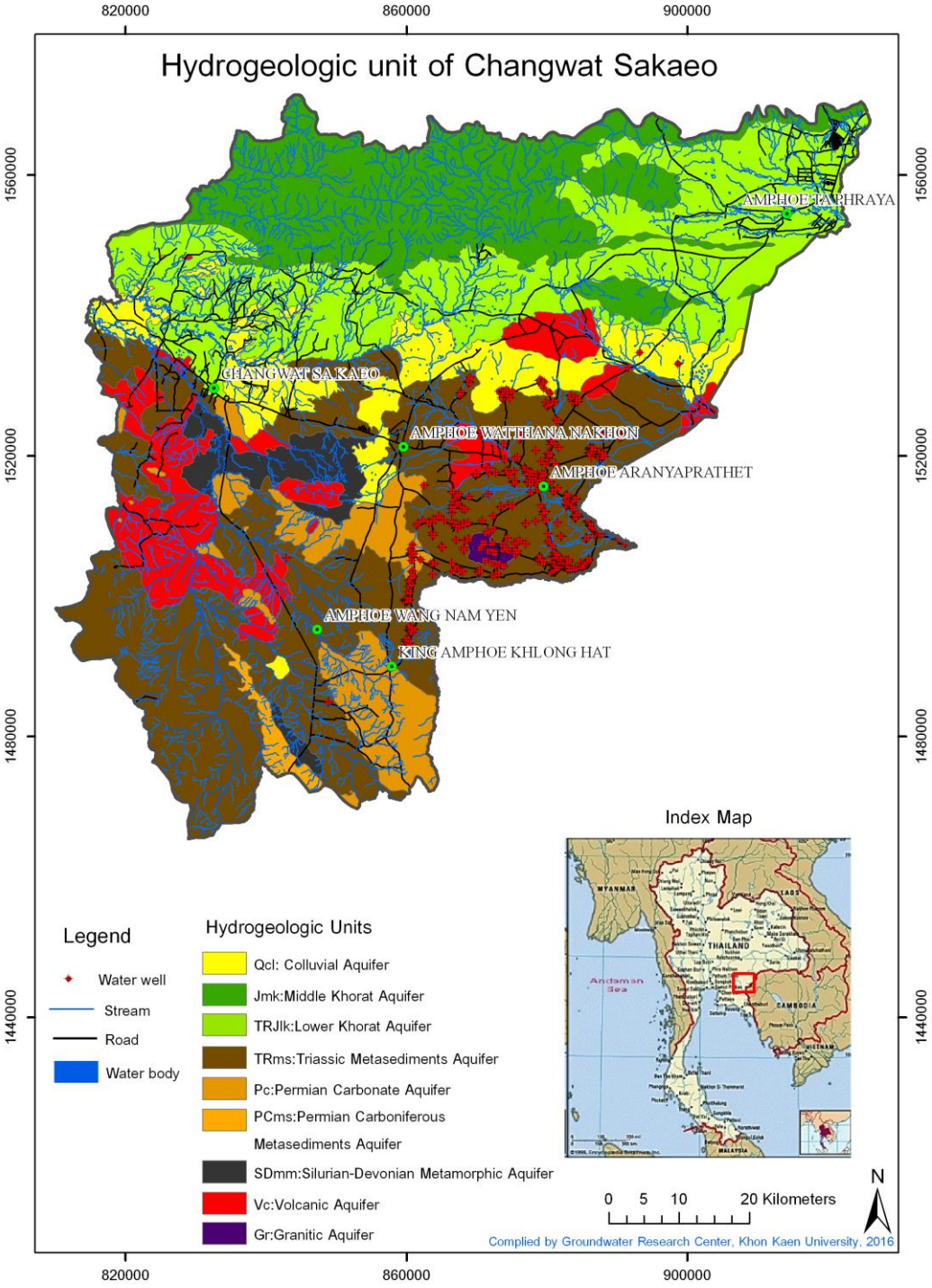
aquifer systems extend across the border area in both Thailand and Cambodia and that transboundary relationships occur.

Proposed partnerships and roles
In line with the concept of the project the activities in this pilot are will emphasize transboundary (Thai-Cambodia) cooperation and learning, focusing on improved assessment and monitoring of potential GW resources, determining user needs and resilience potential of regional agricultural land use systems on the basis of enhanced GW use. The envisaged partnership will preferably be at user and local level (districts), provinces) emphasizing building up capacity where it is needed and utilized. These activities will be supported by the international and regional expert teams under the project.

Linkages to current capacity building efforts
The project will use results from earlier GW studies in Cambodia, but in the designated region very little has been done.

Proposed Activities within the overall project approach
In addition to the proposed and described project activities several focused activities will be carried out by the AF project consortium, in collaboration with local partners.

No.	Topic	Partners
1	Conducting a joint GW resource assessment, installing basic monitoring system; supporting the GW management capabilities in Cambodia	Project, with support of Thailand DNR, Cambodia partners
2	Dialogue with main stakeholders, potential to increase GW use in support of food production and rural water supply	Project, with support of Thailand DNR, Cambodia partners
3	Setting up joint task force to develop resilience enhancing measures in the framework of integrated surface-GW management	Project, with support of Thailand DNR, Cambodia partners



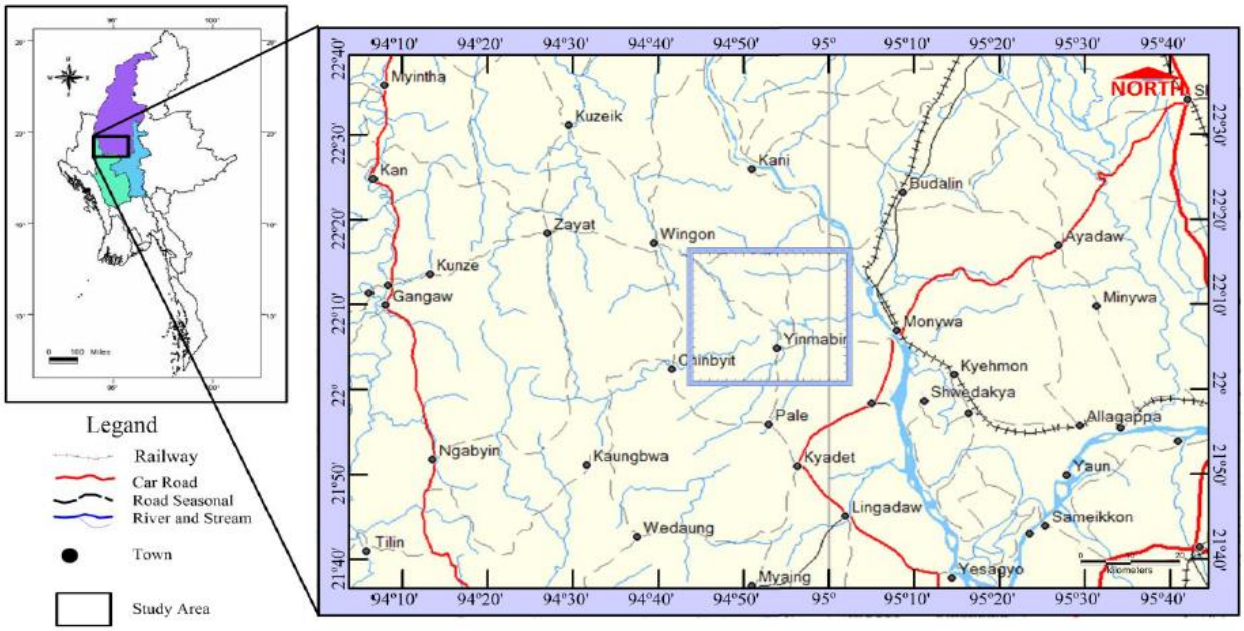
Overview

map of the hydrogeologic units of Changwat province and Sakaeo province, southeast Thailand that form part of the transboundary Thai – Cambodia Siem Reap hydrologic basin. Although highly variable in nature the aquifer systems locally offer significant potential for sustainable GW use in support of more climate resilient agriculture. There is little confirmed information on the Cambodia side of the border.

Pilot area 4: Myanmar Dry Zone, Yinmabin – 99 Ponds irrigation scheme pilot area

Proposed pilot area location:
The 99 Ponds GW irrigation scheme in YinmabinTownship, Sagaing Region, is a 900 km^2 area in Myanmar's Dry Zone. Total population of the township is around 137,000 people

Site characteristics:
The area is underlain by alluvial, Irrawaddy and Pegu aquifers, which provide flow at varying depths and flow rates and are used for both domestic purposes and irrigation. Shallower Kokkogon Alluvial aquifer is used mainly for domestic supply. The deeper, semi-confined, high yielding Ywatha Aungban aquifer was developed in 1994-5, with drilling of 417 artesian tube wells supplying water to 99 ponds, to irrigate 8181 acres. The scheme was extended with a further 32 wells and eight ponds in 2000. A total of more than 1980 tube wells (government and private) have been developed in the area. Poor construction and lack of operational flow regulation valves mean that many artesian wells are allowed to flow uncontrolled. Both yield and artesian water levels have declined significantly from pre-development conditions (artesian flow levels have dropped from 439 to 408 feet above MSL.); and water levels fluctuate seasonally and depending on discharge from other wells. There is increasing concern amongst farmers and water managers about availability of water and wastage from the system; but some well owners are unwilling to cap wells for fear of losing flow.



Location of the proposed pilot area in Myanmar, Central Dry Zone

Rationale for selection:
Ministry officials have highlighted the urgency of a) regulating free-flowing wells and b) monitoring of levels to understand the recharge dynamics of the system, in order to prevent wastage and long-term depletion of the aquifers. Both technical and social inputs are required to help communities understand the dynamics of the system and allay fears about capped wells losing water.

GW activities carried out in the area to date:
Some monitoring of GW levels has been conducted by WRUD since 1994 (Tin Win, 2016). Recharge study of similar aquifers in neighbouring region (Monywa) (Than Zaw, 2016).

Proposed partnerships and roles:

- Department of Irrigation and Water Utilisation – GW monitoring, inputs to resource assessment and recharge studies; management plan formulation

- Yangon Technical University / Mandalay Technical University – local scale resource assessments and modelling
- Local NGO, in collaboration with WHH or Mercy Corps; stakeholder engagement, community consultation and training

Publications and other resources

-Tin Win (2016) – Fluctuation of water level changes in Yinmarbin Artesian Zone.
-Than Zaw (2016) - Hydrogeological Framework and Spatially Distributed Groundwater Recharge Patterns, A Study around Ayardaw Township (Myanmar) Using Geospatial Approach
- Presentations at Workshop on reviewing the water well drilling experiences and hydrogeological status in Naypyitaw, Myanmar. March 2016.

Proposed Activities

In addition to the proposed and described project activities several focused activities will be carried out by the AF project consortium, in collaboration with local partners.

