The Indonesian Journal of Computer Science
www.ijcs.net
Volume 13, Issue 5, October 2024
https://doi.org/10.33022/ijcs.v13i5.4272

Assessment on Water Resource Management for Sedawgyi Dam: A WEAP Analysis Approach

[1]Thet Zin Htoo, [2]Yin Yin Htwe, [3]Cho Cho Thin Kyi
info.thetzinhtoo@gmail.com, yinyinhtwe.civil@gmail.com, ccthinkyi@gmail.com
[1]Ph.D Candidate, Department of Civil Engineering, Mandalay Technological University.
[2]Associate Professor, Department of Civil Engineering, Mandalay Technological University.
[3]Professor, Department of Civil Engineering, Mandalay Technological University.

Article Information

Received : 8 Jul 2024
Revised : 24 Aug 2024
Accepted : 30 Sep 2024

Keywords

Agricultural water demand, Domestic water demand, IWRM, Sedawgyi, and WEAP

Abstract

Since digitalization spread ubiquitously in almost all industries, many traditional businesses have also joined the trend, including PT. XYZ. This company is a startup company that sells queue machines and kiosks. Since 2019, PT. XYZ runs its business through Indonesia's e-commerce such as Tokopedia and Shopee. However, many competitors appear to collect more customers which made PT. XYZ is difficult to compete with the market industry as a newcomer. In this queue machine and kiosk industry, PT. XYZ already has an official certification from Indonesia's government and PT. XYZ machines were produced and painted by themselves. But, these main values don't increase sales because of the lack of brand awareness. Therefore, the company needs a digital transformation to enhance its digital marketing strategy. This study objective uses BMC, PESTEL, and SWOT to analyze the as-is model and to-be model of the company so that the analysis will have a digital transformation strategy to increase brand awareness and sales. The results of this research show that digital marketing is needed to replace current marketing methods and carry out initiatives related to human resources, organizational structure, policy, technology, and community.

A. Introduction

Water resource management is a critical aspect of sustainable development, particularly in regions facing significant variations in water demand and supply[13]. Integrated Water Resources Management (IWRM) represents a holistic approach to managing water that emphasizes the interconnectedness of water resources and their management. It seeks to balance economic efficiency, social equity, and environmental sustainability in the development and management of water resources. IWRM integrates various aspects of water management, including water allocation, water quality protection, environmental conservation, and stakeholder participation, aiming to ensure the long-term availability of water for current and future generations. This approach recognizes that water is a finite and vulnerable resource, requiring coordinated efforts across sectors and scales to achieve effective and sustainable management.

WEAP (Water Evaluation And Planning) is a widely utilized integrated water resources planning tool that plays a crucial role in assessing and managing water systems worldwide. Developed by the Stockholm Environment Institute (SEI), WEAP provides a robust framework for evaluating the complex interactions between water supply, demand, and environmental impacts within a river basin or any defined geographic region. This tool is invaluable for decision-makers, water managers, and researchers seeking to analyze current water usage patterns, simulate future scenarios, and devise sustainable water management strategies. By incorporating hydrological, economic, and environmental data, WEAP facilitates informed decision-making processes aimed at achieving efficient water allocation, addressing challenges related to climate change and population growth, and promoting water security for both present and future generations.

The Sedawgyi Dam, a vital water infrastructure in Mandalay, Myanmar, plays a crucial role in meeting the domestic, power generation and agricultural water needs of the surrounding areas. The Sedawgyi Dam is a key water infrastructure that supports both domestic and agricultural water needs in the region. Constructed primarily for irrigation and water supply, the dam also plays a role in flood control and hydropower generation. The Sedawgyi Dam operates by regulating water storage and distribution to meet the diverse demands of the surrounding areas. During the summer season, the dam provides essential irrigation water to agricultural lands, while in the wet season, it helps manage excess rainfall to prevent flooding . Despite its critical role, the dam faces challenges such as insufficient water supply coverage for domestic use and inefficient water allocation between different sectors. However, the increasing demand for water, coupled with the challenges posed by seasonal variability and climate change, necessitates a comprehensive and strategic approach to water resource management [4]. This study aims to address the pressing water management issues at Sedawgyi Dam by utilizing the Water Evaluation and Planning (WEAP) system, a robust tool for integrated water resources planning. Through the application of WEAP, this research will analyze current water demand patterns, assess supply capabilities, and explore future scenarios to provide actionable insights for enhancing water distribution and management strategies.

This paper explores the functionalities, applications, and significance of WEAP in enhancing water resource management practices globally.

B. Research Method

The Water Evaluation and Planning (WEAP) provides a comprehensive platform to analyze the interactions between different components of the water system, such as surface water, groundwater, water demand, and environmental needs. WEAP model is built upon several theoretical foundations and principles that guide its development and application. These include integrated water resources management (IWRM), systems thinking, scenario analysis, and participatory planning. IWRM is a process that promotes the coordinated development and management of water, land, and related resources to maximize economic and social welfare without compromising the sustainability of vital ecosystems. It ensures that these components are considered together in a holistic manner, rather than in isolation Systems thinking is an approach to problem-solving that views complex systems in a holistic manner. It emphasizes the interconnections and interactions between different parts of the system. WEAP models the water system as a network of interconnected elements, including rivers, reservoirs, aquifers, water users, and ecosystems. It allows for the examination of feedback loops, delays, and non-linear relationships within the water system. Scenario analysis involves exploring and evaluating different future conditions and management strategies to understand their potential impacts and outcomes.

This section details the methodology used in applying WEAP system to analyze and manage water resources for the Sedawgyi Dam. The methodology includes data collection, model setup, scenario development, analysis and assessment plan.

