# Enabling sustainable and inclusive irrigation development in Cambodia

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**Enabling sustainable and inclusive irrigation development in Cambodia**

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# ENABLING SUSTAINABLE AND INCLUSIVE IRRIGATION DEVELOPMENT IN CAMBODIA

**ABSTRACT**

Cambodia's 16% of the total cultivated area (2.7 million hectare) is irrigated by 950 irrigation schemes most of which were developed by the government. Financing irrigation development in Cambodia has two problems: (a) shrinkage of funds for construction of ongoing or new canal network, leading to delay in completion of projects; (b) crunch for operation and maintenance. This paper, focuses on status of financing irrigation development laying stress on identifying options to fund the irrigation development more aggressively and sustainably. Further, possible approaches, governance reforms required in water sector, and supportive policy and legal aspects are discussed.

**KEYWORDS***:* **financing irrigation, governance, operation and maintenance costs, fiscal crunch**

**JEL Classification: Q25, H54**

## 1. Introduction

In most of the developing counties financial resource constraints towards provision of water for agriculture is of primary concern. Cambodia being no exception suffers from financial crunch for funding construction of canal networks as well as operational and maintenance costs of these networks. The national budget is unable to allocate more funds for irrigation which might lead to a situation where surface irrigation might remain much below its potential and head to a collapse. The World Water Commission (2000) made a strong plea for public–private partnerships and tapping international capital markets for financing water sector development and for creating more efficient management system. This discussion emphasizes the role of international financial markets, particularly the role of multinational corporations in financing water-related infrastructure.

In Cambodia there are about 950 irrigation schemes built by the government which irrigates 16% of the total cultivated area. Of these schemes, 14% are non-functional and there is a lot more potential to expand the irrigated area. In Cambodia's irrigation systems, normally one crop is grown per year primarily during the dry season. Cambodia's relatively low levels of agricultural productivity are mainly due to lack of good water control, highly variable rainfall, poor soil fertility and low levels of fertilizer use (Raju, 2016). Annual rainfall varies from 975 to 2068 mm, but large part of the country gets around 1000 mm; across the 17 river basins, 15 of them get 1000-1300 mm, one river basin receives 1644 mm and another is bestowed with 2068 mm rainfall. Cambodia has 42 river sub-basins with a total area of 181,086 sq km (range 365-17835 sq km).

For agricultural use, groundwater is used in southern and eastern Cambodia, but not used in the northeast. This is because availability of groundwater at lower depth is better at the South

and Northeast region of Cambodia (50 and 75 mts. depth respectively). This is stark contrast to other deltaic situations like Bangladesh, Southern Pakistan, Gangetic plains in Eastern India. Farmers in Cambodia are less aware of groundwater use, as well as about equipment required for groundwater extraction (like pumps, pipelines and either diesel or power operated low horse power pumps). However, harnessing the potential source of alternative irrigation farmers in the downstream of canal command which are dry during the dry season can double their income by using groundwater in the dry season. Since most of these lands are at the downstream of small-scale reservoirs, groundwater recharge levels are high, and farmers can utilize the available and regularly recharged groundwater.

Given the present context the present study tries to make an estimate of the financial expenditure to cover the rehabilitation and construction of the canal networks to meet the water requirements of agriculture for reduction in poverty. Additionally, the paper also focuses on the possibilities for financial and governance reform options in water sector to make it sustainable.

## 2. Present Expenditures on the water sector

Cambodian water sector is financed through budgetary allocations and external assistance – both bi-lateral and multi-lateral agencies. In terms of external assistance, irrigated agriculture (mainly irrigation system rehabilitation) has received US$ 176 million over the last 26 years (1980-2006). This assistance in the form of both loans and grants was meant for capital investments. The grants for technical assistance during 1993-2006, were up to US$ 24 million[1]. All projects/ programs related to capital investments and technical assistance were implemented under the former Directorate General of Irrigation, Meteorology and Hydrology

[1] Source: ADB and MOWRAM, 2007

(Ministry of Agriculture, Forestry and Fisheries) before it was upgraded to the Ministry of Water Resources and Meteorology (MOWRAM) in 1999 are currently implemented under the current MOWRAM. Similarly, all technical assistance grants and the loans were directed by the Directorate General of Irrigation, Meteorology and Hydrology are currently directed by MOWRAM.

In recent years (2000-2007), various donors have jacked up their share of contribution (mainly for capital expenditure) up to US$ 20 million/year, from 10 million during 1990s. Most of these funds are going for construction of new physical works; Mr. Chinn Sinath, deputy director-general of the MOWRAM, pegs the actual need at US$ 70 million/year for the next 10 years, largely for construction of potential irrigation projects. In 2007-08, the government got US$ 30 million from various donors. But it still requires another US$ 40 million/year for operation and maintenance of these systems. Current expenditure pattern indicates, of the total expenditure nearly 30% is being spent on construction of small-scale irrigation systems and another 30% on its operation and maintenance.

With respect to budgetary support, Cambodia has been witnessing raising expenditure for water resources development. Over the last few years, the annual expenditure in water sector has gone up to US$ 3.6 million (in the year 2008) from US$ 2.5 million (in 2005). Interestingly, these investments are only on operation and maintenance of its country wide irrigation structures excluding any capital investment; while the requirement is around 12 million US$ per year. This indicates that over this period around 40% increment in expenses, where administration costs have increased and pumping costs have decreased. Estimations by various studies (by MOWRAM and other donor studies) have indicated that approximately one million ha of land could be irrigated from surface water, by low-lift pimps, small

diversion weirs and 'calmative' canal systems. Owing to inadequate financial support, most schemes are not being managed routinely by the MOWRAM.