No.	Topic	Partners
1	Groundwater resource assessment and study of recharge dynamics	Project. IWMI, DIWU, YTU
2	Groundwater management planning (GW use inventory, stakeholder consultations, GW regulations)	Project, IWMI, DIWU, NGO
3	Participatory planning and implementation of well capping and monitoring programme in artesian areas	Project, NGO's and DIWU

Table 1: Overview with summary data on 4 proposed pilot areas

	PILOT SITE 1 Lao PDR-Thailand	PILOT SITE 2 Vietnam-Cambodia	PILOT SITE 3 Cambodia-Thailand	PILOT SITE 4 Myanmar Dry Zone
Location	Vientiane Plain (VP) (area ~4,500 km2)	Upper Mekong Delta, border provinces in Vietnam and Cambodia	Western Cambodia-Thai border area	Yin Mar Bin, Sagaing, Myanmar Dry Zone (area ~900 km2)
Rainfall/Climate zone	2,000 mm/yr Tropical Dry	1700 mm/yr Humid Subtropical	1400-2000 mm/yr Tropical Dry	800-1100 mm/yr Tropical Dry
Population density and project growth	Average to high +	Very high ++	Average +	Average +
Major land use	Paddy, vegetable crops, forest, urban	Paddy, vegetable crops, cities and villages	Paddy, vegetable crops, forest,	Paddy, vegetable crops (smallholders)
Aquifer type	Alluvium bounded by sandstone on margins and at depth	Alluvium, at depth older, semi-consolidated river deposits (sand and clay)	Thin alluvium, sandstones	Artesian system. Poorly cemented sand and gravel overlain by sand to clay alluvium
Recharge rates	200-400 mm/yr (approx.)	Vietnam: 300 mm/yr Cambodia: not known	Thailand: 200 mm/yr Cambodia: not known	Not known
Interactions with surface water	GW drains to rivers which are affected by hydropower operations; infiltration from small reservoirs and ponds	GW recharge from river channels with high/low seasonal flow; infiltration from small reservoirs and ponds	Recharge from small rivers, ponds, small reservoirs; GW drains to rivers and Tonle Sap lake	GW recharged from rainfall in ranges to west, and possibly seepage from Yama dam
Current abstraction	Relatively low	High to extremely high, deep tube wells and shallow wells	Low (Cambodia) and modest to high in Thailand	High – >1400 tube wells in area ~300 sq miles
Major purposes for abstraction	Domestic, emerging agriculture, small industry (packaged water, salt production)	Irrigation, village supply, city water supply, minor industry	Small scale irrigation, village supply	Irrigation, village supply
Water quality	Salinity (natural), fecal pollution	Good, some concern about arsenic levels, pesticide etc. pollution from surface water	Good, some concern about arsenic levels, microbial pollution at GW points	Generally good (possibly some problems with salinity in the upper aquifer)
Transboundary issues	Recharge from Mekong river and connectivity with adjacent Thai aquifers	Integrated resource management by Cambodia – Vietnam authorities; recharge from Mekong river (floods); pollution threats	Contrast between Thailand and Cambodia regions in utilization of resource; very limited management in Cambodia	None
Major issues/threats groundwater for climate resilience	Expansion of GW use, for irrigation and domestic use, rapid urbanization, poor oversight of (possibly) large extractions	Overall volume of extractions, decreasing recharge; implications of extraction and lesser recharge for shallow domestic wells and downstream replenishment of aquifer	Non-sustainable use in Thailand; undervalued resource in Cambodia; management capabilities and better alignment with user needs	Drawdown and fluctuation of artesian water levels. Concern about wastage from free-flowing boreholes. Unregulated expansion of private wells.

Pilot area 1: Mekong river riparian and transboundary aquifers-Vientiane Plains, Lao PDR

Proposed pilot area location:
Vientiane Plain (VP), 4,500 km^2 area extending across all or parts of Vientiane Capital, Vientiane and Bolikhamxay provinces, population around 0.8 million people. The area directly borders the Mekong river.

Site characteristics:
Vientiane Plain is underlain by alluvial infill overlying sandstone/siltstone with outcropping or buried rocksalt (part of the Khorat Plateau system in adjacent Thailand with very similar aquifers). Groundwater serves domestic purposes (most villages and some urban residential), agriculture (small scale irrigation and livestock), industry (packaged water drinking suppliers, and limited harvesting of rocksalt from saline reserves). Transboundary implications of deep groundwater systems are poorly understood, and not considered for management (unlikely for phreatic aquifer). The same may be said of interaction of groundwater systems with Mekong river surface water.

Rationale for selection:
This one of the larger and perhaps most economically important lowland plains in Lao PDR, and the most intensively studied groundwater resource in the country. A rudimentary monitoring network has been setup and running since 2014; the areas is easily accessible from Vientiane.

Groundwater activities carried out in the Vientiane Plan to date:
Groundwater resources have been studied by various means: regional drilling investigations, resistivity surveys, recharge and discharge estimation studies, water quality assessments, groundwater use perception study, participatory management study, community groundwater irrigation scheme setup and evaluated, GW model constructed, GW Management for upper Vientiane Plain was initiated.

Proposed partnerships and roles:
Natural Resources and Environment Institute (NREI) – GW model development and scenario testing:
Department of Water Resources, Groundwater Management Divisions (DWR-GMD) – management plan formulation including stakeholder engagement
National University of Laos, Faculty of Water Resources (NUOL-FWR) – local scale resource assessments and modelling
National University of Laos, Faculties of Sciences, Engineering and of Environmental Sciences with graduate student project on groundwater related topics.

Linkages to current Capacity building efforts

1) New PhD project on recharge estimation for lower Nam Ngum sub-basin starting in 2017 (NGRTC)
2) MSc study at Hiroshima University by Lao PDR, MONRE, Department of Water Resources Management staff on village level groundwater quality due for completion before end of year
3) Australia's AVID support to further develop curriculum in IWRM and Groundwater at National University of Laos, Faculty of Water Resources

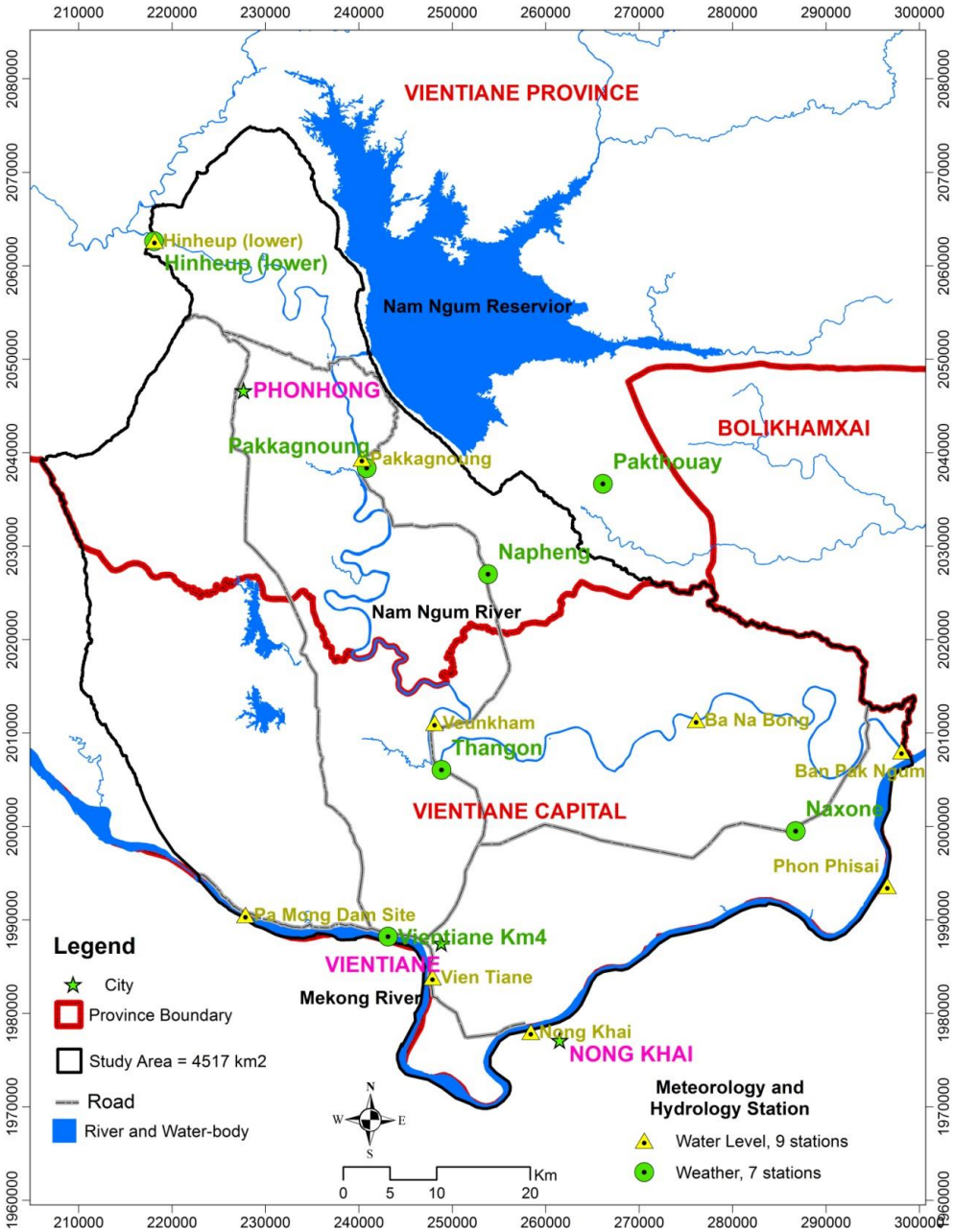
Publications and other resources

1. http://gw-laos.iwmi.org/
2. Suhardiman, D., Pavelic, P., Giordano, M. and Keovilignavong, O. (forthcoming) Agricultural groundwater use in the Vientiane Plains: Farmers' perceptions of opportunities and constraints. Human Ecology J.

Proposed Activities
In addition to the proposed and described project activities several focused activities will be carried out by the AF project consortium, in collaboration with local partners.

No.	Topic	Partners
1	Groundwater management planning (GW use inventory, stakeholder consultations, tailoring GW regulations, decision support tool development, awareness raising).	DWR supported by IWMI & NREI
2	Groundwater planning tool refinement and scenario testing	NREI supported by IWMI or KKU
3	Participatory GW management in alluvial areas	IWMI supported by DWR

Overview of the area



Pilot area 2: Upper Mekong Delta Transboundary Aquifers (Vietnam + Cambodia)

Proposed pilot area location:
Upper Mekong Delta region in Vietnam and adjacent lowlands adjacent to Mekong river in Cambodia, 12,000 km^2 area with a population of an estimated 4 million people. The area is part of major aquifers fed by the Mekong river system.

Site characteristics:
Subtropical lowland river plain with main channels of Bassac and Mekong rivers, intensively used for paddy rice and food crop cultivation. Mekong and Bassac river waters intensively used for irrigation and water supply, but in the dry season increasing use of shallow and deep groundwater from dug wells, shallow and intermediate boreholes. Seasonal floods play an crucial role in natural replenishment of Cambodia and Vietnam Mekong Delta aquifers, but the flooding patterns are strongly affected by changing climate and upstream river developments. A the same time, dependency on reliable and good water supply for food production and domestic use is increasing.

Transboundary implications of deep groundwater systems are poorly understood, and not considered for management (unlikely for phreatic aquifer). The same may be said of interaction of groundwater systems with Mekong river surface water.

Rationale for selection:
This one of the largest and perhaps most economically important transboundary aquifer systems in the Lower Mekong Sub-region. The importance of long-term supply of groundwater (quantity and quality) for food production, both in Cambodia and in southern Vietnam, cannot be overemphasized. The dynamics of the system are explicitly transboundary, while also the effects of regional developments (viz. dam construction, flood control and diversion of Mekong river waters, development of the Ton Le Sap basin) are complex and most likely considerable.

Groundwater activities carried out in the upper Mekong Delta to date:
Groundwater resources are being exploited and studied quite intensively by provincial government organisations on both sides of the border. In Vietnam this is partly executed and supported by DWRPIS. In Cambodia government policy on GW is not very well developed and there is very limited capacity to engage in active and focused interventions

Proposed partnerships and roles:
Vietnam's NAWAPI (MONRE) institute and its southern branch, the Division for Water Resources Planning and Investigation in the South of Vietnam (DWRPIS). In view of the situation in Cambodia, the execution of the activities in this pilot area will need substantial support from international experts

Linkages to current capacity building efforts
There is an unique opportunity to apply and learn from the well-developed groundwater system knowledge and data management in the Vietnamese provinces for the rather poorly monitored and studied Cambodian aquifers. The Vietnamese experience includes the ongoing efforts to develop IWRM-based approaches to address climate change threats and long-term water supply strategies. The project is a first to address groundwater oriented resource management issues in the transboundary area with inclusion of knowledge transfer, capacity building and regional cooperation.

Publications and other resources
Various DWRPIS reports and publications by DWRPIS

1. Erban, L. S.M. Gorelick & H.A. Zebker, 2014; Groundwater extraction, land subsidence and sea-level rise in Mekong Delta, Environ. Res. Lett. 9.
2. The Mekong Delta System: Interdisciplinary Analysis of a River Delta, F.G. Renaud and Claudia Kuenzer (eds.), Springer 2012, pp. 463; incl.: Frank Wagner, Vuong Bui Tran and F.G. Renaud; Groundwater Resources in the Mekong Delta: Availability, Utilization and Risks, pp. 201-220.
3. Climate Change Adaptation Planning for Urban Water Supply in Soc Trang Province, Dierks, R, 2016, Conference paper

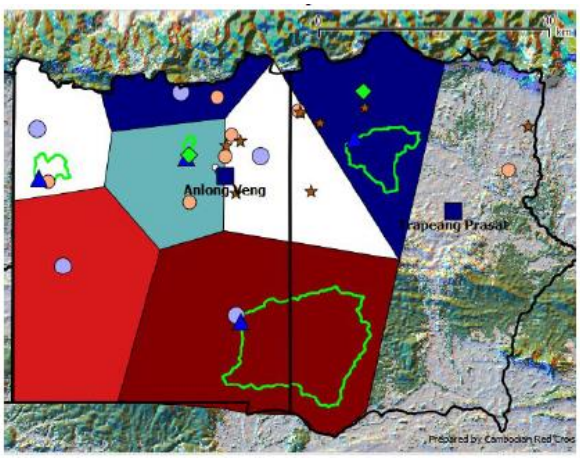
Proposed Activities within the overall project approach
In addition to the proposed and described project activities several focused activities will be carried out by the AF project consortium, in collaboration with local partners.