1. Study Area and Data Collection

Study Area

The Sedawgyi Dam is situated in the Mandalay Region of Myanmar, near the city of Pyin Oo Lwin. The Sedawgyi Dam is a key example of water resource management, hydrology, and environmental impacts. It is built on the Chaungmagyi River, a tributary of the Ayeyarwady River, Myanmar's largest river system. The region is characterized by hilly terrain, which influences the hydrology and water flow patterns in the area shown in Figure 1. The dam and its reservoir are located in a valley that captures runoff from the surrounding hills. The Sedawgyi Dam creates a reservoir that stores water for multiple purposes, including irrigation, hydroelectric power generation, and flood control. The reservoir's storage capacity and surface area vary seasonally, depending on rainfall and water usage. The Chaungmagyi River experiences seasonal variations in flow, with higher flows during the monsoon season (June to October) and lower flows during the winter season (November to May). The dam regulates the river flow to provide a consistent water supply for downstream uses. The region around the Sedawgyi Dam is home to diverse flora and fauna. The construction of the dam has affected local ecosystems, particularly aquatic habitats. The Sedawgyi Dam study area serves as a case for integrated water resources management (IWRM), where multiple uses of water (irrigation, power generation, flood control, and domestic use) are balanced. The Sedawgyi Dam study area provides valuable insights into the complexities of water resource management in a developing country context. By balancing the needs for irrigation, power generation, and environmental protection, the study area exemplifies the principles of integrated water resources management and sustainable development. The experiences and findings from this case study can inform strategies in other regions dealing with comparable issues.

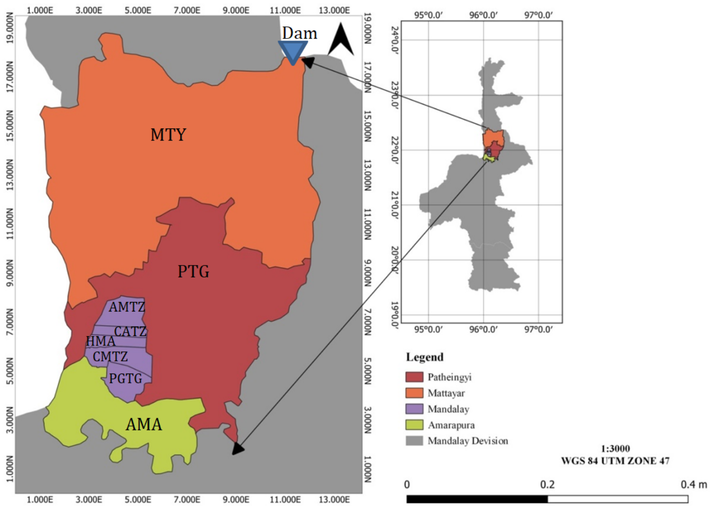


Figure 1. Study Area and Dam Location

Data Collection

Data collection is a critical step in the WEAP modeling process. The following data were gathered for the Sedawgyi Dam and its surrounding areas:

- Hydrological Data: Historical records of Chaungmagyi river flows, Dam site precipitation, evaporation, and reservoir levels are collected form the Deaprtment of Irrigation and Water Resource Development (Mandalay Region).[DIWRD]
- Demand Data: Current and projected water demand for domestic, agricultural puprposes are appointed to collected as the nodes (township base for domestic and area based for agricultre). [DIWRD]
- Infrastructure Data: Information on the dam's capacity, irrigation canals, water treatment plants, and distribution networks are collected from Mandalay City Developemt Committee. [MCDC]

2. Model Setup

The WEAP model setup involves defining the study area and creating a schematic that represents the water system. Key steps include:

- Defining the Study Area: Setting the geographic boundaries of the model, including the Sedawgyi Dam and its downstream areas.
- Creating the Model Schematic: Developing a visual representation of the water system, including rivers, reservoirs, demand sites, and transmission links.

- Inputting demand and supply Data: Entering the collected data into WEAP, specifying parameters such as catchment characteristics, water demand profiles, and operational rules for the dam.

3. Scenario Development

Scenarios are developed to explore different management strategies and future conditions. Key scenarios considered in this study include:

- Reference Scenario: Represents the current situation based on observed data and existing management practices.
- Demand Growth Scenario: Projects increased water demand due to population growth and economic development.

4. Analysis

The WEAP model runs simulations for each scenario, producing outputs that are analyzed to understand water system performance. Key analysis steps include:

- Assessing Water Balance: Evaluating the balance between water supply and demand under different scenarios.
- Identifying Deficits and Surpluses: Pinpointing areas and periods with water shortages or excesses.
- Evaluating Management Options: evaluating how well various management techniques work to solve problems with water resources.

C. Result and Discussion

1. Model Setup

To establish the spatial boundary of the Sedawgyi Dam study area in WEAP, begin by utilizing the built-in GIS-based layers such as oceans, countries, states, cities, and major rivers to situate the study area within its broader geographic context. Enhance the model by adding external raster and vector layers: a local map raster layer as the background map, and vector layers including Myanmar administrative areas, water lines, water areas, and reservoir locations shown in Figure 2. These layers provide a detailed and comprehensive spatial framework that aids in visualizing and understanding the water system's intricacies. Ensure all these layers are adapted to the geographic coordinate system used by WEAP, WGS84, which is based on latitude and longitude, for accurate model development and results presentation. This spatial setup allows for precise delineation of the study area, facilitating the effective integration of hydrological, environmental, and socio-economic data essential for robust water resource management and planning.