FIGURE 1

Given this background, there is a strong felt need, among the senior officials of the MOWRAM, to create a separate fund for long-term growth and sustainability of irrigation systems. Further, the Royal Government of Cambodia has plans[2] to increase its irrigated area to 872,000 ha (by 2025) from its present scenario (672,000 ha by year 2015). The Plan has made following projections for water demand in the country: a) Irrigation – paddy -2.6 million ha fixed with wet irrigated: 20,000 ha increase per year; b) secondary and commercial crops, orchards not included in the proposed plan – low irrigation rate in 2025 (35.5%). However, there is no data for use levels; c) livestock (1.7% of demand); d) aquaculture, not included (0.12% of demand); e) domestic water (9.9% of demand); f) industrial water (3.3% of demand); g) but requirement for environmental flows is not included. The major stress is on irrigation infrastructure by rehabilitation of existing infrastructure, including construction of additionally new and necessary facilities in each river sub-basin of the country. One of the recent studies[3] has estimated US$ 32.13 million (civil works cover 73% of the total cost) for 27 selected sub-projects in three provinces (Kampong Thom, Siem Reap, and Banteay Meanchey).

[2] Proposed Master Plan of Water Resources Development in Cambodia, Draft prepared by the Korea Water Resources Corporation (2007).
[3] Carried out by the TEAM consulting engineering and management company limited and SDC consulting company limited with support of the Asian Development Bank and RGC/MOWRM (November 2007).

To meet future demands, the country requires huge fund, specifically committed to develop required water infrastructure and its maintenance. Cambodia requires to create and operate an irrigation investment fund for medium and large-scale irrigation systems. The following section tries to estimate the fund size required for the rehabilitation and construction of the canal networks across the country.

## 3. Estimation of the fund size

### *3.1 Estimation of the costs for rehabilitation and construction*

The national irrigation potential has been estimated at 1.6 million ha (NPMO, MOWRAM). The National Project Management Office (NPMO) of MOWRAM estimated the existing irrigation coverage at about 1,050,000 ha, of which 160,000 are served by small-scale irrigation schemes[4], 620,000 ha by medium-scale schemes and 270,000 ha by large-scale irrigation schemes. However, only about 56% of these irrigated areas are effectively served. The effective irrigation coverage is therefore about 588,000 ha or about 21% of the total area of 2.8 million ha under food crop production. Based on the irrigation coverage target of 650,000 ha in the strategy for agriculture and water (2006-10), the coverage gap to be filled is about 62,000 ha, by the year 2010, and the remaining 350,000 ha in the next five years (2010-2015). Additionally, 50% of the existing irrigated area (i.e. 244,000 ha) needs rehabilitation for efficient utilization of water resources.

TABLE 1

[4] Cambodia has three types of irrigation schemes. In Cambodia, irrigations schemes are classified as small when command area is less than 200 hectares. In contrast, medium irrigation schemes cater to command area between 200-5000 hectares and large projects have a command area of more than 5000 hectares.

The estimation of the costs towards rehabilitation and construction is based on the following assumptions on recent rehabilitation costs of small reservoirs of various sizes in recent years in: a) various parts of India[5], and b) recent projects and studies carried out in Cambodia[6].

a) Catchment area - US$ 500/ha

b) Water spread area - US$ 1000/ per sq km

(Improvements to reservoir bund, sluices, weirs, desilting)

c) Command area development - US$ 500/ha

(including field channels, outlets)

d) Rehabilitation costs may be provided in the above unit rate basis. This cost will constitute 75% of the total project cost. The remaining 25% of the cost toward institution and maintenance and management is to be arrived and added to get the total project cost.

e) The allocation in the total project cost is:

- Institutional development 10%
- Physical rehabilitation 75%
- Maintenance and management 15%

f) Based on the above, unit cost of US$ 2500/ha for small and US$ 3500/ha for medium scale reservoir projects and US$ 5000/ha may be adopted for project formulations.

The following tables (Table 2 and 3) provide the estimation of the (i) investment costs for utilization of potential irrigation area and (ii) investment costs for rehabilitation area respectively.

[5] Asian Development Bank, 2006. Rehabilitation and Management of Tanks in India: A Study of Select States. Publication Stock No. 122605.

[6] TEAM Consulting Engineering and Management and SDC Consulting, 2007. Water Sector Analysis. Cambodia: TA N04848: Water Resources Management (Sector) Project.

TABLE 2

TABLE 3

To regulate the irrigation sector, one can therefore think of two possibilities for financial and governance reform options in water sector. First, setting up a Financially Autonomous Irrigation Agency (FAIA), and second an independent Regulatory Commission for Water Resources (RCWR). The suggestion of an RCWR has a recent genesis, prompted by the way many infrastructure projects like power, ports and roads are attempting to raise finances from markets and improve upon their operational efficiency by introducing some commercial principles. The National Strategic Development Plan (NSDP) (2006-2010) of the Royal Government of Cambodia (p.xiv) clearly underlines that "successful and timely implementation of NSDP strategies and achievement of NSDP targets would need substantial and well-directed additional investments and their focused and effective use. Such investments need to be made both in the public and private sector"; it also said (p.xv) "expected resources not being available particularly from External Development Partners". These suggested financial and governance reform options in the water sector are very much in tune with the strategy adopted by the NSDP. The following sections take up the discussion on the creation of the FAIA and RCWR.