No.	Topic	Partners
1	Setting up a system of joint groundwater monitoring; supporting the GW monitoring capabilities in Cambodia	Project, with support of DWRPIS, Vietnam, Cambodia partners
2	Inventory and quantification of GW abstractions and use by different sectors; starting dialogue with main stakeholders	Project, with support of DWRPIS, Vietnam, Cambodia partners
3	Preliminary orientation on resilience enhancing measures in the framework of integrated surface-groundwater management	Project, with support of DWRPIS, Vietnam, Cambodia partners

Pilot area 3: NW Cambodia – Eastern Thailand border area

Proposed pilot area location:

Site characteristics:
The area is characterized by modest rainfall and a distinct dry season. Increasingly, due to climate change effects, monsoonal rains are late and come in the form of intensive cloudbursts, leading to flooding. Groundwater system are poorly studied, but it is well known that groundwater use for domestic and agriculture irrigation purposes is widespread. There is a significant water deficiency in the second half of the dry season, viz. March-May, increasing pressures on groundwater use. Measures for recharge and storage are considered.



Regional water deficiencies occur in parts of northwest Cambodia (May 2013 situation). At the same time there is a water surplus in upstream catchments. Integrated surface-groundwater management and groundwater recharge can significantly contribute to climate resilient rural land use.

Rationale for selection:
Vulnerability of rural population; potential to increase sustainable groundwater use in support of rural livelihoods, food production and rural (domestic) water supply; significant potential to increase climate change resilience on the basis of improved and more sustainable groundwater management

Groundwater activities carried out in the area to date
Experts of Khon Kaen Groundwater Research Centre (Thailand**)** compiled the hydrogeologic units of Changwat province and Sakaeo province that forms a part of the Siem Reap hydrologic basin (see overview map). Inventories were also made of drill well locations in the border area, on the basis of several data bases from the Thai Government offices. For the Thailand side, there is rather comprehensive information regarding surface- and groundwater resources and wells as shown in the map as well as other relevant data, e.g. land use, soils, communities, etc.. Mostly rural population in the border

area and the rural districts down to Ton Le Sap rely on groundwater resources (with several water wells in every village). The aquifer is meta-sedimentary aquifer, but with a rather variable groundwater potential across the region. It is assumed that similar aquifer systems extend across the border area in both Thailand and Cambodia and transboundary relationships occur.

Proposed partnerships and roles

In line with the concept of the project the activities in this pilot are will emphasize transboundary (Thai-Cambodia) cooperation and learning, focusing on improved assessment and monitoring of potential groundwater resources, determining user needs and resilience potential of regional agricultural land use systems on the basis of enhanced groundwater use. The envisaged partnership will preferably be at user and local level (districts), provinces) emphasizing building up capacity where it is needed and utilized. These activities will be supported by the international and regional expert teams under the project.

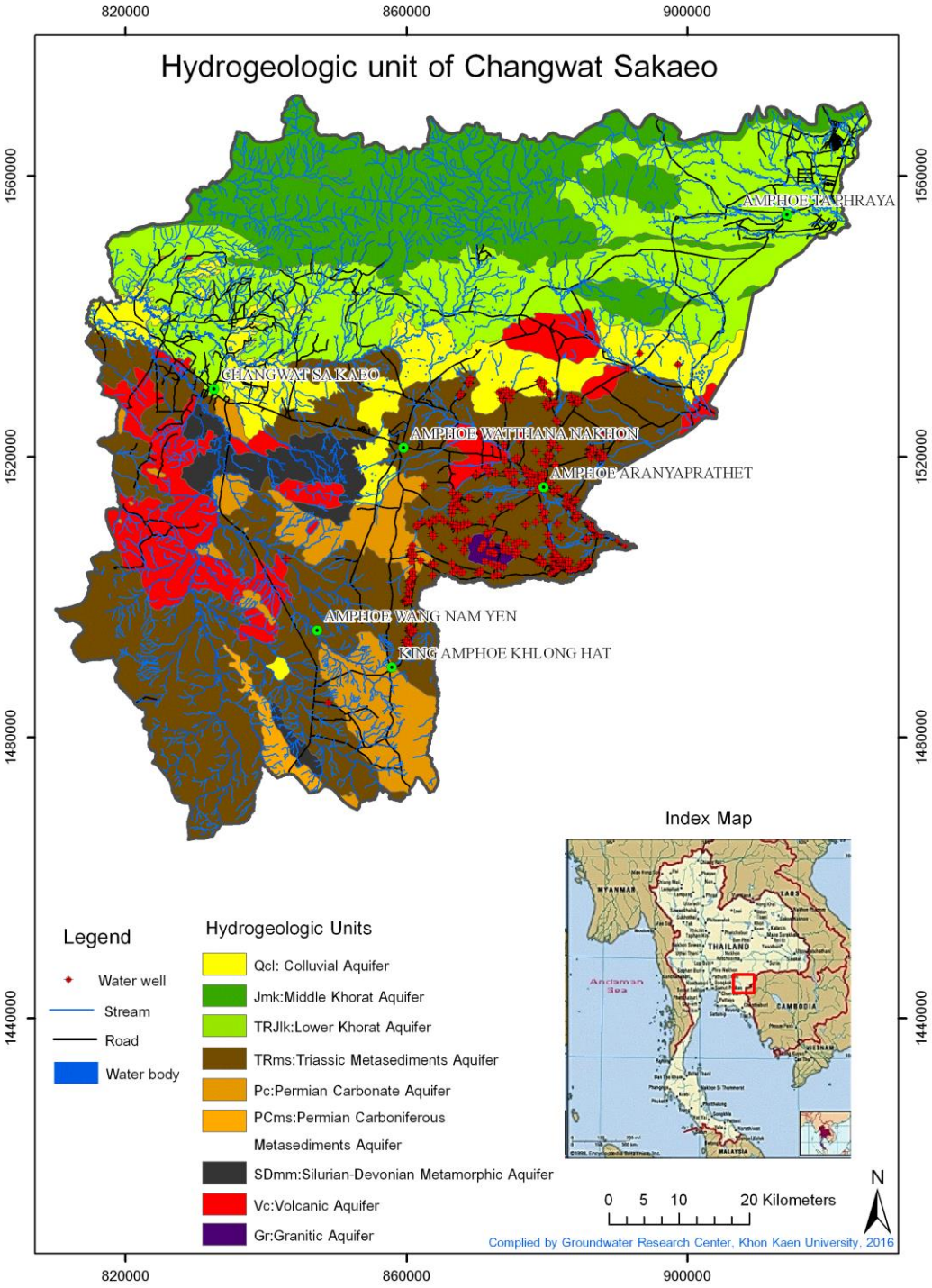
Linkages to current capacity building efforts

The project will use results from earlier groundwater studies in Cambodia, but in the designated region very little has been done.

Proposed Activities within the overall project approach

In addition to the proposed and described project activities several focused activities will be carried out by the AF project consortium, in collaboration with local partners.

No.	Topic	Partners
1	Conducting a joint groundwater resource assessment, installing basic monitoring system; supporting the GW management capabilities in Cambodia	Project, with support of Thailand DNR, Cambodia partners
2	Dialogue with main stakeholders, potential to increase GW use in support of food production and rural water supply	Project, with support of Thailand DNR, Cambodia partners
3	Setting up joint task force to develop resilience enhancing measures in the framework of integrated surface-groundwater management	Project, with support of Thailand DNR, Cambodia partners

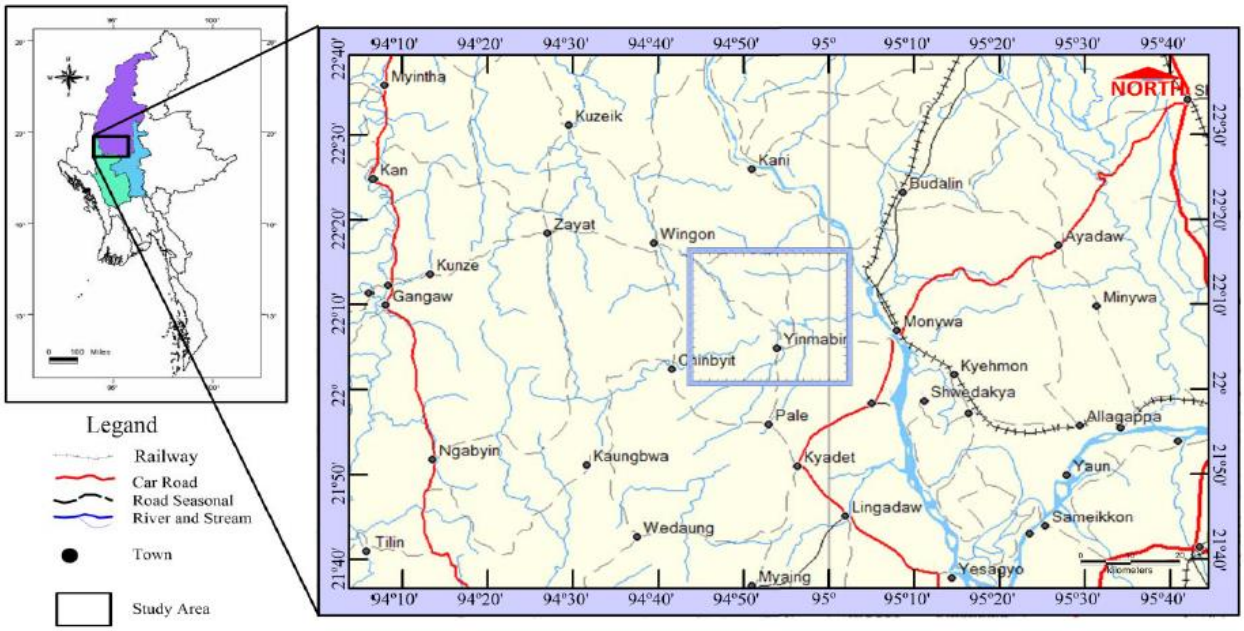


Overview map of the hydrogeologic units of Changwat province and Sakaeo province, southeast Thailand that form part of the transboundary Thai – Cambodia Siem Reap hydrologic basin. Although highly variable in nature the aquifer systems locally offer significant potential for sustainable groundwater use in support of more climate resilient agriculture. There is little confirmed information on the Cambodia side of the border.

Pilot area 4: Myanmar Dry Zone, Yin Mar Bin – 99 Ponds irrigation scheme pilot area

Proposed pilot area location:
99 Ponds groundwater irrigation scheme, Yin Mar Bin Township, Sagaing Region. 900 km^2 area in Myanmar's Dry Zone. Total population of the township is around 137,000 people

Site characteristics:
The area is underlain by alluvial, Irrawaddy and Pegu aquifers, which provide flow at varying depths and flow rates and are used for both domestic purposes and irrigation. Shallower Kokkogon Alluvial aquifer is used mainly for domestic supply. The deeper, semi-confined, high yielding Ywatha Aungban aquifer was developed in 1994-5, with drilling of 417 artesian tube wells supplying water to 99 ponds, to irrigate 8181 acres. The scheme was extended with a further 32 wells and 8 ponds in 2000. A total of more than 1980 tube wells (government and private) have been developed in the area. Poor construction and lack of operational flow regulation valves mean that many artesian wells are allowed to flow uncontrolled. Both yield and artesian water levels have declined significantly from pre-development conditions (artesian flow levels have dropped from 439 to 408 feet above MSL.); and water levels fluctuate seasonally and depending on discharge from other wells. There is increasing concern amongst farmers and water managers about availability of water and wastage from the system; but some well owners are unwilling to cap wells for fear of losing flow.