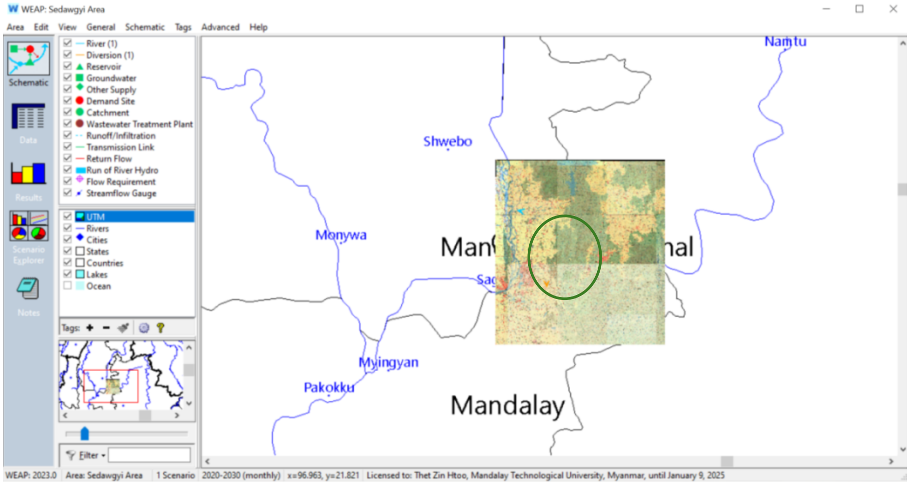


Figure 2. Layout View of WEAP

Creating Model Schematic

Figure 3 shows how to first identify the research area's fundamental parameters in WEAP, including setting the current account year as 2020 and the scenario timeline from 2020 to 2050 with monthly time steps, in order to set up a water resources model for the Sedawgyi Dam study area. Create supply nodes for the reservoir, groundwater sources, and river nodes, and establish demand nodes for agricultural, domestic, and industrial uses, specifying their respective capacities and monthly water demands. Connect these nodes using transmission links, ensuring they are appropriately sized and prioritized based on the importance of each demand site. Input the relevant supply data, such as reservoir inflows, groundwater recharge rates, and river flows, along with demand data for the current account year to accurately reflect the water system's status in 2020, thereby laying a foundation for scenario analysis through 2050.

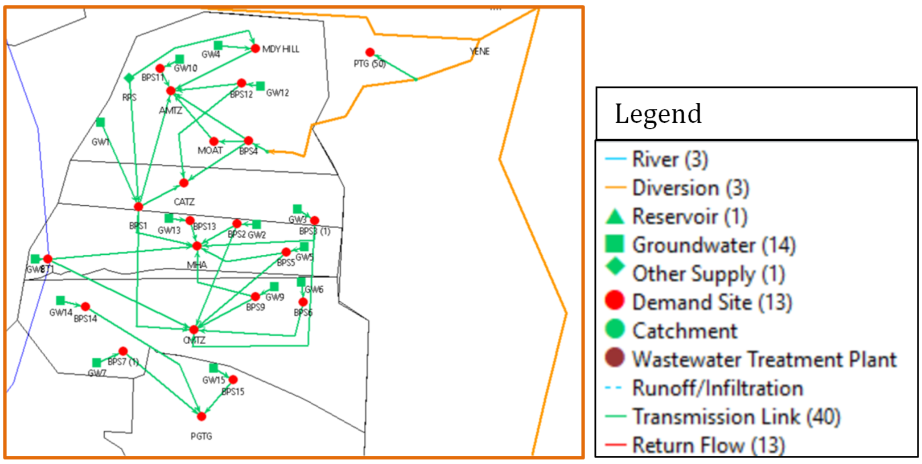


Figure 3. Schematic View

Inputting Demand and Supply Data

In the setting up of water demand analysis for the Sedawgyi Dam study area within WEAP, demand nodes are categorized into aggregate or individual demand sites, contingent upon the available water use data and desired analysis depth.

This study focuses on analyzing individual demand sites for various townships: Aungmyaethazan (AMTZ), Chanayethazan (CATZ), Maharaungmyae (MHA), Chanmyathazi (CMTZ), and Pyigyitagon (PGTG). Employing an annual demand method with monthly variation, the WEAP model incorporates diverse parameters, including annual activity levels, water use rates, monthly variations, and consumption rates for each demand node, as detailed in Table 1.

Table 1. Demand and Supply Sites

Supply Site			Demand Site	
Reservoir	**River**	**Groundwater**	**Township**	**Pumping Stations**
Sedawgyi dam	Chaungmagi, Mandalay main canal, Yene canal	GW 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	AMTZ, CATZ, MHA, CMTZ, PGTG, PTG_A, AMRA_A, MAT_A, MOAT, MANDALAY HILL RESERVOIR	PBS1, 2, 3, 4, 5, 6, 9, 11, 12, 13, 14, 15

To calculate crop water requirements and net irrigation needs for an irrigation demand, the CROPWAT model is utilized. CROPWAT is an irrigation planning and management decision support tool. The methods used for its calculations are taken from FAO 56. Monthly outputs, total crop water requirement for Sedawgyi Irrigated Area, can be produced by it include net irrigation water requirements, effective rainfall, actual crop evapotranspiration (ETc), and reference evapotranspiration (ET0). The entire amount of irrigation water needed are shown in Figure 4 [14]. WEAP models were then created for different irrigated areas and household data. Monthly domestic of the Mandalay city is varied with seasonal and temperature variation. Household data and total population are also collect from the MCDC and 2014 based census. These baseline data could analysed and separate into three differnet groups such as the monthly based standard water demand per capita, current demand variation and supply site and tentative exceedance population.