## 4. Setting up Financially Autonomous Irrigation Agency (FAIA)

The creation of FAIA can be an effective means of: a) introducing administrative and financial autonomy; b) increasing accountability; c) facilitating contacts with, and contracting out to farmers, NGOs and private firms; d) introducing less politicized procedures to set and collect water charges; and e) mobilising private sector funds. The key concept here is self-

financing and sustainability. The main idea is that after a pre-defined nascent period, such corporations must provide for O&M and recurrent expenditure out of their own revenues (capital expenditures may still continue to be "largely" funded by the state). They must have both the mandate and the authority to set water charges at a level adequate to cover their expenses and service their debts. Once such self-financing has been established and recourse to treasury funding for recurrent and O&M expenditure cut off, they can also sell debt in the bond market (World Bank, 1997; 26).

A review of irrigation financing in several countries (Small et al., 1989) identified FAIAs as one potentially powerful reform. Small and Carruthers (1991) argue that this approach is desirable from the efficiency perspective because a policy of user fees implemented by a FAIA creates the potential for improvements, both in the operation and maintenance of existing irrigation facilities and in the process by which investment decisions are made. The potential for improvements in O&M stems in part from the greater control that a FAIA can have over its budget. But the key to attain higher efficiency under FAIA lies in linking incentives of the agency staff with their performance in satisfying the demands of end users. If the income of these FAIAs is dependent on the revenue they themselves collect for irrigation service, this will provide incentive for more regular and stricter collection of revenues from user groups. Since users withholding payment in response to poor service will then have a direct impact on agency budgets (including salaries), it also creates incentives for better irrigation service to facilitate fee payment. Financial autonomy thus provides a functional link between collection of revenue from users of irrigation water and more effective irrigation performance by suppliers of water (Svendsen, 1991). Further, with financial autonomy, incentives are created to increase agency income, and to reduce costs.

Taken together, these factors should help establish a relationship of mutual dependence between the supply agency (i.e. irrigation department) and FWUC. The irrigation agency provides an essential service to farmers, i.e., irrigation water in the quantity and quality desired by the user, while users, in turn, provide the agency with the financial resources necessary for its existence and operation. It is the possibility of creating this critical link that distinguishes the FAIA from the typical irrigation department approach. To be an effective FAIA, it is necessary to establish the link between incentives and performance, irrespective of the kind of financial autonomy it has.

Structurally, FAIA can be an agency of user groups, or a private company, or an autonomous corporation created by the government under the Company Act, or a combination of any two or more of these. So long as it can introduce commercial principles, link incentives with performance, meet the O&M costs (and a part of capital cost), and promote efficiency, equity and sustainability in the use of canal irrigation waters, we feel it serves the purpose.

The capital and debt markets have provided an important alternative source of funding. The debt markets trade bonds of public sector undertakings and corporate debentures. Major investors in these bonds are institutions, due to the investment pattern may be specified by the Cambodian government. There are prospects for such financing to become a major source of funding in the near future, but there are certain conditions to be met:

- Only companies and corporations can issue papers which can be traded in these markets to raise funding. State issued papers are subject to the overall ceiling on state borrowing.

- The bonds must be professionally designed and issued, with terms, interests, and payment modes that attract the specific market segment to which a particular issue is addressed.
- The issuing companies or corporations must have the capacity to generate enough cash flow to service the bonds, which is constrained by the very low levels of water charges at present.

**5. Setting up Regulatory Commission for Water Resources (RCWR)**

In recent years there has been growing interest in privatization as a solution to the financial crunch faced by the irrigation sector as well as other infrastructure such as power, ports, and roads. The NSDP of Royal Government of Cambodia (2006-10) supports private sector participation in all sectors. It had gathered sufficient support to privatize infrastructure projects like roads, ports, power, telecommunications, and urban infrastructure, including domestic water supply. In many cases, it is now the private sector which has the capability of sourcing large funds internationally.

However, it is easy to underestimate the dangers of introducing commercial principles in a situation where the forces of competition do not work. The state continues to be responsible for providing appropriate regulatory frameworks which assist investors and infrastructure entities on the one hand and protect consumers from monopolistic exploitation on the other. The commercialization of infrastructure and unbundling also lead to a considerable increase in transaction costs which have to be mitigated through transparent and appropriate regulation. In a free market environment, costs of production/service are kept low by competition. But canal irrigation is more of a natural monopoly, and unless its costs are kept under tight control and its operations made transparent, it runs the danger of passing on the

high costs to the users of water. Indeed, the corporate arrangement provides less accountability and transparency than for government (especially Plan) expenditures. The price for faster turn-around in expenditure appears to be a reduction in cross-checks. Thus, there is need for an independent regulatory body such as an RCWR as a complement to financially autonomous agencies, to ensure transparency in the operations of such an agency.