Location of the proposed pilot area in Myanmar, Central Dry Zone

Rationale for selection:
Ministry officials have highlighted the urgency of a) regulating free-flowing wells and b) monitoring of levels to understand the recharge dynamics of the system, in order to prevent wastage and long-term depletion of the aquifers. Both technical and social inputs are required to help communities understand the dynamics of the system and allay fears about capped wells losing water.

GW activities carried out in the VP to date:
Some monitoring of groundwater levels has been conducted by WRUD since 1994 (Tin Win, 2016). Recharge study of similar aquifers in neighbouring region (Monywa) (Than Zaw, 2016).

Proposed partnerships and roles:

- Department of Irrigation and Water Utilisation – groundwater monitoring, inputs to resource assessment and recharge studies; management plan formulation

- Yangon Technical University / Mandalay Technical University – local scale resource assessments and modelling
- Local NGO, in collaboration with WHH or Mercy Corps; stakeholder engagement, community consultation and training

Publications and other resources

-Tin Win (2016) – Fluctuation of water level changes in Yinmarbin Artesian Zone.
-Than Zaw (2016) - Hydrogeological Framework and Spatially Distributed Groundwater Recharge Patterns, A Study around Ayardaw Township (Myanmar) Using Geospatial Approach
- Presentations at Workshop on reviewing the water well drilling experiences and hydrogeological status in Myanmar. Naypyitaw, March 2016.

Proposed Activities

In addition to the proposed and described project activities several focused activities will be carried out by the AF project consortium, in collaboration with local partners.

No.	Topic	Partners
1	Groundwater resource assessment and study of recharge dynamics	Project. IWMI, DIWU, YTU
2	Groundwater management planning (GW use inventory, stakeholder consultations, GW regulations)	Project, IWMI, DIWU, NGO
3	Participatory planning and implementation of well capping and monitoring program in artesian areas	Project, NGO's and DIWU

Groundwater resources in Greater Mekong Sub-region: Collaborative management to increase resilience

A collaboration of Vietnam, Lao PDR, Cambodia, Thailand and Myanmar to increase climate resilience in the greater Mekong Sub-region through improved groundwater management and transboundary cooperation

Annex II: ADB case study brochure on improved water management and climate change in Vietnam

PROJECT RESULT / CASE STUDY

July 2016

Project
Strengthening Water Management and Irrigation Systems Rehabilitation Project

In Viet Nam, Some Farmers are No Longer at the Mercy of the Monsoons

New laws, policies, training centers—and plenty of infrastructure upgrades like water pumps and irrigations systems—are helping Vietnamese farmers deal with the challenges of weather, geography, and climate change.

Viet Nam is helping farmers respond to climate change to protect their harvests and their livelihoods.

HAI DUONG PROVINCE, VIET NAM – In 60 years working the land, Phung Minh has been at the mercy of the rains. They have nourished his crops but they have also destroyed them. Viet Nam's current drought, the worst in decades, has wreaked havoc on farms. But when the skies open, the damage can also be severe.

"The water stays in the field for weeks," says Phung. "I've lost so many crops that way over the years."

But recent storms which brought floods that previously would have destroyed his harvest did no damage; the water was quickly drained away by a new pump station near his farm in Hai Duong province, in Viet Nam's Red River Delta. The pumps have removed one of the challenges faced by Vietnamese farmers like Minh, but others remain as weather patterns become increasingly unpredictable.

In the nearby Nghi Son area, Nguyen Thi Tuan, 52, looks forward to the day that a new pump station will help her manage confusing new weather threats to her livelihood. Her groundnut, ginger, and corn crops usually thrive mid-year. Now they are at the mercy of erratic weather. "This year there's been no water, but in past years there have been floods at this time of year. We don't understand why."

The pump stations are two of 10 being built or rehabilitated in three northern Vietnamese provinces under the Strengthening Water Management and Irrigation Systems Rehabilitation Project. The project, supported by a $100 million loan from the Asian Development Bank, is part of Viet Nam's effort to manage rising agricultural and industrial demand for scarce water resources. In addition to pumps and

other infrastructure investments, the government is enacting new water-related laws and policies, and educating a new generation of water management experts.

Hit hard by El Nino

The country's geography puts it at a disadvantage; a long, flat coastline exposes it to flooding and salt-water intrusion, especially in the fertile river deltas. As the current severe water shortages show, there's a high risk of drought as well. Viet Nam's plains rise quickly to highlands, which are susceptible to erosion and leave little space for catchment areas to store water.

> "This year there's been no water, but in past years there have been floods at this time of year. We don't understand why."
> Nguyen Thi Tuan

Moreover, climate patterns have been disturbed by a warming planet and the onset of El Nino—a periodic weather event characterized by higher ocean temperatures that is worsened by climate change, and which caused recent heatwaves.

Viet Nam has been hit particularly hard by El Nino. Reservoir levels dropped by two-thirds in 2015, with river water in the Central Regions 20% to 40% lower than average at the end of the rainy season. River flows were down 40% in the Mekong Delta, allowing saltwater intrusion to occur earlier than usual and much further upstream to areas untouched by salinity for nearly a century.

"Usually the Mekong Delta floods every year at the end of October, but last year there were no floods," says Ho Le Phong, a specialist in natural resources and agriculture at the Asian Development Bank's Viet Nam Resident Mission. "Now there's a very severe drought going into its fourth year."

Changing weather patterns damaged 60,000 hectares of crops in Central and Central Highland regions in 2015, according to the Ministry of Agriculture and Rural Development, while 104,000 hectares of 2015-2016 winter-spring crops were severely impacted in the Mekong Delta. Recently, the Asian Development Bank approved $3 million in grant assistance from its Asia Pacific Disaster Response Fund to support relief efforts in the wake of the drought and salt water intrusion in the South Central, Central Highlands and Mekong Delta regions.

Rising demand for scarce water stocks

Viet Nam is acutely exposed to climate change, which is projected to disrupt rainfall patterns—shrinking river flows—and induce greater evaporation from paddy fields. This affects the agriculture, industry, and energy sectors, all of which rely on increasingly scarce water stocks. By 2020, water use is expected to reach 120 billion cubic meters, up from 80 billion cubic meters in 2008.

Another strong focus the of government's response is to improve water use efficiency in drought-affected provinces through innovative water-saving irrigation technologies and maintenance of existing infrastructure.

"Irrigation infrastructure has to be designed to a high standard, particularly in the face of increased natural disasters, to get the best return on investment," says Sanath Ranawana, a natural resources management specialist at ADB. "These systems should be designed and built stronger and better to withstand extreme climate conditions."

Farmers are also being helped by the government's new Water Law, which was enacted in 2014 and for the first time recognizes the economic value of water. As Viet Nam improves its water management to more accurately reflect that value, it will need many more water specialists to implement new, more efficient systems.

Expanding water resources expertise

But there aren't enough trained people to do that work. At the only institution in Viet Nam dedicated solely to training water specialists, Ha Noi's Water Resources University, 12,000 students squeeze into a space meant for 6,000. "The demand is huge," says Tran Viet On, vice rector of the university.

Tran is also director of an ADB-supported program to build a second water resources campus—part of the project that is also financing the construction of the 10 pumping stations.

This year half the students at Ha Noi will be transferred to the new campus, now nearing completion at a sprawling site in Hung Yen Province, adjoining Ha Noi. Eventually, 13,400 students will be able to study a wide range of courses including mechanical engineering, urban planning, and new disciplines such as disaster risk management.

“There will be many new subjects,” says Mr. Tran. “This will be a training center for science and technology in the water sector.”

The expertise these graduates will bring to bear on Viet Nam’s water challenges may take a few years to make a difference. But already the tide is turning in favor of farmers like Phung Min and Nguyen Thi Tuan, as they enjoy the break from fickle weather provided by the new pump stations.

“This helps us a lot during droughts and floods,” says Nguyen. “Life will be better than before.”

John Larkin is an External Relations Specialist in ADB’s Department of External Relations. Learn more about ADB's work in Viet Nam.

Groundwater resources in Greater Mekong Sub-region: Collaborative management to increase resilience

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Annex III: An overview of UNESCO water related project references (recent projects)

GEF International Waters - UNESCO Portfolio

Updated: Jan 2016

1. FINALIZED PROJECTS

GEF ID	Full project title & acronym	Location		UNESCO HQ/Field Office coordination	Project type (MSP/FSP)	GEF Implementing Agency	Role of UNESCO	Duration	Total GEF allocation (USD)	Total co-financing budget (in USD)	Total budget (USD)	UNESCO's component of GEF resources (USD)	UNESCO-IHP resources (USD)
		Region	Countries										
2041	Managing Hydrogeological Risk in the Iullemeden Aquifer System	Regional Project: West Africa	Mali, Niger, Nigeria	UNESCO/IHP	MSP	UNEP	executing partner (jointly with OSS)	2003-2007	958,000	780,000	1,738,000	80,000	80,000
3342	Development of Methodologies for GEF Transboundary Waters Assessment (TWAP)	Global	/	UNESCO/IHP & UNESCO/IOC	MSP	UNEP	executing partner	2009-2010	1,083,500	1,040,000	2,123,500	150,000	75,000
3343	Enhancing the use of science in International Waters projects to improve project results (IW-SCIENCE)	Global	/	UNESCO/IHP	MSP	UNEP	executing partner	2009-2011	1,000,000	1,095,000	2,095,000	70,000	70,000
3726	Groundwater Governance: A Global Framework for Action	Global	/	UNESCO/IHP	FSP	FAO	executing partner	2010-2012	1,750,000	2,700,000	4,450,000	590,000	590,000
4029	Integrated natural resource management in the Baikal Basin transboundary ecosystem	Asia	Mongolia, Russian Federation	UNESCO/IHP	FSP	UNDP	executing partner	2010 - 2014	3,898,000	10,670,000	14,568,000	1,200,000	1,200,000
2722	Fostering a Global Dialogue on Oceans, Coasts, and SIDS, and on Freshwater-Coastal-Marine Interlinkages	Global	/	UNESCO/IOC	MSP	UNEP	executing partner	2005-2008	994,600	1,121,125	2,115,725	994,600	0
2474	Promoting Ecosystem Based approach to Fisheries Conservation and LMEs	Global	/	UNESCO/IOC	MSP	UNEP	executing partner	2004-2006	995,000	740,000	1,735,000	995,000	0
1032	Sustainable Management of the Shared Living Marine Resources of the Caribbean Large Marine Ecosystem (CLME) and Adjacent Regions	Regional	Antigua and Barbuda, Bahamas, Barbados, Belize, Brazil, Colombia, Costa Rica, Dominican Republic, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago	UNESCO/IOC	FSP	UNDP/UNOPS	executing partner	2008-2012	8,500,000	49,500,000	58,000,000	1,220,000	0

2600	Strategic Partnership for the Mediterranean Sea Large Marine Ecosystem (MedPartnership) - Regional Component: Implementation of agreed actions for the protection of the environmental resources of the Mediteranean Sea and its coastal areas	Mediterranean	Albania, Algeria, Bosnia-Herzegovina, Croatia, Egypt, Lebanon, Lybia, Montenegro, Morocco, Palestinian Authority, Syria, Tunisia,Turkey	UNESCO/IHP	FSP	UNEP	executing partner	2009-2015	11,891,000	35,597,700	47,488,700	1,770,000	1,770,000
3690	Protection and Sustainable Use of the Dinaric Karst Transboundary Aquifer System (DIKTAS)	South East Europe	Albania, Bosnia-Herzegovina, Croatia, Montenegro	UNESCO/IHP	FSP	UNDP	executing agency	2010-2015	2,160,000	3,403,570	5,563,570	2,160,000	2,160,000
3900	GEF IW:LEARN: "Strengthening IW Portfolio Delivery and Impact."	Global	/	UNESCO/IHP	FSP	UNEP, UNDP	executing partner	2011-2015	4,095,000	5,204,824	9,299,824	515,000	515,000
4489	A Transboundary Waters Assessment Programme: Aquifers, Lake/Reservoir Basins, River Basins, Large Marine Ecosystems, and Open Ocean to Catalyze Sound Environmental Management	Global	/	UNESCO/IHP & UNESCO/IOC	FSP	UNEP	executing partner	2012 - 2015	5,000,000	24,074,000	29,074,000	2,500,000	1,500,000
4212	Global foundations for reducing nutrient enrichment and oxygen depletion from land based pollution, in support of Global Nutrient Cycle	Global	/	UNESCO/IOC	FSP	UNEP	executing partner	2010-2014	1,718,182	2,398,165	4,116,347	453,682	0
4452	Standardized Methodologies For Carbon Accounting And Ecosystem Services Valuation Of Blue Forests	Global	/	UNESCO/IOC	FSP	UNEP	Executing partner	2012 - 2016	4,500,000	18,590,000	23,090,000	300,000	0
											Total:	12,998,282	**7,960,000**