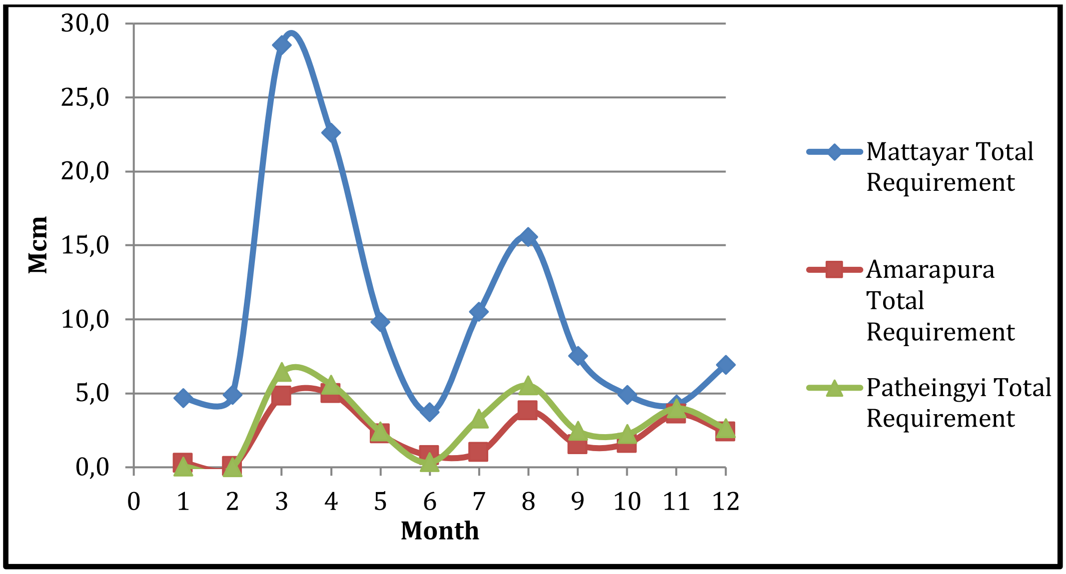


Figure 4. Total Agricultural Water Demand for Each Township

The annual demand reflects the total water requirement for each site, determined by multiplying the overall activity level by the water use rate. Activity levels are denoted as population or households for urban areas and hectares for agricultural regions in WEAP's demand analysis. The annual water use rate represents the average annual water consumption per unit of activity, with Mandalay City assigned a rate of 1.825 m³/cap due to its urban characteristics. Variation of monthly water demand, indicative of the distribution of annual demand across each month, is sourced from water bill income data provided by the Department of Revenue of the Mandalay City Development Committee. Consumption rates depict the water loss from the system, calculated as a fraction of inflows. Urban areas are assumed to consume 16% of the total inflow, while the remaining 84% returns to the environment. Hence, Table 2 displays the consumption for the five townships in this study is set at 16%, while a rate of 8% is used for closed-type systems and 16% for open-type systems in other demand sites. After calucluating the requirements of data simulation for WEAP programme, schemetic data inputting are in all done.

Table 2. Monthly Consumptive Use of Deamand Sites

Demand Site	Annual activity level	Annual water use rate	Monthly variation (%)	Comsumption (%)
PTG_A	8218.24 ha	6500 (m3/ha)	Water useage of each node	60
MTY_A	18223.18 ha	6501 (m3/ha)		60
AMAR_A	460.44 ha	6502 (m3/ha)		60
AMTZ	286177 cap	54.75 (m3/cap)		16
CATZ	211841 cap	54.75 (m3/cap)		16
MHA	259047 cap	54.75 (m3/cap)		16
CMTZ	304888 cap	54.75 (m3/cap)		16
PGTG	255378 cap	54.75 (m3/cap)		16
MOAT	N/A	0.045 Mcm		16
HILL	N/A	0.01 Mcm		10

Demand sites

Monthly variation of water usage of the domestic demand can evaluate by converting the revanue tax devided with the unit rate of the tax. All of the Mandalay residents use more likely in dry season and in winter. These results are shonwn in table 3. After estimating the absolute population growth for each sites which are shown in table 4, demand reference for those sites are defined in reference scanerio.

Table 3. Monthly Variataion of Demand Properties

Month	PTG_Agr	MTY_Agr	AMAR_Agr	AMTZ	CATZ	MHA	CMTZ	PGTG	MOAT	HILL
Jan	0.3	3.8	1.0	7.7	7.3	7.6	7.0	8.0	8.5	8.5
Feb	4.3	3.9	0.2	7.7	7.3	7.6	7.0	8.0	7.6	7.6
Mar	16.0	23.1	17.9	7.7	7.3	7.6	7.0	8.0	8.5	8.5

Apr	16.0	18.2	18.5	9.0	9.3	9.7	9.7	9.3	8.2	8.2
May	6.9	7.9	8.3	9.0	9.3	9.7	9.7	9.3	8.5	8.5
Jun	12.0	3.0	2.9	9.0	9.3	9.7	9.7	9.3	8.3	8.3
Jul	9.3	8.5	3.6	8.6	9.0	9.0	9.0	8.7	8.5	8.5
Aug	12.9	12.6	14.1	8.6	9.0	9.0	9.0	8.7	8.2	8.2
Sep	7.0	6.1	5.6	8.6	9.0	9.0	9.0	8.7	8.5	8.5
Oct	6.4	4.0	6.0	8.0	7.8	7.0	8.0	7.3	8.2	8.2
Nov	8.6	3.4	13.3	8.0	7.8	7.0	8.0	7.3	8.2	8.2
Dec	0.3	5.6	8.8	8.0	7.8	7.0	8.0	7.3	8.5	8.5
Total	100	100	100	100	100	100	101	100	100	100

Table 4. Population Growth

Year of Census	**Growth rate (%)**	**Expected Population (pearson)**						
		AMTZ	**CATZ**	**MHA**	**CMTZ**	**PGTG**	**PTG**	**MTA**
2015	current	266365	197175	241113	283781	237698	263725	258001
2020	0.72	286177	211841	259047	304888	255378	283340	277191
2025	0.71	307157	227371	278038	327240	274100	304112	297512
2030	0.59	325768	241148	294885	347068	290708	322539	315539
2035	0.44	340389	251971	308120	362645	303755	337015	329701
2040	0.3	350740	259633	317489	373672	312992	347263	339727
2045	0.18	357105	264344	323250	380453	318672	353565	345892
2050		357105	264344	323250	380453	318672	353565	345892

Supply sites

The Sedawgyi Irrigated area provides water coverage for five townships for domestic use and three townships for agricultural purposes. In the domestic sector, the townships of Aungmyaethazan (AMTZ), Chanayethazan (CATZ), Maharaungmyae (MHA), Chanmyathazi (CMTZ), and Pyigyitagon (PGTG) receive water from underground wells and partially from the Sedawgyi main canal. The water from the Sedawgyi Canal is primarily collected by the Moat passing through BPS4, which then distribute it to the townships of CMTZ, MHA, and PGTG.