The setting up of RCWR has been recommended for two reasons: first to bring transparency in the operations of FAIA, especially if it is to work on commercial lines, and second to ensure that pricing of water is distanced from political interference. FAIA represents a move towards bringing some elements of corporate culture in irrigation financing. It is better to charge the users of water to recover all costs of O&M at least, and if possible even capital costs. The first purpose of an RCWR, of creating transparency, is essential to keep costs down and prevent exploitation of water users by the corporation. However, this same transparency can also help distance pricing from political interference. When the current level water tariff is so low that even recovering O&M costs may require drastic increases in water rates (often more than four times), users are likely to object, obviously having political repercussions, which no political party can afford to ignore. It becomes essential to involve farmers in the entire exercise of fixing fees and checking on how they are spent, and convincing them that higher tariff would help the agency to render better service. Yet it is not an easy task to convince farmers that it would be in their interest to pay a reasonable water tariff.

RCWR can help in this direction by playing the role of an independent judiciary between the farmers and the agency. A precondition for success is that it be headed by a well-known person with a record of impeccable honesty, and should have representatives from both the

farmers' side as well as from the agency's side. It can always take technical experts to work out the `appropriate' level of tariffs. But the prime function of such a body would be to ensure transparency in costs of canal irrigation, especially capital costs. It would make known the contracts between private builders and the agency to people at large, would ensure access to information relating to these contracts, would invite NGOs and farmer groups to scrutinize these costs and encourage them to participate in the bids. This would help create healthy competition amongst construction companies, and check the large leakages (rent seeking) that often characterize this sector.

In the reformation of the irrigation sector for management transfer of irrigation systems to user's organizations, it is essential to redefine the role of the stakeholders and related agencies of the government, NGOs and user's organizations. These roles may be summarized as follows –

TABLE 4

## 6. Strategy and Policy options

The proposed strategy and policy options are in tune with two important strategies of the Royal Government of Cambodia: one, the National Strategic Development Plan (2006-2010) suggested governance reforms[7]; second, the long-term vision identified in the Strategy for Agriculture and Water (2006-2010). What we have proposed in the following sections has taken care of these broad strategies for the water sector. Also proposed are supportive policy

[7] NSDP (2006-10) clearly emphasizes good governance in all sectors. As part of its strategy NSDP says (p.45) "Good governance is the most important pre-condition for achieving sustainable socio-economic development with equity, equal opportunity and social justice.

and legal provisions required for robust management of the water sector in Cambodia required for the next few decades. These proposed strategy and policy reforms would enable Cambodian irrigation sector and its stakeholders to move ahead of other countries in Southeast Asia.

***6.1 Reforms in water sector governance***

a) Set up Independent Water Resources Regulation Authority with following key responsibilities.

- Water allocations across sectors –domestic, industrial, agriculture, environmental.
- Design and implement efficient conveying mechanisms from source to consumer level – take overall view of the entire state.
- Water auditing at project level (all projects)
- Enhance water use efficiency levels.
- Rationalise water tariff across sectors
- Performance measurement criteria at all levels
- Convergence of all related schemes/programmes

b) Water Sector Reforms

- The water sector need to unbundle its functions into: a) water procurement, b) operation and maintenance, c) distribution & revenue collection, d) pricing.
- Restructuring the MOWRAM's irrigation branch into two departments – a) minor irrigation (since 90% of irrigation comes from small and medium reservoirs), and b) major irrigation (since the required skill, technology is different than the minor irrigation). Both these departments can be headed by a Chief Engineer and then unbundled its functions and staff as listed above.

- Water utility reforms would require suppliers to behave more like commercial undertakings. This will imply adoption of more active pricing, introduction to metering, tariff restructuring, improved cost-recovery, and greater self-financing. This will often entail managerial and organizational reforms.

c) Set up autonomous bodies: Handling of any additional funding, and faster decision making and adopting improved processes, requires an autonomous body to be set up by the Cambodian government. The body may be headed by a retired and well experienced government official or an outside person, well-versed with government procedures. It can be under the direct supervision of the MOWRAM. But, more important is, this body will have all the powers to design new activities and projects, outsource skills and execution, have third party monitoring and evaluation and handle all required funding and mobilize funding on its own with active support from the government. This would enable the entire process, to move on a faster track, and reduce all the procedural delays, and enable to evolve innovative and efficient methods of improving water sector and livelihoods of farmers. Successful experiences of China (SIDDS) and India (JSYS in Karnataka, WASMO in Gujarat) may be adopted with refinement to suit local conditions.

d) Promote public-private sector participation: Cambodia needs to promote massive investments through public-private-commune mode. The NSDP (2006-2010) clearly promotes private sector involvement through BOOT basis (p, xiii) in rehabilitation of physical infrastructure, including irrigation facilities.

- Privatisation is appropriate in some cases, though it can take many forms and full private ownership is an extreme and rare variant. The French model of concessions

and lease contracts has influenced a number of developing countries, e.g, Cote d'Ivoire, Guinea, Malaysia, Morocco and Thailand. Regulated private companies also operate in Santiago de Chile and Guatemala City.

- Explore various options to design, execute, operation and maintain the systems
    - BOOT – Build, own, operate and transfer
    - ROOT – Rehabilitate, own, operate and transfer and any other

e) Promote River Basin Organisations: To move towards integrated water resources management, Cambodia needs to promote mechanisms to set up river basin and sub-river basin organisations (RBOs). These RBOs can take care of assessment of water resources (both ground and surface flows) availability, emerging competing water demands (drinking water, agricultural, industrial, livestock and fisheries, and environmental flows). RBOs need to develop systems for annual and seasonal allocations across the competing sectors.