2. ON-GOING PROJECTS

GEF ID	Full project title & acronym	Location		UNESCO HQ/Field Office coordination	Project type (MSP/FSP)	GEF Implementing Agency	Role of UNESCO	Duration	Total GEF allocation (USD)	Total co-financing budget (in USD)	Total budget (USD)	UNESCO's component of GEF resources (USD)	UNESCO-IHP resources (USD)
		Region	Countries										
	GEF IW:LEARN: "Strengthening IW Portfolio Delivery and Impact."	Global	/	UNESCO IOC and IHP	FSP	UNDP	Executing partner	2015 - 2019			5,201,750	250,000	250,000
											Total:	**250,000**	**250,000**

3. PROJECTS IN THE PIPELINE

GEF ID	Full project title & acronym	Location		UNESCO HQ/Field Office coordination	Project type (MSP/FSP)	GEF Implementing Agency	Role of UNESCO	Duration	Total GEF allocation (USD)	Total co-financing budget (in USD)	Total budget (USD)	UNESCO's component of GEF resources (USD)	UNESCO-IHP resources (USD)
		Region	Countries										
	Enabling implementation of the Regional SAP for the sustainable management of the Nubian Sandstone Aquifer System (NSAS) – Project Preparation Grant (PPG) Phase	Regional North Africa	Chad, Libya, Egypt, Sudan	UNESCO-IHP	PPG	UNDP	Executing agency	2016-2017	150,000	0	150,000	150,000	150,000
	Enabling implementation of the Regional SAP for the sustainable management of the Nubian Sandstone Aquifer System (NSAS) – Full size project	Regional North Africa	Chad, Libya, Egypt, Sudan	UNESCO-IHP	FSP	UNDP	Executing agency	2017-2021	3,500,000	20,000,000	23,500,000	3,500,000	3,500,000
5301	Enabling countries of the Transboundary Syr Darya Basin to Make Sustainable Use of their Groundwater Potential and Subsurface Space with Consideration to Climate Variability and Change	Central Asia	Kyrgyz Republic, Kazakhstan, Tajikistan	UNESCO/IHP	FSP	UNDP	Executing agency	2015 - 2020	3,500,000	21,000,000	23,156,000	3,500,000	3,500,000
	Strengthening the institutional capacity of African Network of Basin Organization (ANBO), contributing to the improved transboundary water governance in Africa	Africa	ANBO countries	UNESCO-IHP	FSP	UNDP	Executing partner	2015 - 2018	2000000	7,030,000	9,030,000	2000000	2000000
	Enabling implementation of the Regional SAP for the Dinaric Karst Aquifer System	South East Europe	Albania, Bosnia-Herzegovina, Croatia, Montenegro	UNESCO-IHP	FSP	UNDP	Executing agency	2017 - 2021	2500000	16,000,000	18,500,000	2500000	2500000
	Mediterranean Sea Program - Strategic actions for the protection of Mediterranean coastal aquifers	Regional Mediterranean	Albania, Algeria, Bosnia-Herzegovina, Croatia, Egypt, Lebanon, Lybia, Montenegro, Morocco, Palestinian Authority, Syria, Tunisia,Turkey	UNESCO-IHP	FSP	UNEP	Executing agency	2017-2022	3,500,000	18,000,000	21,500,000	3,500,000	3,500,000
	Study of the Kilimanjaro transboundary aquifer shared between Kenya and Tanzania	Regional East Africa	Kenya, Tanzania	UNESCO/IHP	FSP	UNDP	Executing agency	2016-2020	2,000,000	20,000,000	22,000,000	2,000,000	2,000,000
	Fostering multi-country cooperation and conjunctive surface and groundwater management in the Bug and Neman Transboundary River Basins and related aquifers	Eastern Europe	Poland, Belarus, Ukraine	UNESCO/IHP	FSP	UNDP	Executing agency	2017-2021	4,150,000	15000000	19,150,000	4,150,000	4,150,000
	Reducing climate change-induced risks and vulnerabilities from glacial melting in high altitude glacier systems of Central Asia through strengthening regional cooperation on integrated water and land management practices	Regional	Kyrgyzstan, Tajikistan, Turkmenistan, Kazakhstan and Uzbekistan	UNESCO-IHP	FSP	UNDP	Executing agency	2015- 2020	5000000	25000000	30,000,000	5,000,000	5,000,000
	Nile Integrated Groundwater and Surface Water Project	Regional North Africa	Burundi, DR Congo, Egypt, Ethiopia, Kenya, Rwanda, South Sudan, Sudan, Tanzania, Uganda	UNESCO-IHP	FSP	UNDP	Executing agency	2018 - 2022	4000000	20000000	24,000,000	4,000,000	4,000,000
	Raising global awareness about the role of aquifers and groundwater in sustaining wetlands and their ecosystem services	Global	Global	UNESCO-IHP	FSP	UNDP	Executing agency	2015 - 2018	3,000,000	15000000	18,000,000	3,000,000	3,000,000
											Total:	**21,650,000**	**21,650,000**

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Annex IV: Background information on UNESCO's GRAPHIC programme (Groundwater Resources Assessment under the Pressures of Humanity and Climate Change)

United Nations
Educational, Scientific and
Cultural Organization

International
Hydrological
Programme

50 years

GRAPHIC

GRAPHIC

GROUNDWATER AND CLIMATE CHANGE

Mitigating the Global Groundwater Crisis and Adapting to Climate Change

POSITION PAPER AND CALL TO ACTION

INTERNATIONAL HYDROLOGICAL PROGRAMME
Division of Water Sciences

GRAPHIC
GLOBAL COMMITMENT TO GROUNDWATER AND CLIMATE CHANGE

The United Nations Educational, Scientific, and Cultural Organisation (UNESCO) International Hydrological Programme (IHP) initiated the Groundwater Resources Assessment under the Pressures of Humanity and Climate Change (GRAPHIC) project in 2004[1] to better understand the effects of climate change on global groundwater resources.

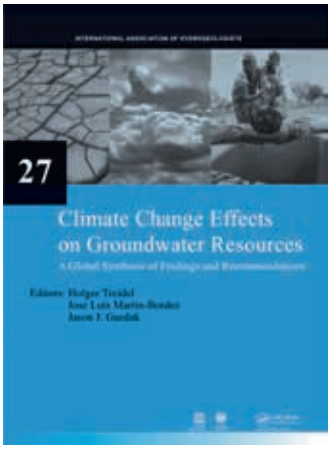
Vision of GRAPHIC:

- advance sustainable groundwater management considering projected climate change and linked human effects.

Mission of GRAPHIC:

- provide a platform for exchange of information through case studies, thematic working groups, scientific research, and communication.
- serve the global community through providing scientifically based and policy-relevant recommendations.
- use regional and global networks to improve the capacity to manage groundwater resources.

GRAPHIC improves understanding of how groundwater interacts within the global water cycle, supports ecosystems and humankind and, in turn, responds to complex and coupled pressures of human activities and climate change. To achieve these objectives within a global context, GRAPHIC is a collaborative effort and umbrella for international research, education, and outreach. GRAPHIC has international investigations covering major geographical regions, groundwater resource topics, and methods to help advance the combined knowledge needed to address scientific and social aspects of the global groundwater crisis in the context of climate change.



Climate Effects on Groundwater – A Global Synthesis of Findings and Recommendations[2] is a compilation from 20 studies in more than 30 countries under GRAPHIC network.

GRAPHIC uses a multidisciplinary scientific approach that extends beyond physical, chemical, and biological investigations to include human systems of resource management and governmental policies. GRAPHIC has been divided into subjects, methods, and regions. The subjects encompass (i) groundwater quantity (recharge, discharge, and storage), (ii) quality, and (iii) management aspects. GRAPHIC uses many scientific methods, including analysis of field data, geophysics, geochemistry, paleohydrology, remote sensing, and modelling. GRAPHIC has regional studies in Africa, Asia and Oceania, Europe, Latin America, and the Caribbean and North America.

Additional information about GRAPHIC is available at **www.graphicnetwork.net**.

INTERNATIONAL CLIMATE NEGOTIATIONS – NEED FOR MORE EXPLICIT DISCUSSIONS REGARDING GROUNDWATER

2015 is a momentous year for climate change mitigation. Three key global summits – on finance (Third International Conference on Financing for Development), on the adoption of the post-2015 development agenda, including the Sustainable Development Goals - SDGs (United Nations Sustainable Development Summit), and on climate (21st Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change - COP21) – will define the ambition and direction of economic advance, social inclusion and environmental sustainability; to which climate change is the greatest threat.

The 2030 Agenda for Sustainable Development includes dedicated goals on climate change (SDG13) and water and sanitation (SDG 6). COP20 resulted in the Lima Call for Climate Action which was a critical step toward reaching a legally binding and universal agreement on climate at COP21 in Paris. Groundwater is critical for mitigating climate change impacts because many efforts to reduce greenhouse gas emissions depend on reliable access to sustainable water resources. Strategic management for climate resilient groundwater resources is the foundation for long-term adaptation and mitigation plans, and should therefore be incorporated in future global climate negotiations. Moreover, as water related hazards exacerbate inequalities, which are disproportionally felt by developing and vulnerable communities, climate resilient groundwater infrastructure is a key for development and poverty reduction.

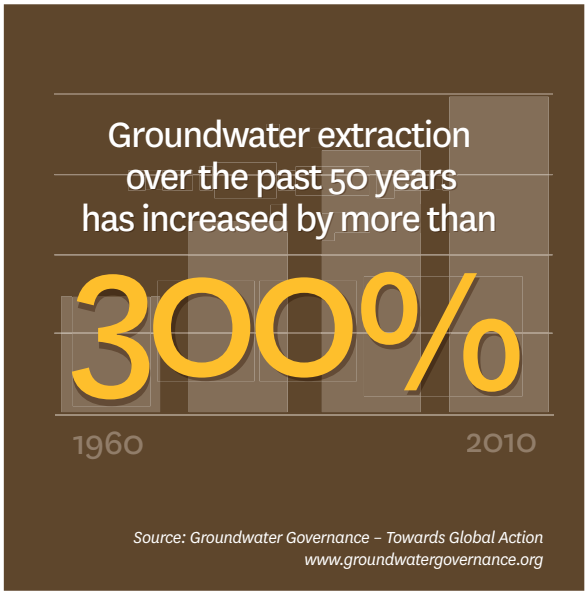
Explicit consideration of the global groundwater crisis and the role of groundwater resources in climate change adaptation and mitigation are therefore essential in climate change negotiations and mitigation solutions.

GROUNDWATER AND CLIMATE CHANGE

Groundwater is an essential part of the hydrological cycle and is a valuable natural resource providing a primary source of water for agriculture, domestic, and industrial uses throughout the world. Nearly half of all drinking water in the world[3] and about 43% of all water effectively consumed in irrigation[4] is sourced from groundwater. Groundwater is vital for sustaining many streams, lakes, wetlands, and other dependent ecosystems[5].

Global groundwater resources are in a state of crisis[6] because of over-abstraction in many semiarid and arid regions and the uncertain consequences of climate change[7]. Climate change is expected to significantly modify the global hydrological cycle and there is a broad consensus that climate change effects will be felt by humans mainly through its impacts on water resources globally, including groundwater resources[8,9], and water-related disasters such as floods and droughts. Direct impacts of climate change on natural processes (groundwater discharge, recharge storage and quality) may be exacerbated by the human response to these impacts, such as increased groundwater abstraction due to extended and more frequent droughts. The effects of climate change on groundwater resources are therefore closely linked to sustainable development goals and to global change drivers, including population growth, land use changes, and urbanization[10].

The **purpose of this paper** is to highlight the important role groundwater has in meeting the demands for drinking water, agricultural and industrial activities, and sustaining ecosystems, particularly in the context of adaptation to and mitigation of the impacts of climate change. This paper outlines several key recommendations that are particularly relevant for future international climate negotiations.