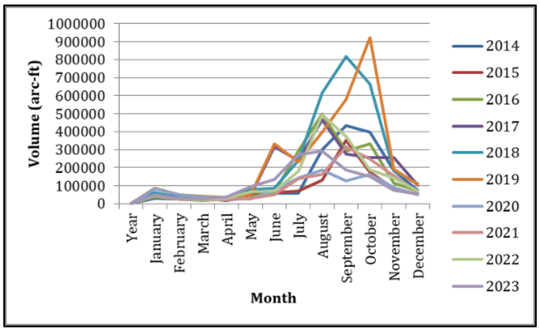
The integration of water sources from both underground wells and the Sedawgyi Canal underscores the importance of a reliable and sustainable water management system for the region. Given the growing population and the increased demand for water, it is essential to continuously monitor and evaluate the efficiency and sustainability of the current water distribution system. Therefore, it is essential to evaluate the current water distribution system in Mandalay city to determine the efficiency of the water sources and assess the extent of water depletion required. An underground test of the existing supply wells for domestic water supply is summarized in Table 5.

Table 5. Activity Tube wells in BPS stations

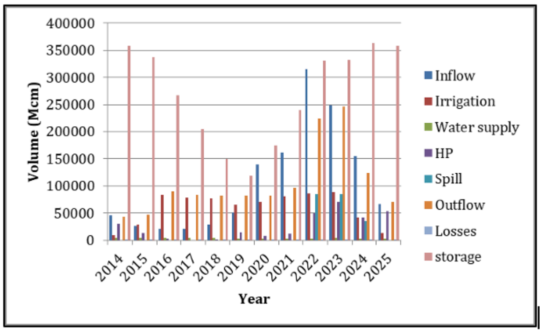
Node	No. of Tube Well	Storage Capacity (Mcm/month)	Initial Storage (Mcm/month)	Maximum Withdrawal (Mcm/month)	Natural Recharge (Mcm/month)
GW 1	27	3.696	3.65476	2.22	1.30588
GW 2	3	0.412	0.40608	0.282	0.16588
GW 3	2	0.272	0.27072	0.066	0.03884
GW 4	3	0.412	0.40608	0.3	0.17648
GW 5	3	0.412	0.40608	0.006	0.00352
GW 6	2	0.272	0.27072	0.03	0.01764
GW 7	2	0.272	0.27072	0.102	0.06
GW 8	2	0.272	0.27072	0.012	0.00704
GW 9	2	0.272	0.27072	0.012	0.00704
GW 11	2	0.272	0.27072	0.066	0.03884
GW 12	4	0.544	0.54144	0.132	0.07768
GW 13	2	0.272	0.27072	0.012	0.00704
GW 14	3	0.412	0.40608	0.282	0.16588
GW 15	2	0.272	0.27072	0.03	0.01764

This assessment will not only highlight areas where improvements are needed but also contribute to the development of strategies for optimizing water usage and reducing wastage. In addition to assessing water efficiency, it is also important to consider the environmental impact of water extraction and distribution. Ensuring that water management practices are sustainable will help protect local ecosystems and maintain the quality of the water supply. Collaborative efforts between local authorities, engineers, and environmental experts will be crucial in achieving these goals and securing a sustainable water future for Mandalay city.

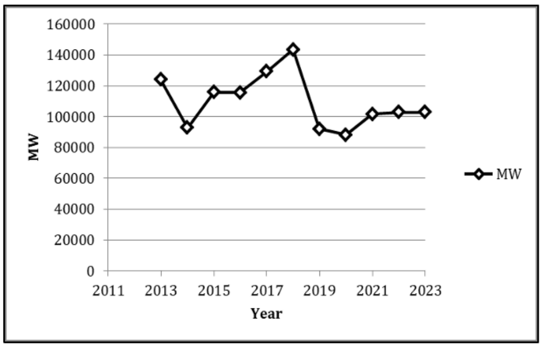
Another water secource for city supply is the surface water that are directly connect to the Mandalay Main Canal (known as Sedawgyi Canal). In order to simulate WEAP data schematic, period record for reservoir operation of Sedawgyi Dam is also prepared supplied by MDRD. The follwing figures are the required the information for dam opertaion which are essential to input the data section in WEAP model.



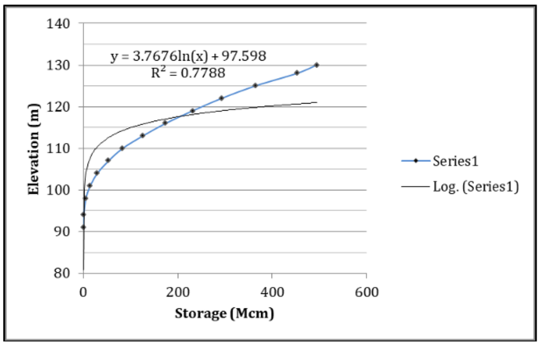
(a) Inflow volume of reservoir



(b) Reservoir operation water volumes



(c) Electricity production



(d) Reservoir volume-elevation curve

Figure 5. Sedawgyi Dam Reservoir Operation Data

3. Scenario Development

Developing a reference scenario for the WEAP (Water Evaluation and Planning) model entails establishing a baseline representation of current and future water resources and demands, assuming no additional interventions or changes. This scenario functions as a benchmark for assessing the impacts of various management strategies or policies.

The process begins with inputting the requisite data for demand and supply sites. After that, the temporal framework of the reference scenario is established, encompassing both supply and demand nodes. The spatial extent of the model is defined by delineating watersheds, river basins, and administrative boundaries. All water supply sources, such as reservoirs, underground wells, and canal networks, along with demand nodes, including cities and agricultural areas, are identified and mapped. Transmission links and return flows between successive nodes are connected to accurately represent water pathways.