The functions of River Basin Boards may vary ranging from

- preparation of basin level and regional plans,
- maintenance of the allocation of water supplies for different uses,
- generation of hydroelectric power
- investigations for further allocations if it is to be made
- maintenance of the multi-purpose projects
- monitoring etc.
- promote integrated water resources management

Thus, different Basin Boards across Cambodia may have different motivations behind their formation, which are basically needs-specific. Moreover, the funding of these Boards differs:

While some may generate their own funding and budget, others may depend on the government.

d) Reclassify irrigation systems: In Cambodia, irrigation systems below 200 ha command area is categorized as small-scale irrigation. These systems cater to 90% of the total irrigated area in the country. Farmers groups, during extended discussions across the six FWUCs expressed and field observations indicated that these systems require recategorization for better management.

In case of Cambodia, though categories (small, medium and large) are indicated, more clarity, in terms of management and functions, is required for the local commune, provincial office and the country government. What is essential to separate the category, based on size into two broad categories, Minor irrigation (0-500 ha) and Major irrigation (above 500 ha). The MOWRAM needs to restructure itself cater to these needs. Skills, technology, capacity building, information system, monitoring, water regulation mechanism, control over source and distribution varies across these two broad categories.

While, all minor irrigation systems (0-500 ha) can have one FWUC, major irrigation systems (above 500 ha) can have 3 tier organization systems of FWUCs – FWUC at field canal level, FWUC group at branch canal level, and FWUC Union at the large-scale irrigation system level. In both cases, sub-basin or and river basin users organization need to be encouraged. At country level, they can a federated structure headed by an FWUC apex body[8].

e) Integrate small reservoirs with large-scale command areas, wherever technically feasible

[8] A recent publication from the Asian Development Bank (2008) on Irrigation Management Transfer presents experiences of various countries in this regard. Also see websites of INPIM for global experiences in this regard. www.inpim.org.

- Prepare location, size and feasibility of reservoir filling in canal commands and through canals
- Develop estimates for additional storage to be gained across the projects and districts
- Need to estimate likely benefits by linking these reservoirs.

f) Stress on ecological and social dimensions in consultation of FWUCs: Across all provinces, the rapid assessment and our field observations, besides interviews with FWUC chair persons clearly stressed the need for physical rejuvenation of the entire system of each reservoir. It starts from the catchments area treatment, desiltation of reservoir bed area, strengthening of reservoir bund and plugging all leakages, stone-pitching wherever required, calibration of designed and actual flows in the canals, and installation of gauge records at all cross-regulators. None of the FWUC records indicate water flow levels and quantity. In fact, there are no gauge records installed in any of the FWUC systems.

g) E-governance and monitoring cell

- Promote GIS based systems for effective monitoring at all levels. Establish or outsource the geographical information system based water resources (including tanks and groundwater) map to be accessible to all levels of officers (assistant engineer to State level)
- Provide and computerize all levels of offices (up to assistant engineer level)
- Enabling offices, at all levels (including regional and FWUCs) with computers and on-line formats.
- On-line grievance cell
- Pollution load estimates in river and streams and make it mandatory to install water treatment plants in all in-let points.

- Establish on-line monitoring systems and monitoring it on regular basis.
- Evolve a set of performance monitoring and evaluation indicators at all levels.

h) Carry out environmental impact assessment: Cambodian irrigation systems are mostly located in the ecologically sensitive region, and linked to different sub-basins of the Mekong River Basin. Thereby, each system needs to be carefully assessed for their ecological contributions and their links to local livelihoods. e.g., Field observations indicated, burning of 60% of rice straws in the field itself, rather than using them as fodder (as used in several Asian countries – India, Pakistan, Sri Lanka) and as natural manure.

***6.2 Irrigation management transfer***

a) Decreased role by the government and increased role by user groups: The Ministry of Economy and Finance has to cooperate in making funding available for the development of irrigated agriculture sector which also includes the establishment and operationalizing the FWUC until they can operate on a self-help manner. Sufficient operation and maintenance budgetary allocation as stipulated in the Policy (MOWRAM, 2000) will have to be provided. As per this policy, the responsibility of operation and maintenance and the emergency repair shall rest with FWUC in a gradual process.

The above expenditure applies only for the irrigation schemes constructed by the government fund and or the support from the international and national agency. The Policy says, farmers' communities will be encouraged to plan and develop irrigation schemes by utilizing their own resources. Upon request technical assistance could be provided by the government to the farmers in this regard.

b) Management Transfer. Keeping in view of the global trend, and successful cases in several countries Cambodia needs to move towards management transfer.

- Select any 3-5 projects for pilot basis at the level of branch canals.
- Need to prepare action plan to cover the entire state in 2-3 years (details for the project design is discussed in section-2 of this paper).
- Set up Irrigation Management Transfer cell headed by an Engineer-in-Chief or Chief Engineer at the country level and convert one executive engineer at the provincial level in all projects to facilitate irrigation management transfer.
- Identify NGOs or professional organizations to facilitate the process.
- Need to cover both rural and urban water supplies.