ROLE OF GROUNDWATER IN ADAPTATION TO CLIMATE CHANGE

GROUNDWATER IS CRUCIAL FOR SOCIETY'S ADAPTATION TO CLIMATE CHANGE

In many regions, groundwater provides a secure, sufficient, and cost-effective water supply. Use of groundwater is particularly

relevant to sustaining access to potable-water supplies because groundwater resources are resilient to drought and the impacts of increased freshwater demand during these periods. During droughts, use of groundwater for irrigation can increase, including the use of non-renewable groundwater resources, which may impact the sustainability of groundwater resources.

SUPPORT ADAPTATION IN DEVELOPING COUNTRIES

Information from intensively studied groundwater systems can help inform groundwater monitoring in areas where monitoring infrastructure and resources are limited. Mapping analogues from other parts of the globe in terms of climate change impact studies and adaptation approaches is a promising first-order approach. Using global analogues of adaptation can lead to policy and best-practices to water resource managers and groundwater governance in similar climatic and socio-economic settings. International support for adaptation programs should take precedence in developing countries, providing incentives for capacity strengthening in groundwater management, planning, and conceptualization of adaptation programs.

GROUNDWATER FOR HUMAN DEVELOPMENT

GROUNDWATER IS A KEY RESOURCE FOR HUMAN DEVELOPMENT

Despite the importance of groundwater resources for domestic uses, irrigated agriculture, and other industry, groundwater has often been neglected in development strategies and projects. Groundwater can play an important role in many sustainable development goals, including improving access to drinking water, sanitation, and hygiene.

GROUNDWATER AND CLIMATE POLICIES ACCOUNT FOR IMPORTANT DIFFERENCES BETWEEN THE DEVELOPED AND DEVELOPING WORLD:

While groundwater resources in nearly all regions of the world are stressed by overuse, population growth, and climate change, there are important differences in policy and management to minimize stressors on groundwater resources between the developed and developing world. In the developed world, water management can be complicated by a number of institutional, political and socioeconomic barriers, which include the lack of sufficiently dense monitoring well networks, disparate sampling, data reporting and archiving strategies, inadequate data sharing policies, and in many regions, the lack of groundwater use reporting requirements. In the developing world, such management strategies are in their infancy. Policy efforts to implement adaptive management must recognize these important differences and address limitations appropriately.

POLICY RECOMMENDATIONS: A CALL TO ACTION

The role of groundwater in human development

- Groundwater is a key resource for human development and has an important role in many sustainable development goals.
- Groundwater provides drinking water to at least 50% of the world's population and 43% of all the water used for irrigation.
- Groundwater sustains the base flow of rivers and important aquatic systems.
- Sustainable groundwater is an issue of national and international security.
- Groundwater systems are highly vulnerable on Small Island Developing States (SIDS).

Groundwater is a critical resource for adaptation to climate variability and climate change

- Groundwater provides a unique buffer during extended dry periods.
- Knowledge is fragmented regarding climate change impacts on groundwater quality.
- Science policy is needed to better quantify groundwater withdrawal and sustainable yield.
- Support for adaptation should take precedence in developing countries.
- Programs that empower women and advance gender equality are needed.

IMPROVED GROUNDWATER GOVERNANCE IS NEEDED FOR SUSTAINABLE GROUNDWATER RESOURCES

- Create an adequate basis for governance through political commitment and leadership.
- Build effective institutions and permanent stakeholder engagement mechanisms.
- Systematically make linkages to other water sources and other sectors (Water-Energy-Food-Climate).
- Groundwater management needs to integrate regional water and agricultural policies.
- Public finances related to groundwater need to be reviewed critically for sustainable groundwater management.
- Policy must account for important differences between the developed and developing world in terms of addressing climate and human stresses on groundwater resources.

PROMOTE GROUNDWATER MANAGEMENT STRATEGIES TO REDUCE VULNERABILITIES

- Integrated water resources management should be adopted.
- Managed Aquifer Recharge (MAR) is a promising adaptation approach.

COLLABORATE WITH PARTNERS OF SPECIALIZED KNOWLEDGE

- Need to collaborate with programs and agencies with specialized knowledge (e.g. NASA's Gravity Recovery And Climate Experiment (GRACE) satellite mission)

WATER-ENERGY-FOOD-CLIMATE NEXUS

GROUNDWATER IS AN INTEGRAL COMPONENT OF THE WATER-ENERGY-FOOD-CLIMATE NEXUS

Climate change and economic development increase pressure on global water, energy, and food resources, amplifying trade-offs and conflicts among these resources and stakeholders[11]. Groundwater is an important component of the global hydrologic cycle and climatic system,including regional climate feedbacks that are important drivers of the Water-Energy-Food-Climate Nexus. Groundwater is necessary for many human and natural systems, and is a substantial economic resource in most developed and developing countries. The management of groundwater resources has policy implications outside of the water sector, including agriculture and food security, energy, human health, and sustainable ecosystems. Thus, policy decisions need to carefully assess their implications for climate-water-society connections and the sustainability of groundwater resources.

IMPROVED GROUNDWATER GOVERNANCE

IMPROVED GOVERNANCE IS NEEDED FOR SUSTAINABLE GROUNDWATER RESOURCES

Many groundwater resources are vulnerable to climate change and coupled human activities because of 1) inadequate legislation, regulations, and national water policies that provide no clear priorities or directions to responsible government agencies, and 2) limited financial means and personnel to sustainably manage groundwater resources and water supply systems.

Political commitment and leadership are essential to create an adequate basis for governance. Building effective institutions, comprising the legal and regulatory framework, organisation (both governmental and non-governmental) and permanent stakeholder engagement mechanisms are at the core of groundwater governance[12]. Likewise, the implementation and adoption of laws and regulations by all stakeholders are essential to enable effective management (Fig.1).

ADAPTIVE GROUNDWATER MANAGEMENT NEEDS TO INTEGRATE REGIONAL WATER AND AGRICULTURAL POLICIES

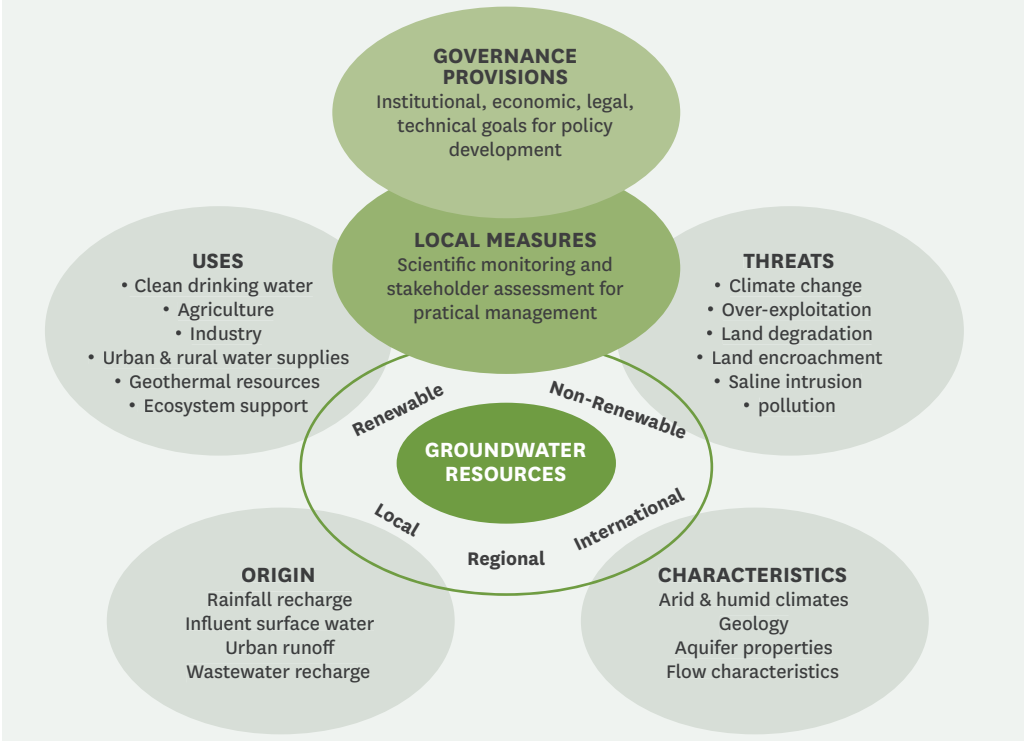
Water-stressed regions may achieve sustainable groundwater resources by effectively integrating regional water and agricultural policies. Such policies can control illegal groundwater abstraction, create water banking infrastructure and policy, diversify crops and implement best practices for water-efficient irrigation. Such management approaches need to strike a balance between ecological protection, human development, and acceptable socio-economic costs.

GENDER, CLIMATE CHANGE, AND GROUNDWATER

CONTINUED NEED FOR PROGRAMS THAT EMPOWER WOMEN AND ADVANCE GENDER EQUALITY

Women represent at least half of the workforce in agriculture and food production, and often bear the daily burden of carrying water to their families. Although women play such a pivotal role in water resource management, sanitation and hygiene (especially in rural areas), gendered water data are among the least available of national-level indicators, and 45% of countries do not produce any gender statistics related to water[13]. Climate change, inadequate access to water, and poor water quality negatively affect women's and girls' health, education, employment, income, and empowerment in ways that are distinct from their male counterparts[14-16] There are corresponding risks to both local and global food production and the care of livestock[17]. Additionally, in academia, women are under-represented in hydrogeology studies mainly because of the structure of academia and historically low numbers of women entering the field[18].

Figure 1: Interlinkages in Groundwater Governance



ASSESSMENT OF GROUNDWATER AVAILABILITY AND SUSTAINABILITY

STRONGER LINKS BETWEEN SCIENCE AND POLICY ARE NEEDED TO BETTER QUANTIFY GROUNDWATER WITHDRAWAL AND SUSTAINABLE YIELD

Freshwater withdrawals for agriculture, households, and industry have major effects on most groundwater resources representing one of the few components of the groundwater budget that society can most directly influence by adaptive management practices and policy decisions. Because there is a temporal lag (months to years) in many aquifers before the trending effects of groundwater withdrawals become evident, there is a tendency to neglect studies that are needed to properly support groundwater management until water-resource crises materialize. This reactionary stance can be improved if there is policy that supports scientific efforts to better monitor, quantify, and regulate groundwater withdrawals. Improved estimates of withdrawals will complement efforts to quantify recharge, and lead to improved estimates of current and future groundwater storage. Adaptive management planning will require best estimates of sustainable groundwater yield, which is not currently available for aquifer systems in many regions of the world.

KNOWLEDGE IS FRAGMENTED REGARDING CLIMATE CHANGE IMPACTS ON GROUNDWATER QUALITY

Climate change impacts and threats to groundwater quality are multiple and significant. However, our knowledge of regional scale groundwater quality processes under the pressures of climate change remains fragmented.

Examples of factors and their expected effects on groundwater quality

FACTOR	EXPECTED EFFECT
Hydroclimatic Systems	
Reduced rainfall and prolonged drought periods	Reduced transport of surface contaminants to groundwater, but increased contaminant concentrations in residual waters[19]
Increased groundwater temperatures	Increased reaction rates of biogeochemical processes
Reduced permafrost; and increased frequency of high intensity rainfall events	Accelerated mobilisation of pollutants to groundwater[20]
Declining groundwater levels due to increased pumping	Mobilisation of some oxidation-sensitive contaminants in groundwater
Agricultural Systems	
Smart water saving techniques reducing the quantities of surface waters used for irrigation practices	Decreased recharge and reduced transport of agricultural chemicals to the water table
Increased fertilizer application to crops, due to increased nutrient leaching from soils	Increased risk of groundwater in rural areas
Increased pesticide applications to crops due to augmented weeds and insects with rising temperatures	Increased risk of groundwater in rural areas
Increased recharge due to changing climate or agricultural practices	Mobilize naturally occurring salts in the soil and negatively affect groundwater quality
Socio-economic Systems	
Predicted migration of populations away from high risk areas[21]	Increased risk of contamination in urban areas
Coastal Systems	
Sea-level rise	Sea-water intrusion and degradation of coastal groundwater[22]

GROUNDWATER SYSTEMS ARE HIGHLY VULNERABLE ON SMALL ISLAND DEVELOPING STATES (SIDS)

Although all islands are vulnerable to saltwater intrusion, SIDS rely on small coastal aquifers that are at higher risk of saltwater contamination from sea level rise, pumping, and wave over wash events. In the absence of coordinated and sustained national and international action, low-lyig islands in the Pacific that are highly dependent on scarce, polluted and increasingly saline groundwater resources, and impacted by climatic variability and change, are facing dramatic choices. In many other islands around the world, degradation of groundwater quality and growing water demands are posing short-medium term threats to human health and impairing ecosystem services[23].

