INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES

Vol 14, Issue 8, (2024) E-ISSN: 2222-6990

Agro-Hydrological Modeling Systems in Peninsula Malaysia: Panacea to Youth Development

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To Link this Article: http://dx.doi.org/10.6007/IJARBSS/v14-i8/22551 DOI:10.6007/IJARBSS/v14-i8/22551

Published Date: 16 August 2024

Abstract

This paper considers the role of Agro-Hydrological Modeling Systems (AHMS) in fostering youth progress in Peninsula Malaysia. In the face of rising world challenges, climate change, increase in population, and resource scarcity, the sustainable management of agriculture and water resources is supreme. Peninsula Malaysia, renowned for its rich agricultural diversity, serves as a unique backdrop at the crossroads of various challenges, offering an ideal context to explore the potential of AHMS in youth empowerment. This study is exploratory, using data gathered from documents and literature analyses. This paper not only underscores the significance of AHMS in the Malaysian context but also elucidates its concrete impact on fostering youth engagement, education, innovation, and the cultivation of sustainable farming practices. Furthermore, it observes the obstacles encountered in implementing AHMS for youth development, highlighting the various opportunities awaiting exploration.

Keywords: Agro-Hydrological Modeling Systems, Youth Development, Sustainability, Agriculture, Peninsula Malaysia, Research Outcome

Introduction

Peninsula Malaysia is graced with a bountiful agricultural heritage, yet it grapples with pressing issues, including climate change, water scarcity, and demographic shifts (Ismail, Kamal, Abdullah, et al., 2020; Khan, 2014; Ouassanouan et al., 2022; Swain et al., 2020). These issues necessitate innovative solutions addressing agricultural and hydrological challenges and actively empowering the nation's youth for a sustainable future. Despite the global recognition of the need for sustainable farming practices and resource management, integrating youth into these efforts remains a substantial challenge in the Malaysian context(Abdullah et al., 2012). Malaysia, a nation renowned for its diverse agriculture, grapples with the imperative to harness its youthful demographic dividend while mitigating the risks associated with climate change, water scarcity, and shifting agricultural landscapes. However, a study conducted by Norehan et al. (2016) reveals that the "majority of the farmers are in their old or advanced age, while the young rarely engaged in farming in the study area." this study is further supported by Bakar et al. (2022). Affirms these findings by saying, "The agricultural sector is perceived negatively and viewed as less prestigious by society. The youth lack interest in working in the agricultural sector; hence, it is now monopolized by foreign workers."

Malaysia's population for the third quarter of 2021, released on November 8, 2021, was estimated at 32.67 million (Ganasegeran et al., 2022), a 0.2 percent increase over the third quarter of 2020. (32.60 million). According to Mahidin (2020) report, the total agricultural exports increased from RM115.5 billion in 2019 to RM118.6 billion in 2020. Meanwhile, total agricultural sector imports increased, reaching RM98.0 billion in 2020, up from RM93.5 billion in 2019. Food security has become more critical due to the pandemic's impact on agricultural production and prices. Ensuring food supply stability is vital, especially for farming items with low self-sufficiency and high import dependency. To mitigate the effects of climate change on agricultural production, the internal food supply gap, import dependence, and the virtual displacement of water used for agricultural production for export, youth participation in applying AHMS and developing sustainable water resources is necessary.

Despite the efforts and successes achieved in Peninsula Malaysia's agricultural sector, smallholders with an average age of over 55 continue to dominate the industry (Bakar et al., 2022; Noor & Nur Syamila, 2023; RAIS & MARGARITA, 2022; TheStar, 2021). According to TheStar (2021), Only 15% of Malaysia's youth, who comprise 44% of the country's overall population, work in agriculture. Farmers who are getting older may be less receptive to implementing contemporary technology necessary to boost output and minimize environmental harm. In this regard, adaptation of AHMS and enrollment of more youth in this sector becomes essential.

Low-skilled foreign workers make up 31% of the agricultural workforce, and farming is primarily a labor-intensive industry with little adoption of farm technology and automation (TheStar, 2021). This implies an excellent opportunity for the youth to be engaged in this sector when harnessed.

A brief review of the related literature reveals the increasing importance of AHMS in optimizing agricultural productivity and water resource management. Albano et al. (2017); Kassing et al. (2020) highlight how AHMS, through data-driven modeling, can aid in precision

agriculture, allowing for optimal crop management and resource allocation. Similarly, Banda et al. (2022); Ismail (2020) emphasize the significance of AHMS in addressing climate variability by predicting and adapting to changing precipitation patterns, thereby contributing to sustainable water resource management. These studies underscore the potential of AHMS to address critical agricultural and hydrological challenges but do not comprehensively explore their role in youth development.