Based on the capacity of the farmer organizations, the policy clearly states that, the irrigation systems shall be transferred to the FWUCs for their sustainable operation and maintenance and for the promotion of irrigated agriculture. Irrigation systems not fully transferred shall be jointly managed by the FWUC and the government. The right to operate the transferred irrigation scheme and related infrastructures and the responsibility of its protection shall be with the FWUC recognized by the government. After the scheme has been transferred, the Department of Agriculture of the MOWRAM shall conclude necessary agreement with the FWUC for proper utilization of irrigation facilities and related infrastructure.

If FWUC need financial, technical or other assistance, the government or private sector may provide it. But in the future, PIMD requires that all assistance to irrigation systems will be provided in ways that encourage local investment by the FWUC. Assistance may be provided in ways that build the capacity of the FWUC to be self-reliant. Assistance need to be restructured so that it may be provided in ways that avoid creating dependence of the FWUC on the government.

### *6.3 Promote solar powered irrigation pumps to replace diesel use*

Cambodia has indication of deposits of fossil fuels, natural gas and coal, and over 84% of the primary energy consumption is contributed by fuel wood. Less than 9% of rural households have access to a grid-quality electricity services. Per capita consumption of electricity is only about 48 kwh/year[9]. Those who depend mainly on rechargeable batteries and small diesel-fueled isolated generation have paid with very high unit prices of electricity. For more details see Box 1.

Measurement during 1981-88 at Phnom Penh showed an average sunshine duration of 6-9 hours per day with high average of 5 kwh/m2/day indicating considerable potential of solar energy. The application of Photovoltaic system with total installed capacity of around 130 kwh is a recent development in Cambodia, as donoted by international organisations such as UNICEF, Red Cross, SIDA and FONDEM who installed demonstration systems on health and rehabilitation centers. Solar Home Systems with an output of 12v, 50-70 Ah are being used for low income households in rural areas and require a US$ 40 investment per household. The cost of energy generated is approximately US 24.4 cents/kwh[10] .

[9] Cambodia Energy Sector Strategy (draft), 2004. website:
[10] Op cit.

**Box-1. Pumping Costs to farmers**

An employee of Water Resources Department, in Prey Veng area of the Mekong delta region in southern Cambodia, owns 6 hp diesel pumpset. In wet season the entire area remains flooded. Hence, the diesel pump is used in dry season, twice a month to irrigate rice fields. Each time operates for 8 hours, with a total consumption of 70 liters of diesel per month. Pump alone costs US$ 300, plus another US$ 200 for filter pipelines. Thus, total investment of US$500 per household. Total expenditure for diesel is US$100 per season. Pump renting would cost 0.75 cents per liter of diesel consumption. This is in addition to own diesel use. Each time, a 6 hp pump can irrigated 2.5 ha.

In Prey Veng province, some 13766 wells are installed with diesel pumps. On an average, every year witnesses additional 100 wells in this province. Thus, an additional investment of US$ 50,000 per year in this province alone, to lift water.

Pump using farmers generally cultivate vegetables, sugarcane, water melon to make more money compare to rice crop. All of them feel the heavy pinch of water lifting costs in the absence of an alternative option.

When we tossed the idea of solar powered pumps, they quickly jumped on it and expressed willingness to invest up to US$ 500 per household and there may be a total of 5000 households ready to pick this gadget. But they have hardly heard about solar pumps!

Source: Author's field visit during January 2008.

Large-scale use of solar powered pumps would reduce O&M costs to farmers and the government. In recent years, technology to use solar power for pumping from lower depths has been considerably improved. Field observations across six provinces indicated that farmers and even the MOWRAM agencies are pumping water from either rivers and or canals, at a depth of 1-4 meters. Solar pumps can lift up to 10 meters depth as its technology has been clearly demonstrated in recent years. This innovative effort has been made by

different agencies in Africa, South America, India (Chandel, Naik and Chandel[11], 2015). The Government of Cambodia and donor agencies may need to explore this option. Scale of operation at country level would enable the interested agencies to work out refined models to suit the local conditions.

Till now, one solar powered pump has been installed (at US$800 in Kampong Chhang) in 2006 and works for most part of the day with 50mm wide pipe line. Both farmers across 6 provinces that we interviewed and officials of the groundwater department and of MOWRAM are keen to see more functional solar pumps across the country. They are sure about large scale reductions in costs currently incurred for pumping water and related fuel costs. But all of them prefer to have capital investments either from the external aid or through long-term loans with subsidy component built in. Farmers were willing to make down payment of 30% as their initial investment to these gadgets.

In Prey Veng province of southern Cambodia, more than 13,000 diesel pumps are currently being used to extract water from the depths of 1-2 meters (directly from main canal) and 3-6 meters (directly from Mekong river). MOWRAM uses around 3 million litres of diesel per year for its 55,000 pumps of various sizes (depth range 1-10 meters) spread across the country. Use of solar pumps would help in replacing these diesel guzzling pumps. More importantly, solar powered pumps help to save critical costs to individual farmers.

### *6.3.1 Key Options*

- Provide enabling policy and legal framework, in favour of encouraging solar energy in rural areas and particularly for water resources sector.

[11] A complete database maintained by World Bank pertaining to use of Solar energy for irrigation projects in different countries is available at http://www.worldbank.org/en/data/interactive/2016/12/08/solar-water-pumping-knowledge-base.