GROUNDWATER MONITORING IS AN IMPORTANT FIRST STEP

Groundwater levels should be monitored regularly to establish baseline conditions and help make best informed management decisions, including how groundwater can be used for climate change adaptation.

GROUNDWATER MANAGEMENT STRATEGIES TO REDUCE VULNERABILITIES

SUSTAINABLE GROUNDWATER IS AN ISSUE OF NATIONAL AND INTERNATIONAL SECURITY

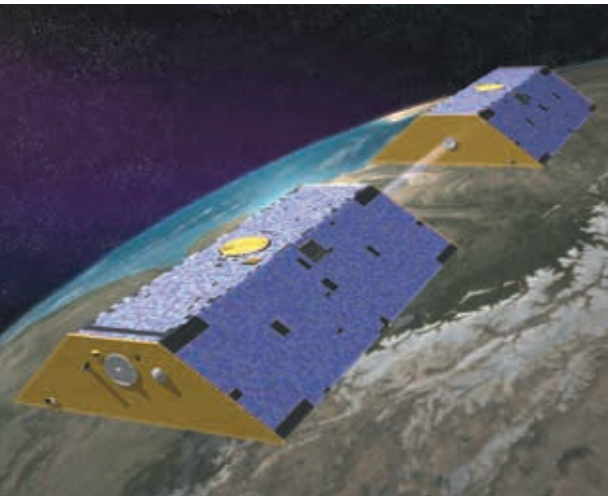
Groundwater is a key component to national and international water security[22]. International climate discussions need to continue to develop a policy infrastructure that shares groundwater resources across political boundaries as an important component of national and international adaptation strategies.

INTEGRATED WATER RESOURCES MANAGEMENT NEEDS TO BE ADOPTED MORE UNIVERSALLY

Integrated Management of Water Resources (IMWR) includes the conjunctive use of surface-water and groundwater for optimal use as one water resource. IMWR should meet strategic local objectives and be flexible over time as projected climate-groundwater interactions become certainties or unexpected realities.

MANAGED AQUIFER RECHARGE (MAR) IS A PROMISING ADAPTATION APPROACH

Support programs and initiatives that assess the suitability of managed aquifer recharge (MAR) and artificial storage and recovery (ASR) projects, particularly in developing countries. Artificial recharge and managed storage and recovery projects will likely become more important strategies of many local water managers to store excess renewable water supplies in aquifers during wet periods, which can be used to off-set limited surface-water supplies during dry periods.



GRACE satellites (source: NASA).

COLLABORATE WITH PARTNERS OF SPECIALIZED KNOWLEDGE

COLLABORATE WITH PROGRAMS AND AGENCIES WITH SPECIALIZED KNOWLEDGE

Local water management agencies looking for assistance with adaptation strategies should contact one of the several international programs and agencies with specialized knowledge about groundwater and climate change[24], including GRAPHIC, International Groundwater Resource Assessment Centre (IGRAC), and the International Association of Hydrogeologists (IAH) Commission on Groundwater and Climate Change.

PROMISING NEW TECHNOLOGIES

NASA's Gravity Recovery And Climate Experiment (GRACE) satellite mission has revolutionized the monitoring of the global water cycle. By monitoring the temporal variations of the Earth's gravity field with an unprecedented temporal and spatial resolution, GRACE has provided new insights into water masses stored at the surface and in the subsurface, including "inaccessible" groundwater systems. GRACE provides sufficient accuracy to track changes in the Earth's gravity associated with water [25]. Major advances encompass the quantification of groundwater overexploitation in major agricultural regions of the world[26] and the evaluation of water policies with regard to sustainability goals[27]. The GRACE mission prepared by the American and German space agencies (NASA and DLR), was launched in 2002 for an initial life of 5 years. After 10 years of reliable service, the success of the mission has encouraged NASA and DLR to launch a follow on mission, planned for 2017.

CONTRIBUTORS

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Groundwater resources in Greater Mekong Sub-region: Collaborative management to increase resilience

A collaboration of Vietnam, Lao PDR, Cambodia, Thailand and Myanmar to increase climate resilience in the greater Mekong Sub-region through improved groundwater management and transboundary cooperation

Annex V: Detailed budget and budget Excel sheets

Budget (Excel sheets, Annex V)

Sheet 1: Summary project budget
Sheet 2: Breakdown of the project execution costs (CCOP-TS)
Sheet 3: Implementing Entity (MIE) management fee (UNESCO)
Sheet 4: Budget disbursement schedule with time-bound milestones.
Sheet 5: Detailed project budget, Excel format (Annex)

Sheet 1: Summary project budget

Project Component		2,017 Year 1	2018 Year 2	2019 Year 3	2020 Year 4		4 year Total US $
ANNUAL TOTALS PER COMPONENT							
Component 1		510,500	324,200	119,200	246,100		1,200,000
Component 2		101,000	208,500	174,500	16,000		500,000
Component 3		130,900	315,100	413,500	140,500		1,000,000
Component 4		66,000	98,500	175,500	160,000		500,000
Component 5		121,700	314,500	395,300	168,500		1,000,000
	Subtotals	**930,100**	**1,260,800**	**1,278,000**	**731,100**		**4,200,000**
Project Execution Costs 8.5 %		79,059	107,168	108,630	62,144		357,000
	Subtotals	1,009,159	1,367,968	1,386,630	793,244		4,557,000
Management Fee 7.5 %		75,687	102,598	103,997	59,493		341,775
	Totals	**1,084,845**	**1,470,566**	**1,490,627**	**852,737**		**4,898,775**

Sheet 2: Explanation and breakdown of the project Execution costs

			2017 Year 1	2018 Year 2	2019 Year 3	2020 Year 4		4 year Total US $	
	Project/Programme Execution cost 8.5 %								
Exec.-1	Project Coordinating Technical Advisor		45,000	55,000	55,000	25,000		180,000	
Exec.-2	CCOP-TS Support staff		22,500	22,500	22,500	22,500		90,000	
Exec.-3	Operational costs		10,000	10,000	10,000	10,000		40,000	
Exec.-4	Project related regional travel & stay		6,500	6,500	6,500	6,500		26,000	
Exec.-5	External services (website, accountant)		5,250	5,250	5,250	5,250		21,000	
		Subtotal	**89,250**	**99,250**	**99,250**	**69,250**		**357,000**	

Sheet 3: Explanation and breakdown of the MIE Management fee 7,5 %

			2017 Year 1	2018 Year 2	2019 Year 3	2020 Year 4		4 year Total US $	
	Project Management Fee charged by the Implementing Entity 7.5 %								
Mngmt-1	General programme implementation support		41,000	48,000	42,000	42,000		173,000	
Mngmt-2	Finance, budget and treasury support		11,250	11,250	11,250	12,250		46,000	
Mngmt-3	Reporting to Adaptation Fund, M & E		12,250	12,250	12,250	12,250		49,000	
Mngmt-4	Project related regional travel		6,187	6,500	6,500	6,500		25,687	
Mngmt-5	Operational costs, publications costs		0	9,000	9,000	8,866		26,866	
Mngmt-6	External services (procurement, accountant)		5,000	5,225	5,997	5,000		21,222	
		Subtotal	**75,687**	**104,225**	**103,997**	**57,866**		**341,775**	

Sheet 4: Budget disbursement schedule with time-bound milestones.

Payment	Upon Agreement signature	Year 1	One Year after Project Start	Year 2	Year 3		Year 4		Total %	Total Amount
									(US $)	
Scheduled Date	15-02-2017		15-02-2018		15-02-2019		15-02-2020			
Project Funds, incl. Exec. costs	*22.15%*	1,009,159	*30.02%*	1,367,968	*30.43%*	1,386,630	*17.41%*	793,244	*100%*	**4,557,000**
Implementing Entity Fee	*22.15%*	75,687	*30.02%*	102,598	*30.43%*	103,997	*17.41%*	59,493	*100%*	**341,775**
Total		**1,084,845**		**1,470,566**		**1,490,627**		**852,737**		**4,898,775**

Sheet 5: Detailed project Activity budget

Activity	Project Component	Outcome(s)	Cost items	2017 Year 1	2018 Year 2	2019 Year 3	2020 Year 4	4 year Total US $	Remarks Number
	Component 1: Groundwater Resource assessment and monitoring	Harmonised regional GW resource inventory supporting regional GMS approach to address challenges of climate change and resilience; information-based policy to manage resources and further develop new GW based resilience strategies and practical interventions.							
Incept-1	Component work package Inception & preparation		National expert time, TA tima	15,000				15,000	
Incept-2	Inception visits 5 countries and data collection		National expert time, TA time, travel & stay, data costs	90,000				90,000	
Incept-3	Inception report contributions		National expert time, TA time	9,600				9,600	
Activ. 1.1	Component techncial coordination and support		national expert time, TA time	7,000	9,600	9,600	7,000	33,200	
Activ. 1.2	Database and GIS systems set-up and management, 4 pilot areas: groundwater related data inputs and costs		GIS expert time, data files	50,000	25,000	25,000	15,000	115,000	
Activ. 1.3	5 Country Workshops on project scope and setting up project network (CoP)		Workshop costs, TA time, travel & stay, consumables	125,000				125,000	
Activ. 1.4	Groundwater resources & aquifer status reports, 4 pilot areas		TA time, national expert time		50,000			50,000	
Activ. 1.5	Development of basic groundwater monitoring system in 4 pilot areas, installation of equipment		National expert time, TA time,	19,200				19,200	
Activ. 1.6	Equipment costs (4 pilot areas)		Equipment costs	120,000	35,000	20,000		175,000	
Activ. 1.7	Pilot area localised data collection approach and practicalities, with paticipation of stakeholders and groundwater users		National expert time, travel & stay, consumables	16,000				16,000	
Activ. 1.8	Pilot areas resilience potential characterization; 1 central workshop for four pilot areas		National expert time, TA, workshop costs, travel & stay		55,000			55,000	
Activ. 1.9	Mid-term evaluation of groundwater resources status of pilot areas, 4 dedicated workshops, at the end of year 2		Workshop costs, TA time, national experts time, travel & stay, consumables		68,000			68,000	
Activ. 1.10	Regional project Conference (Siem Reap, Cambodia) and field visit; participants from 5 countries, national expert teams, TA support team, invited speakers, and supporting resource persons		Workshop costs, TA time, national experts time, travel & stay, consumables				155,000	155,000	
Activ. 1.11	Support Mid-term review and Project Steering Committee meetings		TA time, national expert time		7,000	9,000		16,000	
Activ. 1.12	National technical expert inputs for Project Steering Committee meetings (8 times)		National expert time, TA time	9,200	9,100	9,100	9,100	36,500	
Activ. 1.13	Output Evaluation and dissemination - visibility products in and ouside the region		National expert time, TA time, consumables	10,000	20,000	10,000	20,000	60,000	
Activ. 1.14	General consumables and logistics		Consumables	2,000	2,000	2,000	2,000	8,000	
Activ. 1.15	National pool of experts time (5 countries, multiple institutions)		National expert time	27,500	28,500	22,500	26,000	104,500	
Activ. 1.16	International TA support, pool of experts		TA expert time, travel & stay	10,000	15,000	12,000	12,000	49,000	
			Subtotal	510,500	324,200	119,200	246,100	**1,200,000**	

