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# Assessment of Irrigated Water Allocation in the Stung Chrey Bak Catchment of Tonlesap Lake Basin using the WEAP model

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**Abstract:** *Water allocation in the Chrey Bak catchment faces the management problem that can cause water scarcity. Thus, water management and allocation for agriculture is conducted using the WEAP model to predict water demand. The study depends on collected data such as, stream flow (discharge), irrigation water need for each irrigation scheme in the Stung Chrey Bak catchment which exist of 7 irrigation schemes. There are two scenario is created; the reference scenario, and annual increase in irrigation demand: 5% of irrigate area in dry season is increase annually. These scenarios are made to answer the question "what if". To achieve this, water discharge in each stream was generated from the SWAT model. The results showed that water demand is reported enough for all scenarios in wet season. In contrast, the dry season rice meets water shortage especially, Tang Krasang irrigation scheme. This scheme lacks of 64 thousand $m^3$ 2014 and 49 thousand $m^3$ in 2025. Chrey Bak and Trapaeng Trabek, both of these schemes meet water scarcity only in annual increase in irrigation demand. The Chrey Bak irrigation scheme lacks of 368 m3 in 2017 and 24 thousand m3 in 2025. In Trapaeng Trabek, water scarcity occurs in 2017 to 2025 the same as Chrey Bak irrigation scheme. In 2017 this scheme lacks of 2 thousand m3 in 2017 and 118 thousand m3 in 2025. It is recommended that farmer should understand how to manage water, improve irrigation system, and water use efficiency. Furthermore, the officer of PDoWRAM should enlarge the existing reservoir in Tang Krasang irrigation scheme because the old one is not effort to store large amount of water to guarantee the sustainable use of water for irrigation.*

**Keywords:** water allocation; water scarcity; reference scenario; WEAP model

## 1. INTRODUCTION

Water resources management in Cambodia is connected to many sectors such as, agriculture, water supply and sanitation, energy, industry navigation, tourism, and fisheries. People are deal with water scarcity in dry season and in early wet season (small-dry season). By reason of water shortage, irrigation scheme plays crucial role in water supplementary for rice production. Nonetheless, water from irrigation infrastructure is deficient to meet current requirement.

Many irrigation schemes were constructed with injudiciously design during the period 1975 to 1978 (by Khmer Rouge Regime). Many of these schemes are decrepit and in a state of disrepair. Recognizing of essential of water to increase rice production, the Royal Government of Cambodia has repaired many of schemes to restore water in order to make the availability of rice production either dry or wet season.

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The rehabilitation and development of irrigation infrastructure are improved with little of water availability to ensure the sustainability of surface water or groundwater use in the catchment. Two research questions have been indicated in this thesis. These are: How can different hydrological scenarios be presented and communicated as part of decision-support process within a forum of catchment level water users and manager? How does supply of water in each irrigation scheme vary by difference scenario? The objectives of the study are to predict the amout of water demand in each irrigation scheme in the Stung Chrey Bak catchment and understand of the possibility of supporting catchment management through scenario. The scope of study are the

## 2. METHODOLOGY

### 2.1. *Study area*

The study was conducted in the Stung Chrey Bak catchment. Stung Chrey Bak catchment located in Kampong Chhnag Province with the area of about 700 $km^2$ consist of 3 main rivers, Srae Bak, Chakteum, and Chrey Bak main stream with the parallel length of 23km, 28km, and 54km. The irrigation scheme in the catchment is distribute from upstream to downstream of catchment as shown in the Figure 1

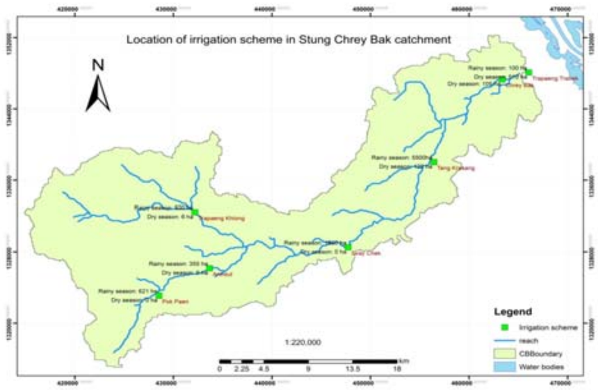



**Figure 1.** Study area: Stung Chrey Bak catchment.

## 2.2. *Water Availability In The Stung Chrey Bak Catchment*

Stream discharge was generated from SWAT model (Oeurng *et al*, 2015). Water availability of each irrigation scheme is shown in Figure 2.