Historical data is utilized to calibrate the model, ensuring it accurately reflects past conditions. A future time frame for the reference scenario is then set, typically extending to the year 2050. It is assumed that current policies, regulations, and management practices will continue without significant alterations. Projections for population growth and economic development are employed to estimate future water demands.

This methodological approach ensures that the reference scenario provides a robust foundation for evaluating the sustainability and efficiency of various water management strategies. Additionally, the reference scenario facilitates the identification of potential areas of concern, such as regions susceptible to water shortages or those requiring infrastructural improvements. It also aids in understanding the long-term implications of maintaining current water usage practices in the face of changing climatic conditions and demographic shifts.

Moreover, by using this reference scenario, policymakers and water resource managers can make more informed decisions, ensuring that water resources are allocated efficiently and sustainably. The scenario also provides a critical tool for stakeholder engagement, enabling transparent communication about the potential impacts of different water management options. Ultimately, the reference scenario serves as a vital component of comprehensive water resource planning, supporting efforts to achieve long-term water security and resilience.

4. Analysis

After analyzing the data with the WEAP application, it was observed that the highest domestic water demand for Mandalay City occurs in the CMTZ and AMTZ townships. PGTG and MHA townships also exhibit similar domestic water demand patterns. Figure 6 displays the domestic demand of reference scenario. In terms of agricultural water demand, it was found that the MTY township requires approximately 27 million cubic meters (Mcm) during the dry season, followed by PTG, which requires under 10 Mcm. During the monsoon season, the water requirement drops to half of the dry season levels due to effective rainfall. The reference scenario, based on current observed data, indicates that the overall domestic water demand will remain at 1.6 Mcm.

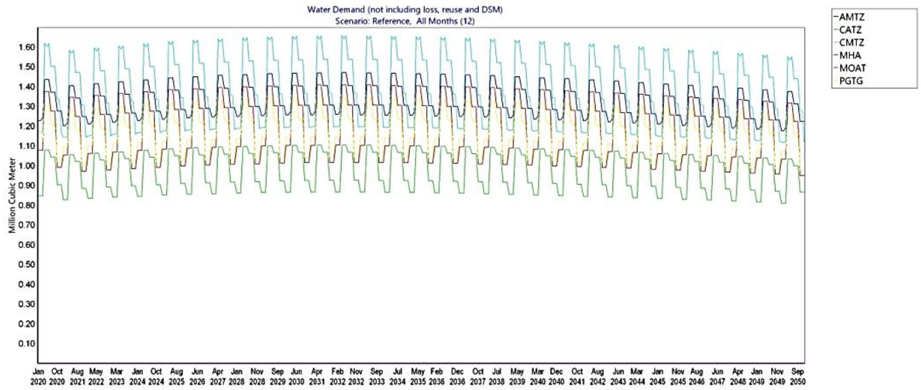


Figure 6. Domestic Water Demand

The highest domestic water demand is concentrated in the CMTZ and AMTZ townships, reflecting the dense population and high urbanization levels in these areas. PGTG and MHA townships also show significant domestic water needs, following a similar pattern to CMTZ and AMTZ. The current domestic water demand for these areas stands at approximately 1.6 million cubic meters (Mcm). However, the existing water supply system can only fulfill 10% of this demand, indicating a substantial shortfall.

In the agricultural sector, however in Figure 7, MTY township exhibits the highest water requirement, needing around 27 Mcm during the dry season. This high demand is due to extensive agricultural activities and the lack of rainfall during this period. PTG township also shows notable water needs, though significantly lower, at less than 10 Mcm. During the monsoon season, effective rainfall significantly reduces the water requirement to about half of the dry season's demand.

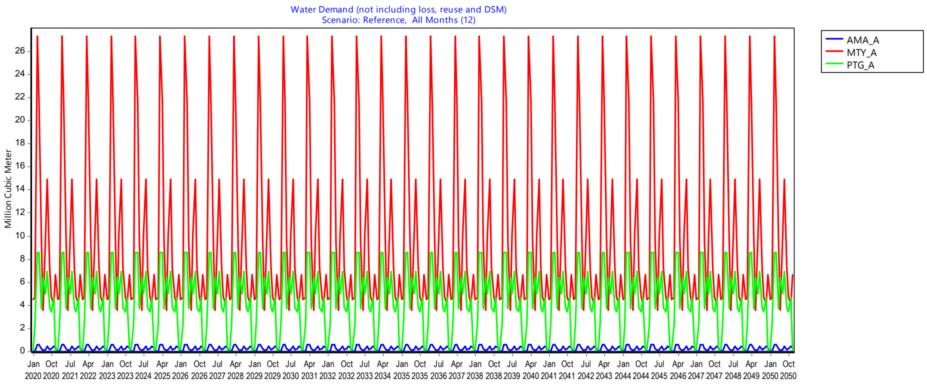


Figure 7. Agricultural Water Demand

Figure 8 illustrates the percentage of water demand and site coverage met over time for various townships and agricultural areas in Mandalay City under the reference scenario from January 2020 to December 2050. The agricultural areas, represented by lines such as MTY_A (MTY Agricultural) and PTG_A (PTG Agricultural), show a demand coverage close to 100% throughout the entire period. This indicates that agricultural water demands are fully met, suggesting a surplus or adequate provision for irrigation needs. Other townships like CATZ (Chanayethazan), CMTZ (Chanmyathazi), MHA (Maharaungmyae), and PGTG (Pyigyitagon) show similar patterns to AMTZ, with demand coverage consistently ranging in 10 to 35%. This underscores the critical issue of inadequate water supply for domestic needs across these areas.