	Activity	Project Component	Outcome(s)	Cost items	2017 Year 1	2018 Year 2	2019 Year 3	2020 Year 4	4 year Total US $	Remarks Number
		Component 2: Priority use and stakeholders	Increased participation by GW users in different sectors who are aware of resource management issues and have access to information and guidelines that support more sustainable use region-wide.							
	Incept-4	Component work package Inception & preparation		national expert time, TA time	6,000				6,000	
	Incept-5	4 pilot areas; visits to communities and local government, NGO's		national expert time, travel & stay	32,000				32,000	
	Incept-6	Inception report contributions		national expert time, TA time	3,500				3,500	
	Activ. 2.1	Resilience strengthening pilots		national expert time, TA expert time, operational costs, travel & stay		45,000	35,000	15,000	95,000	
	Activ. 2.2	Materials & equipment, installation costs in 4 pilots		materials & equipment		40,000	3,000		43,000	
	Activ. 2.3	Pilot areas socio-economic and water users characterization		national expert time, external consultant services	28,000	28,000			56,000	
	Activ. 2.4	Gender balance programme set-up and implementation		national expert time, TA expert time, operational costs, travel & stay	3,000	11,000	11,000		25,000	
	Activ. 2.5	Information products on vulnerability issues for each of the four pilot areas, for different groundwater user groups		national expert time, TA expert time, travel & stay		24,000	36,000		60,000	
	Activ. 2.6	Dialogue meetings with national policymakers and experts on strategic importance of groundwater resources in the overall climate change adaptation discussion		national expert time, TA expert time, operational costs, travel & stay		27,000			27,000	
	Activ. 2.7	Pilot for regional water-supply companies that use groundwater information on groundwater management tools		time, operational costs, travel & stay			34,000		34,000	
	Activ. 2.8	Resilience Agenda, Atlas, interAction in pilot area meetings (product preparation, local workshops)		national expert time, TA expert time, operational costs, travel & stay		14,000	37,000		51,000	
	Activ. 2.9	Output Evaluation and dissemination - visibility products in and ouside the region		National expert time, TA time, consumables	5,000	10,000	10,000		25,000	
	Activ. 2.10	National pool of experts time (5 countries, multiple institutions)		National expert time	12,000	7,000	6,000		25,000	
	Activ. 2.11	International TA support, pool of experts		TA expert time, travel & stay	10,000				10,000	
	Activ. 2.12	General consumables and support services		Consumables	1,500	2,500	2,500	1,000	7,500	
				Subtotal	101,000	208,500	174,500	16,000	**500,000**	

	Activity	Project Component	Outcome(s)	Cost items	2017 Year 1	2018 Year 2	2019 Year 3	2020 Year 4	4 year Total US $	Remarks Number
		Component 3: Resource management, information tools and equipment	Greater resilience and sustainable GW resource use, with protection of low income and vulnerable user groups. Transboundary groundwater policies more robust and climate change ready.							
	Incept-7	Component work package Inception & preparation		national expert time, TA time	9,000				9,000	
	Incept-8	Expert meeting on resource management information concepts and tools; option and start up development		TA expert time, national expert time, travel & stay	32,000				32,000	
	Incept-9	Inception report contributions		national expert time, travel &	3,500				3,500	
	Activ. 3.1	Application of database and GIS tools; specialised information products that can be derived from it What do the results tell us (statistics in the database, geographical info: .		TA expert time, national expert time, travel & stay	52,000	32,000	32,000		116,000	
	Activ. 3.2	Tailored database and GIS tools development and demonstrations, data hosting and provision services		External services; supporting TA expert time, national expert time, travel & stay;		45,000	45,000	25,000	115,000	
	Activ. 3.3	Revisit resilience potential: what can user do with it; how to exploit this ? Prepare Resilience potential asssessment		Supporting TA expert time, national expert time		56,000	42,000		98,000	
	Activ. 3.4	Pilots supported with groundwater monitoring and management information and applicatin to develop resilience options		Supporting TA expert time, national expert time, travel &		36,000	56,000	31,000	123,000	
	Activ. 3.5	Technical meetings: Co management of Surface and Groundwater, with national expert and MRC, supporting organisations		External services; supporting TA expert time, national expert time, travel & stay;			38,000	22,000	60,000	
	Activ. 3.6	Actual Management interventions like MAR or other		Regional TA expert time		42,000	28,000	12,000	82,000	
	Activ. 3.7	Supporting reslience measures in 4 pilot areas, including installations and equipment		Material costs; supporting TA expert time, national expert		60,000	98,000		158,000	
	Activ. 3.8	Output Evaluation and dissemination - visibility products in and ouside the region		National expert time, TA time, consumables	5,000	10,000	10,000	25,000	50,000	
	Activ. 3.9	National pool of experts time (5 countries, multiple institutions)		National expert time	15,000	23,000	33,000	11,500	82,500	
	Activ. 3.10	International TA support, pool of experts		TA expert time, travel & stay	13,000	3,600	24,000	8,000	48,600	
	Activ. 3.11	General consumables and support services		Consumables	1,400	7,500	7,500	6,000	22,400	
				Subtotal	**130,900**	**315,100**	**413,500**	**140,500**	**1,000,000**	

	Activity	Project Component	Outcome(s)	Cost items	2017 Year 1	2018 Year 2	2019 Year 3	2020 Year 4		4 year Total US $		Remarks Number		
		Component 4: Regional cooperation, coordination and information exchange.	A regionally coherent policy for climate adaptation through sustainable GW resource management; level playing field for all sectoral users in the region, efficiency gains in common approach and support tools.											
	Incept-10	Component work package Inception & preparation		national expert time, TA time	9,000					9,000				
	Incept-11	Research and documentation of policy context and practical cases; documentaiton packages for 5 countries		TA expert time, national expert time, travel & stay	24,000					24,000				
	Incept-12	Inception report contributions		national expert time, travel & stay, TA expert time	3,500					3,500				
	Activ. 4.1	Documentation on transboundary aquifer systems; resource status, transboundary implications and policy reccommendations		National expert time, TA expert time,		16,000	16,000			32,000				
	Activ. 4.2	Pilot areas workshops (4x) on transboundary climate policy		Workshop expenses			45,000	40,000		85,000				
	Activ. 4.3	Application of TBA Assessment Methodology on the four pilot areas		National expert time, TA expert time, Travel & stay, consumables			27,000	26,000		53,000				
	Activ. 4.4	Working group on sharing & co-development of tools		National expert time, TA expert time, Travel & stay, consumables		24,000	24,000	24,000		72,000				
	Activ. 4.5	Working group on national policy and strategy				24,000	19,000	24,000		67,000				
	Activ. 4.6	Regional policy coordination; preparation of White paper for ASEAN forum, emphasizing climate adaptation in transboundary regions		National expert time; support services, TA xpert time		12,000	10,000	12,000		34,000				
	Activ. 4.7	Documentation materials for pilot regions		National expert time			8,000	8,000		16,000				
	Activ. 4.8	Output Evaluation and dissemination - visibility products in and ouside the region		National expert time, TA time, consumables		5,000	10,000	10,000		25,000				
	Activ. 4.9	National pool of experts time (5 countries, multiple institutions)		National expert time	12,000	7,000	6,000	7,000		32,000				
	Activ. 4.10	International TA support, pool of experts		TA expert time, travel & stay	16,000	8,000	8,000	8,000		40,000				
	Activ. 4.11	General consumables and support services		Consumables	1,500	2,500	2,500	1,000		7,500				
				Subtotal	**66,000**	**98,500**	**175,500**	**160,000**		**500,000**				

	Activity	Project Component	Outcome(s)	Cost items	2017 Year 1	2018 Year 2	2019 Year 3	2020 Year 4		4 year Total US $		Remarks Number		
		Component 5: Capacity building and training	Internal capacity in the GMS region to develop CCA policy and practical resilience enhancing interventions, to use state-of-the-art tools and work with CoP, stakeholders and vulnerable groups.											
	Incept-13	Component work package Inception & preparation		national expert time, TA time	9,000					9,000				
	Incept-14			TA expert time, national expert time, travel & stay						0				
	Incept-15	Inception report contributions		national expert time, travel & stay	3,500					3,500				
	Activ. 5.1	Training programme in MAR, ASR and other storage and GW potential strengthening techniques, connected to pilots (2x)		Training workshops		37,500	37,500			75,000				
	Activ. 5.2	Higher eduction scholarships (10 MSc positions) for promising young BSc graduates		Scholarships for training in the region	50,000	50,000	20,000			120,000				
	Activ. 5.3	Transboundary aquifer management; training programme (IGRAC)		Training workshops		42,500	37,500			80,000				
	Activ. 5.4	GGMN – the next level training for the Lower Mekong SubRegion; training and learning-by-doing (IGRAC)		Training workshops	42,500		42,500			85,000				
	Activ. 5.5	Co-management of surface and groundwater; training workshop with MRC experts		Training workshops		42,500		42,500		85,000				
	Activ. 5.6	Information and resources sharing & cooperation on formal training programmes in institutes, recognition of each other certificates, etc.		Training workshops		42,500	40,000	25,000		107,500				
	Activ. 5.7	**Learning and knowledge management** subcomponent; Information repository and sharepoint		Web services, resource materials, national expert time,		40,000	40,000	20,000		100,000				
	Activ. 5.8	Pilot area (4x) on site training stakeholders and groundwater users; development of training materials for end-users		national experts time, TA time, materials			32,000	18,000		50,000				
	Activ. 5.9	Support to professional and higher education formal training programmes in the region		TA expert time, national expert time, travel & stay		20,000	40,000	20,000		80,000				
	Activ. 5.10	Regional Conference on Capacity building, Knowledge management, Studies; Groundwater management and Climate Change Adaptation		Conference costs, national expert time, TA expert time			75,000			75,000				
	Activ. 5.11	Output Evaluation and dissemination - visibility products in and ouside the region		National expert time, TA time, consumables		15,000	10,000	25,000		50,000				
	Activ. 5.12	National pool of experts time (5 countries, multiple institutions)		National expert time	8,000	12,000	6,000	6,000		32,000				
	Activ. 5.13	International TA support, pool of experts		TA expert time, travel & stay	7,200	8,000	8,000	8,000		31,200				
	Activ. 5.14	General consumables and support services		Consumables	1,500	4,500	6,800	4,000		16,800				
				Subtotal	**121,700**	**314,500**	**395,300**	**168,500**		**1,000,000**				

				2017	2018	2019	2020		4 year			
	Project Component			Year 1	Year 2	Year 3	Year 4		Total US $			
	ANNUAL TOTALS PER COMPONENT											
	Component 1			510,500	324,200	119,200	246,100		**1,200,000**			
	Component 2			101,000	208,500	174,500	16,000		**500,000**			
	Component 3			130,900	315,100	413,500	140,500		**1,000,000**			
	Component 4			66,000	98,500	175,500	160,000		**500,000**			
	Component 5			121,700	314,500	395,300	168,500		**1,000,000**			
			Subtotals	930,100	1,260,800	1,278,000	731,100		**4,200,000**			
	Project Execution Costs 8.5 %			79,059	107,168	108,630	62,144		**357,000**			
			Subtotals	1,009,159	1,367,968	1,386,630	793,244		**4,557,000**			
	Management Fee 7.5 %			75,687	102,598	103,997	59,493		**341,775**			
			Totals	**1,084,845**	**1,470,566**	**1,490,627**	**852,737**		**4,898,775**			

				2017	2018	2019	2020		4 year			
	Activity	Project Component	Outcome(s)	Year 1	Year 2	Year 3	Year 4		Total US $			
		Project/Programme Execution cost 8.5 %										
	Exec.-1	Project Coordinating Technical Advisor		45,000	55,000	55,000	25,000		180,000			
	Exec.-2	CCOP-TS Support staff		22,500	22,500	22,500	22,500		90,000			
	Exec.-3	Operational costs		10,000	10,000	10,000	10,000		40,000			
	Exec.-4	Project related regional travel & stay		6,500	6,500	6,500	6,500		26,000			
	Exec.-5	External services (website, accountant)		5,250	5,250	5,250	5,250		21,000			
			Subtotal	**89,250**	**99,250**	**99,250**	**69,250**		**357,000**			
		Project Management Fee charged by the Implementing Entity 7.5 %										
	Mngmt-1	General programme implementation support		41,000	48,000	42,000	42,000		173,000			
	Mngmt-2	Finance, budget and treasury support		11,250	11,250	11,250	12,250		46,000			
	Mngmt-3	Reporting to Adaptation Fund, M & E		12,250	12,250	12,250	12,250		49,000			
	Mngmt-4	Project related regional travel		6,187	6,500	6,500	6,500		25,687			
	Mngmt-5	Operational costs, publications costs		0	9,000	9,000	8,866		26,866			
	Mngmt-6	External services (procurement, accountant)		5,000	5,225	5,997	5,000		21,222			
			Subtotal	**75,687**	**104,225**	**103,997**	**57,866**		**341,775**			