- Loans with subsidy: Provide easy access to financing solar energy equipments through banking and service providing agencies, with lower interest rates. In India, solar units are provided with 5% interest and a long-term loan.
- Awareness creation: Adequately provide information on market characteristics, resource potential and service providers.
- There is a need to conduct detailed resource assessment studies.
- Promote private investment: Promote large scale private sector participation, in install-maintain-operate-collect fee basis. Another option for large scale, or village level schemes, is Build-Own-Operate and Transfer (BOOT) basis. This would reduce user's burden on investments and technicalities.
- Capacity building: Strengthen institutional capacity for planning, implementation and maintenance at all levels. Lack of coordination among concerned stakeholders (government, donors, NGOs, private sector, financial institution) also acts as another barrier in the absence of a comprehensive policy on renewable energy development.
- Exposure visits: As part of capacity building, the government needs to support a delegation of some 12 persons- comprising 6 FWUC representatives and 6 concerned officials – to visit India and other places, where solar powered pumps are in operation (also see Box 1-4). For farmers, seeing is believing. Visits to Uttar Pradesh, where the government has set up an autonomous agency to promote renewable energy and other private agencies sites (e.g, Tata-bp solar) would be useful experience. Indeed, the on-going project of TCP-3101 may support such visit, subject to budget availability.

***6.4 Promote property rights and provide legal provisions***

Need clarity on property rights: To be effective, farmers groups need more clarity on property rights of canals, canal bunds, reservoir bunds, catchments area, reservoir bed area during dry season, common lands, rights of members and how to enforce it during both surplus and scarce situations of water levels in the reservoir.

A reliable quantity and flow of water of suitable quality, and protection from pollution, are basic requirements for irrigation development. The issue of legal security has been evolving from existing or potential water conflicts and is addressed through legal mechanisms for conflict resolution. Security of water rights is, however, also required for non-conflicting situations related to market transactions, such as the commercial transfer of water rights among users or when using water right as collateral for bank credits. Water rights titles, through certain and clear legal instruments, are critical to prevent conflict and to stimulate market mechanisms for enhanced efficiency in water use.

Transferability of water use rights is particularly important for irrigation, so as to encourage investment in water saving practices and permit alternative, higher-value uses of the saved water. However, to curb speculation in water rights, especially when water is scarce, irrigation water is commonly considered to be appurtenant to the irrigated land. Purely market-driven transfer systems are rare, and actual practices, to be consistent with public policy objectives and water plans, are often limited to transfers under the direct control of government water administrations (FAO, 1995)[12].

***6.5 Create committed fund for awareness creation and capacity building***

Both officials and farmer groups (e.g., FWUCs) are in need of wide scale awareness creation and skill up gradation. This may be done through visits to locations in various countries,

[12] FAO, 1995. Reforming water resources policy: A guide to methods, processes and practices. FAO Irrigation and Drainage Paper No.52.

which are similar to Cambodian irrigation systems. Some of the best examples are available for small-scale irrigation systems in Southern states of India (like Karnataka, Andhra Pradesh, Tamil Nadu, and Maharashtra), Sri Lanka, South Africa, and China. Centuries old small-scale irrigation systems in these countries are currently being getting rejuvenated through active participation of water user organizations. These states/countries are also backing their efforts by refining their policy and legal frameworks to facilitate faster development. Learning lessons from their experience and regular visits by Cambodian officials and farmers to these countries/states would help motivate and learn better.

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**Table 1: Types of schemes in the existing irrigated area**

| Type and Number of Schemes | Existing in ha | Effective irrigation ha | Gap area ha | Gap to be covered in ha |
|---|---|---|---|---|
| All schemes<br>a) small-scale<br>b) medium-scale<br>c) large-scale | 1,050,000<br>160,000<br>620,000<br>270,000 | 588,000 | 412,000 | 62,000 (a)<br>350,000 (b) |
| Rehabilitation required for 50% of the existing irrigated area (ie. 588,000 ha) | | | | 244,000 (c) |
| Total area to be rehabilitated in the existing irrigated area | | | | 656,000 |
| Unutilized from potential irrigation area (1,667,000 - 1,050,000 hectare) | | | | 617,000 |
| **Total area that needs to be rehabilitated** | | | | 1,273,000 |

Source: Based on: TEAM Consulting, 2007 and MOWRAM, 2008.

a) Gap area identified for the strategy for agriculture and water 2006-2010.
b) Remaining gap area of 412,000 ha.
c) Rehabilitation required for 50% of the existing irrigated area.

**Table 2: Investment costs for utilization of potential irrigation area**

| Water Resources | Potential Irrigation area in ha | Currently Utilised in ha | Gap area in ha | Gap area in ha and Construction cost in '000 US$ | | | Total costs in '000 US$ |
|---|---|---|---|---|---|---|---|
| | | | | Small-scale (US$ 2500/ha) | Medium scale (@US$ 3500/ha) | Large-scale (@US$ 5000/ha) | |
| 1. Main stream | 734,000 | 400,000 | 334,000 | 111,333 (278,332) | 133,600 (467,600) | 111,333 (556,665) | 1,302,597 |
| 2. Mekong tributaries | 253,000 | 200,000 | 53,000 | 17,666 (44,165) | 21200 (74,200) | 17,666 (88,330) | 206,665 |
| 3. Mekong flooded area | 179,000 | 100,000 | 79,000 | 26,333 (65,832) | 31,600 (110,600) | 26,333 (131,665) | 308,097 |
| 4. Tonle Sap tributaries | 358,000 | 250,000 | 108,000 | 36,000 (90,000) | 43,200 (151,200) | 36,000 (180,000) | 421,200 |
| 5. Outside Mekong Basin | 142,000 | 100,000 | 42,000 | 14,000 (35,000) | 16,800 (58,800) | 14,000 (70,000) | 163,800 |
| **Total** | **1,666,000** | 1,050,000 | 616,000 | 205,333 (513,332) | 246,400 (862,400) | 205,333 (1,026,665) | 2,402,397 |