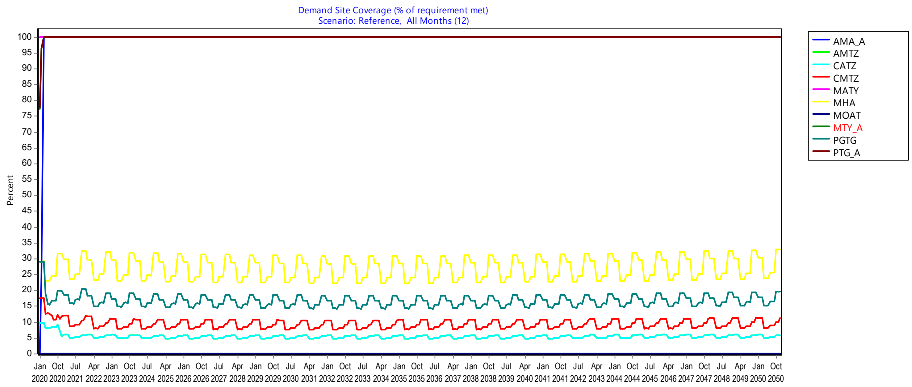


Figure 8. Demand Coverage for Domestic and Aguriculture

Figure 9 is a critical situation with rising unmet water demand across all regions, posing potentially severe consequences if this trend persists. Throughout the period analyzed, CMTZ consistently exhibits the highest unmet demand, contrasting with PGTG which consistently shows the lowest. Notably, there is a discernible seasonal pattern with peaks in demand occurring annually in April. It is crucial to note that the graph covers data only up to December 2050, suggesting that unmet demand may continue escalating beyond this timeframe. The y-axis scale, starting at 0.2 million cubic meters, underscores that even the smallest values represent significant unmet water needs. However, without disclosed data sources, assessing the reliability of these findings remains challenging. Further investigation is imperative to comprehend the underlying factors driving the escalating unmet demand and to explore potential mitigation strategies.

Unmet water demand is evidently increasing across all regions over the depicted timeframe, as indicated by the upward slopes of all colored lines on the graph. CMTZ consistently exhibits the highest unmet demand throughout the period, maintaining the top position on the graph. Conversely, PGTG consistently displays the lowest unmet demand. A notable seasonal pattern is observed with peaks in demand occurring annually around April. This cyclical trend underscores a predictable surge in water demand during that period each year. The graph signals a critical situation with escalating unmet water demand across all regions. CMTZ appears to face the most severe water shortage, while PGTG faces the least. If this trend persists, it could lead to significant consequences. Further investigation is essential to discern the underlying reasons behind the rising unmet demand and to devise potential solutions. Understanding the factors contributing to the seasonal demand peaks would also aid in developing targeted interventions.

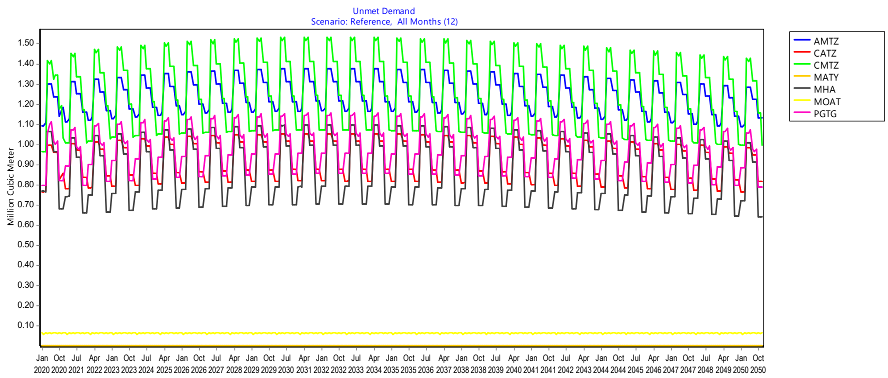


Figure 9. Unmet Demand for Domestic

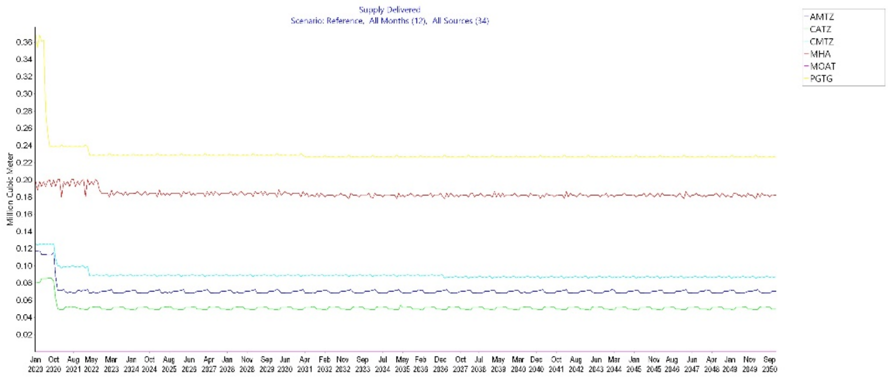


Figure 10. Supply Delivered Water Volume for Domestic

5. Assessment

The reference scenario, which is grounded in current observed data, provides a baseline for understanding future water needs and supply capabilities. Key findings from this scenario include: the demand is projected to remain at 1.6 Mcm, but the current infrastructure can only meet a fraction of this need; there is a consistent over-delivery of irrigation water, indicating that the existing agricultural water supply system is more than sufficient. The agricultural sector receives more water than required, leading to wastage and inefficiencies in water use. The domestic sector faces a severe shortage, with only 10% of the demand being met by the current supply system.

To address these imbalances, several strategic measures should be considered:

1. Identifying and developing new water sources, such as new wells, reservoirs, or alternative water harvesting methods, is crucial. This could include rainwater harvesting, desalination (if applicable), or tapping into new underground aquifers.
2. Upgrading and expanding the current water distribution infrastructure is essential to increase coverage. This might involve extending pipelines, upgrading treatment plants, and improving water storage facilities.
3. Implementing IWRM practices can help harmonize water allocation between domestic and agricultural uses. This approach promotes sustainable water management by considering the entire water cycle and involving all stakeholders.
4. Promoting water conservation practices and technologies among both domestic users and farmers can help reduce demand. This could include introducing efficient irrigation techniques like drip irrigation, and encouraging the use of water-saving devices in households.
5. Establishing policies that incentivize efficient water use and penalize wastage can drive better water management practices. Regulations could also ensure that water allocation prioritizes critical needs and sustains long-term water availability.
6. Engaging local communities, farmers, and other stakeholders in water management decisions ensures that solutions are practical and widely accepted. Educational campaigns can raise awareness about the importance of water conservation and sustainable practices.