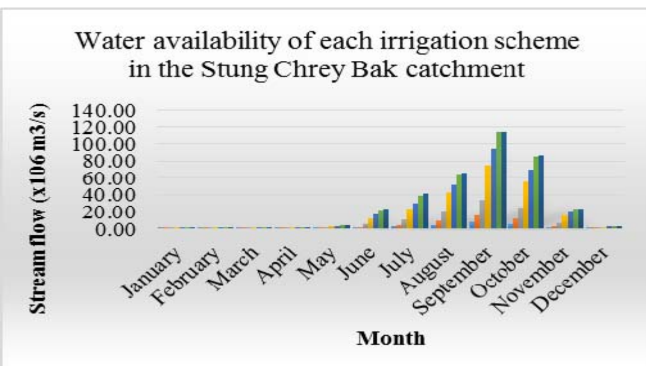



**Figure 2.** Water avialability of each irrigation scheme in the Stung Chrey Bak catchmet.

## *2.3. Rice Crop Water Requirement With Command Area*

Crop water requirement was calculate from CropWat model. The irrigation requirement is the different between the effective rainfall (Pe) and actual crop water requirement. Therefore, it can be calculate using the equation below:

$$IR = CR - Pe \qquad \text{Eq. 1}$$

where IR, CR, Pe is presented in millimeter (mm). Considering all factore, Crop water requirement is calculated as the following table.

| Irrigation scheme | Irrigated area (ha) | | Irrigation requirement (mm) | |
|---|---|---|---|---|
| | Wet | Dry | Wet (180days) | Dry (120days) |
| Scheme 1 | 621 | - | 5509 | - |
| Scheme 2 | 335 | - | 5509 | - |
| Scheme 3 | 920 | - | 5509 | 7300 |
| Scheme 4 | 1800 | - | 5509 | - |
| Scheme 5 | 5500 | 120 | 5509 | 7300 |
| Scheme 6 | 350 | 105 | 5509 | 7300 |
| Scheme 7 | 100 | 510 | 5509 | 7300 |
| Total | 9626 | 735 | | |

## *2.4. Generality of WEAP Model*

WEAP (*Water Evaluation And Planning)* is an IRWM model was developed by Stockholm Environment Institute. It provides a comprehensive, flexible and user-friendly framework for policy analysis. The data input for this study are demand site, and supply and resource. The result of the model was calculate as water demand in each irrigation scheme and amount of water shortage in the scheme. The model interface is shown in Figure 3.

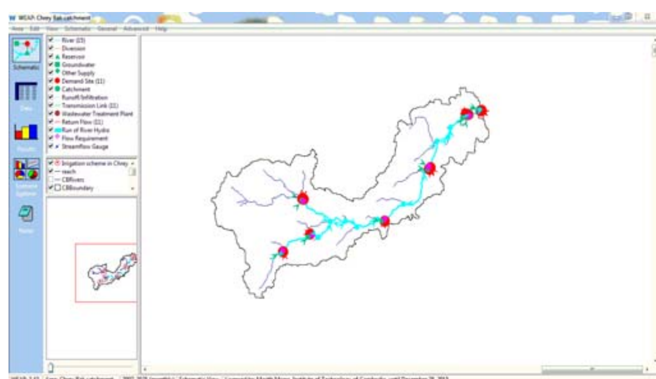


**Figure 3.** WEAP model interface

## *2.5. Calculate algorithm*

- *Demand site*

A demand site's (DS) demand for water is calculated as the sum of the demands for all the demand site's bottom-level branches (Br). A bottom-level branch is one that has no branches below it.

$$AnnualDemand_{DS} = \sum Br(TotalActivityLevel_{Br} \; x \, WaterUseRate_{Br})$$

Eq. 2

Where activity level totals is the command area of the irrigation scheme (hectare) and Water use rate (m3/hectare)

- *Demand site inflow*

The amount supplied to a demand site is the sum of the inflows from its transmission links. (The inflow to the demand site from a supply source (Src) is defined as the outflow from the transmission link connecting them).

$$DemandSiteInflow_{DS} = \sum_{Src} TransLinkOutflow_{Src,DS} \quad \text{Eq. 3}$$

The discharge is montly data in cubic meter per second (m3/s).