Note: a) Cost per ha and gap area across three types of schemes (small, medium, and large-scale) are based on MOWRAM (Mr. Chann Sinath) suggestions. Cost estimates have considered examples of recent years in India, Cambodia, and Sri Lanka, particularly for small and medium scale reservoir projects. For all three types of schemes, costs include – (i) resettlement and rehabilitation, (ii) formation of user's organization, and (iii) capacity building.

b) Scheme-wise gap area and utilized area is based on MOWRAM estimates

c) In case of potential irrigation area, Korea Water Resources Corporation's estimates (in 2007) indicates, by the year 2025, Cambodia will have 875, 000 ha.

d) Figures in parenthesis indicates amount in US$.

**Table3: Investment costs for rehabilitation area**

| Types of schemes | Proposed Rehabilitation area in ha | % to total area | Rehabilitation cost per ha in US$ | Total costs in '000 US$ |
|---|---|---|---|---|
| 1. Small-scale | 196,800 | 30 | 2500 | 492,000 |
| 2. Medium-scale | 262,400 | 40 | 3500 | 918,400 |
| 3. Large-scale | 196,800 | 30 | 5000 | 984,000 |
| Total | 656,000 | | | 2,394,400 |

Therefore, total investment costs required are:

a) for utilizing the potential irrigation area (US$) = 2,402,397,000

b) for rehabilitating existing irrigated area (US$) = 2,394,400,000

Total (US$) = 4,796,797,000

**US$ 4.8 billion for 10 years @ US$ 480 million per year is required.**

**Table 4: Change in stakeholders role**

| **Institutions** | **New Role** | **Role to be dropped** |
|---|---|---|
| State | • Rigorous regulation & enabling policy and empowerment of people's institutions<br>• Encouraging market investments<br>• Technical and managerial support<br>• Resource augmentation<br>• Transfer ownership over tanks to village councils/ FWUCs | • Implementation role and implementation staff<br>• Outdated legal framework<br>• Control perspective |
| Research & Resource Institutions | • Study and documentation of existing practices<br>• Experimentation<br>• Opening new frontier<br>• Outreach and field oriented research and studies | • Conventional outlook<br>• Outdated curriculum and policies<br>• Exclusive reliance on campus based activities |
| NGOs | • Understanding people's needs and aspirations through committed work and pilot field works<br>• Enlarging into research and resource institutional areas<br>• Liaising with government research and resource institutions and people's organisation | • Conventional 'social' outlook<br>• Ordinary quality staff and programs<br>• Conventional 'institutional' view |
| People institutions/ community | • Internal regulation and management of resources | • Expectations of 'doles' and subsidies |

| | | |
|---|---|---|
| institutions | • Managing interference and conflicts<br>• Distribution of benefits to marginal sections<br>• Vibrant civil society – sharing governance<br>• Nurturing leadership with vision on a longer term basis<br>• Setting agenda for mainstream institutions and social auditing of those institutions | • Divisive parochial views and 'tokenism' |

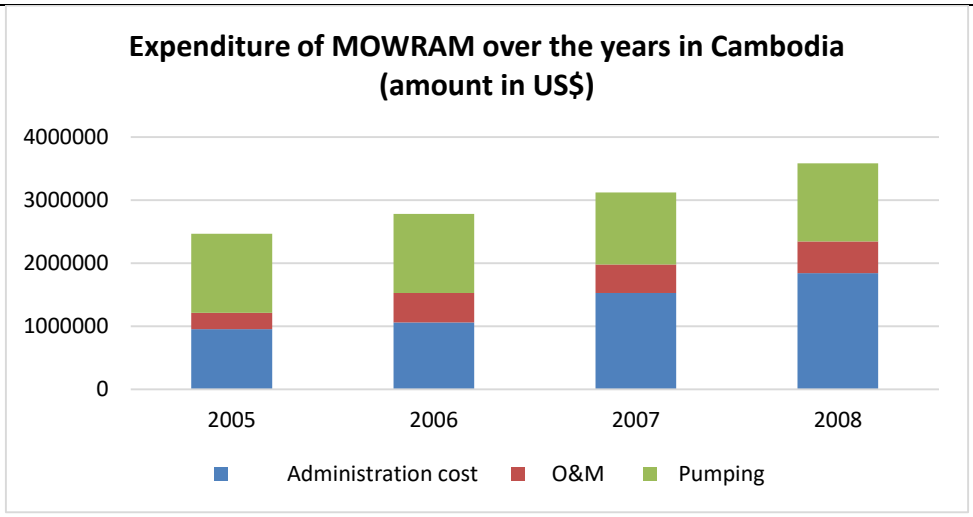


Figure 1: Expenditure of MOWRAM over the years in Cambodia
Source: Source: Collected from Finance section of the MOWRAM, Phnom Penh, during Jan 2008.
Note: 1 US$ = 4000 Riels