However, the current supply delivery system cover 10% of domestic demand, the critical need to explore additional water sources and extend the existing delivery system to meet future demands. On the other hand, the analysis revealed that agricultural water supply exceeds demand, indicating an over-delivery of irrigation water throughout the area. This suggests a surplus of water for irrigation but a deficit in domestic water supply.

The WEAP model analysis underscores the urgent need for strategic interventions to address the water supply-demand imbalance in Mandalay City and its surrounding townships. By exploring new water sources, expanding the delivery infrastructure, and implementing integrated water management practices, it is possible to ensure a more equitable and sustainable distribution of water resources. These measures will not only meet current needs but also accommodate future growth and climatic variations. Therefore, it is imperative to modify the current water management strategies and implement a new integrated water resources management scheme. This would help to rebalance the supply-delivery system, ensuring that both domestic and agricultural water demands are adequately met.

D. Conclusion

In conclusion, the study of the Sedawgyi Dam in Myanmar's Mandalay Region highlights significant challenges and opportunities in integrated water resource management (IWRM). The results showed that water supply coverage for Mandalay City is required to modify to meet the needs. However, the agricultureal water demand have been stable for the current cropping pattern. The WEAP model reveals a significant imbalance between water supply and demand in Mandalay City and its surrounding areas. By implementing efficient irrigation techniques and conservation practices, it is possible to optimize existing resources and achieve a sustainable and resilient water resource management system that can meet the future demands of both domestic and agricultural sectors. These strategies, coupled with stakeholder engagement and supportive policies, are essential for addressing projected future demands and ensuring equitable water allocation.

E. Acknowledgment

Firstly, the author expresses deep gratitude to Dr. Nilar Aye, Professor and Head of the Department of Civil Engineering at Mandalay Technological University, for her invaluable guidance, supervision, and meticulous editing throughout the completion of this paper. The author also wishes to acknowledge Dr. Aye Mya Cho, Professor in the Department of Civil Engineering at Mandalay Technological University, for her unwavering support, and insightful suggestions. Furthermore, sincere thanks are extended to the Stockholm Environment Institute for generously providing a free license for the WEAP software, which was instrumental in conducting this study. Special appreciation goes to the officers and staff of the Mandalay City Development Committee, Irrigation Department, Agricultural Department, and Supervision Committee of Mandalay Industrial Zone for their invaluable data, reference materials, and ongoing support. Finally, the author extends heartfelt thanks to all individuals who contributed to the completion of this paper through their support and encouragement.

F. References

[1] Loucks, D. P., & van Beek, E. (2017). "*Water Resource Systems Planning and Management: An Introduction to Methods, Models, and Applications*". Springer.

[2] Yates, D., Sieber, J., Purkey, D., & Huber-Lee, A. (2005). WEAP21—A Demand-, Priority-, and Preference-Driven Water Planning Model: Part 1: Model Characteristics. Water International, 30(4), 487-500.

[3] Kaung Myat, Nilar Aye, (2017), "Proposal of Water Allocation Plans for Mandalay Area in Myanmar", American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS) (2024) Volume 31, No. 1, pp 24-39.

[4] IPCC. (2014). Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. https://www.ipcc.ch/report/ar5/wg2/

[5] Sieber, J., & Purkey, D. (2011).** WEAP (Water Evaluation and Planning System) User Guide. Stockholm Environment Institute. Available at: [WEAP User Guide](https://www.weap21.org/downloads/WEAP_User_Guide.pdf).

[6] Liu, Y., Gupta, H., Springer, E., & Wagener, T. (2008). "Linking Science with Environmental Decision Making: Experiences from an Integrated Modeling Approach to Supporting Sustainable Water Resources Management." Environmental Modelling & Software, 23(7), 846-858.

[7] Gassman, P. W., Reyes, M. R., Green, C. H., & Arnold, J. G. (2007). "The Soil and Water Assessment Tool: Historical Development, Applications, and Future Research Directions." Transactions of the ASABE, 50(4), 1211-1250.

[8] Rani, D., & Moreira, M. M. (2010). "Simulation–Optimization Modeling: A Survey and Potential Application in Reservoir Systems Operation." Water Resources Management, 24(6), 1107-1138.

[9] Gohari, A., Eslamian, S., Abedi-Koupai, J., Massah Bavani, A. R., Wang, D., & Madani, K. (2013). "Climate Change Impacts on Crop Production in Iran's Zayandeh-Rud River Basin." Science of The Total Environment, 442, 405-419.

[10] Srinivasan, V., Seto, K. C., Emerson, R., & Gorelick, S. M. (2013). "The Impact of Urbanization on Water Vulnerability: A Coupled Human–Environment System Approach for Chennai, India." Global Environmental Change, 23(1), 229-239.

[11] Joyce, B., Mehta, V. K., Purkey, D., Dale, L., Hanemann, M., & Vicuna, S. (2011). "Modifying Agricultural Water Management to Adapt to Climate Change in California's Central Valley." Climatic Change, 109(1), 299-316.

[12] Kashyap, A. (2004). "Water Governance: Learning by Developing Adaptive Capacity to Incorporate Climate Variability and Change." Water Science and Technology, 49(7), 141-146.

[13] United Nations. (2015). Sustainable Development Goal 6: Ensure availability and sustainable management of water and sanitation for all. Retrieved from https://sdgs.un.org/goals/goal6.

[14] Thet Zin Htoo & Yin Yin Htwe (2024), "Assessment on Total Crop Water Requiremnt for Sedawgyi Irrrigated Area", International Conference on Civil and Environmental, Thailand.