*2.6. Defining Scenario*

In the study, there are two scenarios were created; reference scenario, and annul increase in irrigation demand . The scenario were created to answer the question “What if’.

| **Demand management scenarios** | **“what if” question** |
|---|---|
| **Reference** | Irrigation demand will be reduced by 1 percent if the physical infrastructure and management skill of operators are improved. Command area is kept at 10361ha. |
| **Annual Increase in Irrigation demand** | Irrigation demand will be reduced by 1 percent if the physical infrastructure and management skill of operators are improved. Annual increase in irrigation demand for 5 percent from 2014 to 2025 is assumed. Irrigated area is increase to 17720 ha. |

## 3. RESULTS AND DISCUSSION

*3.1. Current account year*

Through the model, water demand for each irrigation scheme was calculated (x10$^6$ m$^3$) (Table 1)

**Table 1:** Water demand in each irrigation scheme for wet season rice (x10$^6$m$^3$)

| **Irrigation** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** |
|---|---|---|---|---|---|---|
| Antreut | 0.14 | 0.15 | 0.15 | 0.14 | 0.15 | 0.14 |
| Chrey Bak | 0.15 | 0.16 | 0.16 | 0.15 | 0.16 | 0.15 |
| Pok Paen | 0.27 | 0.28 | 0.28 | 0.27 | 0.28 | 0.27 |
| Svay Chek | 0.77 | 0.80 | 0.80 | 0.77 | 0.80 | 0.77 |
| Tang Krasang | 2.36 | 2.44 | 2.44 | 2.36 | 2.44 | 2.36 |
| Trapaeng Khlong | 0.39 | 0.41 | 0.41 | 0.39 | 0.41 | 0.39 |
| Trapaeng Trabek | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 |

Regarding to the table, Tang Krasang irrigation scheme consume the most water if compare to Trapaeng Trabek irrigation scheme because command in Tang Krasang irrigations scheme is very large (5500ha) and in Trapaeng Trabek only 100ha for wet season rice.

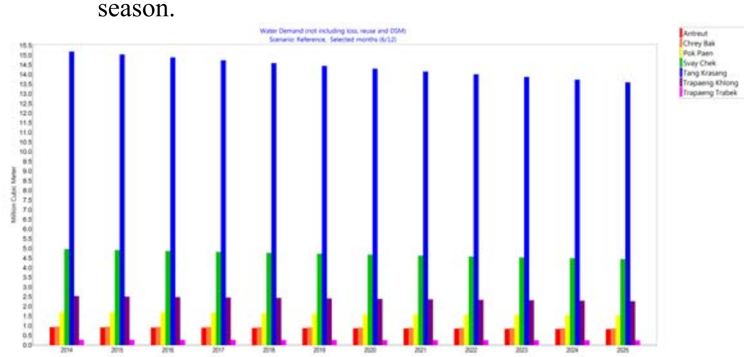
| Irrigation scheme | Jan | Feb | Mar | Dec |
|---|---|---|---|---|
| Chrey Bak | 0.062 | 0.056 | 0.062 | 0.062 |
| Tang Krasang | 0.070 | 0.064 | 0.070 | 0.070 |
| Trapaeng Trabek | 0.299 | 0.270 | 0.299 | 0.299 |

In dry season, Trapaeng Trabek consume the most water compare to the other two schemes. With the command area of 510 ha, this scheme consume 0.29 million m$^3$.

*3.2. Reference scenario*

Reference scenario assume that water demand decrease by 1 percent annually from 2014 to 2025. As a result, in water demand in Tang Krasang irrigation scheme reported decrease from 15.4 million m$^3$ to 14.5 million m$^3$ for wet seaso rice and so on (Figure 4 )

**Figure 4.** Water demand in referenc scenario for wet season.




For dry season rice, water demand reported decrease from 2.7 million m$^3$ to 2.4 million m$^3$.

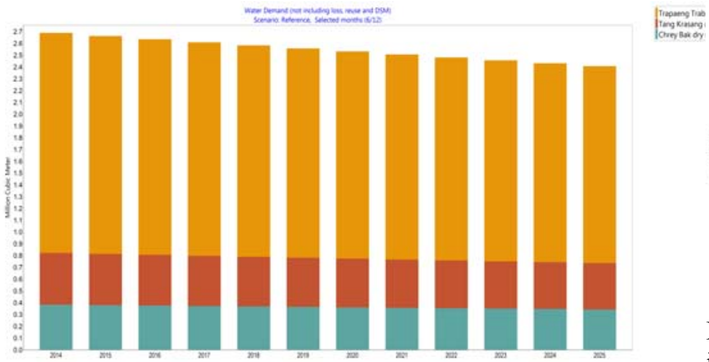


**Figure 5.** Water demand in referenc scenario for dry season.

Water shortage noted occure in the Tang Krasang irrigation scheme in the dry season. Regarding to model, it was calculated (Table 2)

**Table 2: Water scacity in reference scenario ($m^3$)**

| Year | Chrey Bak | Tang Krasang | Trapaeng Trabek |
|---|---|---|---|
| 2014 | 0 | 64547 | 0 |
| 2015 | 0 | 63130 | 0 |
| 2016 | 0 | 61728 | 0 |
| 2017 | 0 | 60340 | 0 |
| 2018 | 0 | 58966 | 0 |
| 2019 | 0 | 57607 | 0 |
| 2020 | 0 | 56274 | 0 |
| 2021 | 0 | 54932 | 0 |
| 2022 | 0 | 53606 | 0 |
| 2023 | 0 | 52300 | 0 |
| 2024 | 0 | 51007 | 0 |

Water scarcity reported decrease from 64 thousand $m^3$ to 51 thousand $m^3$ from 2014 to 2015.

*3.3. Annual increase in irrigation demand scenario*

Annual increase in irrigation demand assumes that the command are of dry season rice increase annually by 5 percent. Through the model, water requirement for this scenario was simulated. Most of farmer in the Trapaeng Trabek irrigation scheme, grow mostly dry season rice because in the rainy season most of irrigated area and irrigation infrastructure is flooded from Boeung Thom. Thus, water demand totally increase from 2.7 million $m^3$ to 4.1 million $m^3$ in 12 years (Figure 6 ).

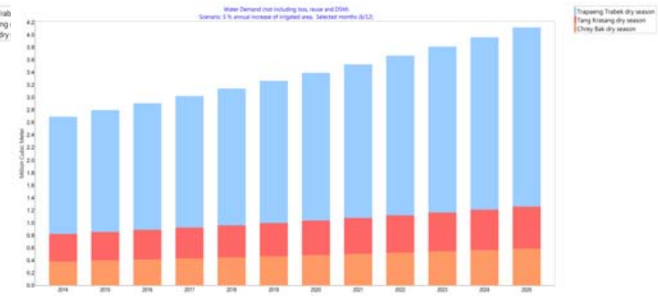


**Figure 6.** Water demand in 5 percents annual increase in irrigation demand

In this scenario, water shortage occur in all irrigation scheme but the different year. In Tang Krasang irrigation scheme, unmet demand occur from current account yaer (2014). But the Trapaeng Trabek irrigation scheme, water shortage occur from 2017 to 2025 and Chrey Bak irrigation scheme from 2018 to 2025. (Figure 7)

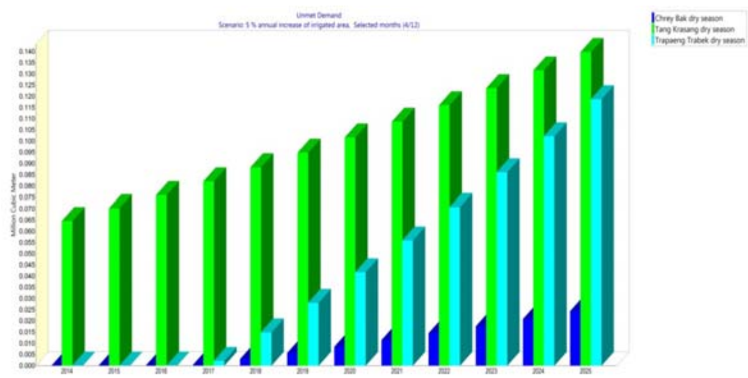


**Figure 7.** Water shortage in annual increase irrigation demand

## 4. CONCLUSIONS

This study attempted to apply WEAP to assess the different demands of irrigated water allocation through different scenarios which include reference scenario and annual increase in irrigation demand. In the current account year 2014, it reported water is enough for wet season rice. Nonetheless, water scarcity occurs in dry season. Dry season rice in Tang Krasang irrigation scheme showed lack of 47 thousand $m^3$ in January and February. In reference scenario, water demand reported decrease from 26 million $m^3$ to 23 million $m^3$ for rainy season rice because irrigation infrastructure and managerial skill should be improved.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