To address this gap, this study is exploratory, using data gathered from documents and literature analyses. Using assessments of the impact of AHMS on agricultural and hydrological outcomes with qualitative analyses of youth engagement, innovation, and sustainability practices. Preliminary findings from this multifaceted approach indicate that AHMS enhances farm productivity and resource management, actively engages youth in innovative techniques, and fosters sustainability awareness, marking a promising pathway for youth development in Peninsula Malaysia. It is on this note that this paper focused on agro-hydrological modeling systems in peninsula Malaysia: panacea to youth development and the scope and objective of this paper are to elucidate the pivotal role of Agro-Hydrological Modeling Systems (AHMS) in fostering youth development in Peninsula Malaysia, addressing the concurrent challenges of agricultural sustainability and engaging the younger generation in a meaningful manner; to explore how AHMS can drive youth engagement, education, innovation, and sustainable agricultural practices; and to discuss the potential benefits, challenges, and opportunities associated with integrating AHMS into youth development initiatives.

What are Agro-Hydrological Modeling Systems?

Agro-Hydrological Modeling Systems (AHMS) are sophisticated computational tools that not only simulate but also substantiate and enhance the interactions between agricultural activities and hydrological processes (Ismail, 2020; Ismail, Kamal, bin Abdullah, et al., 2020; Jiang et al., 2015; Uniyal & Dietrich, 2021; Uniyal et al., 2019; Van Gaelen et al., 2017). These systems integrate multidimensional data on soil properties, land use, climate variables, and water resources to optimize land management, water allocation, and sustainable decision-making (Abbaspour, 2022; Fischer et al., 2008; Fischer et al., 2000; Ismail, Kamal, bin Abdullah, et al., 2020; Rallo et al., 2012).

Significance of AHMS in Peninsula Malaysia

In Peninsula Malaysia, where agriculture plays a pivotal role in the economy, the tangible research outcomes of AHMS encompass:

- AHMS ensures remarkable enhancements in farming productivity through precise irrigation and crop management (Ismail, Kamal, bin Abdullah, et al., 2020; Miha & Matjaž, 2021; Yimer, 2022).
- AHMS provides effective mitigation strategies against the impact of climate change by forecasting and adapting to altered precipitation patterns (Chemura et al., 2020; Puig-Bargués & Rallo, 2022).
- AHMS promotes sustainable water resource management, ameliorating water scarcity concerns through optimized allocation strategies (Abdulkareem et al., 2018; Yimer, 2022).

Youth Development and AHMS: Concrete Research Outcomes

Engaging the Youth

Research has demonstrated that AHMS are potent educational tools, engaging young individuals in hands-on learning experiences rooted in real-world agricultural and hydrological data (Kiker, 2012). The author (Kiker, 2012) has created educational tools and materials specifically focused on activities that may be utilized at different academic levels, ranging from middle school to post-graduate degrees, to encourage youth engagement. The quantifiable research indicates that youth participation increases comprehension of complex systems and phenomena.

Empowering through Innovation

Integrating Agro-Hydrological Modeling Systems (AHMS) in youth development programs has consistently yielded concrete research outcomes that showcase youth-driven innovation (Ahmed et al., 2022; Noor & Syamila, 2023). Youth involvement in designing and implementing modeling systems has led to inventive solutions and novel perspectives on addressing pressing agricultural and hydrological challenges (Bielik et al., 2021; Sebba et al., 2009). This implies that the challenges faced by the agricultural sector due to the low participation of youths can be overcome by implementing AHMS in Peninsula Malaysia.

Promoting Sustainable Practices

Research outcomes underscore that AHMS-oriented youth engagement fosters a culture of sustainability (Noor & Syamila, 2023). In a report titled "Promoting Youth Engagement and Employment in Agriculture and Food Systems, the “High-Level Panel of Experts” on Food Security and Nutrition (HLPE) examines the opportunities, challenges, and trends surrounding young people's involvement and employment in agriculture and sustainable food systems (HLPE, 2021). The purpose of the paper is to evaluate the current state of youth employment and participation in agriculture and food systems to pinpoint the main obstacles that prevent young people from having a meaningful impact on the development of food systems and from earning a living wage from them. With an emphasis on employment, knowledge, and resource accessibility, as well as social innovation support, this research offers a global youth agenda that views youth as active agents of change in agriculture and food systems, both individually and collectively. The study proposes a paradigm shift in understanding youth employment and participation in food systems, viewing them as both a goal in and of themselves and a way of achieving resilient economies of well-being and sustainable transformation of food systems. Policies and strategies to achieve this objective must be grounded in agency, equity, rights, and understanding of youth's position as change agents in all facets of food systems (HLPE, 2021). However, youth actively partaking in AHMS initiatives emerge as advocates for environmentally friendly agricultural practices, thereby contributing significantly to the sustainability of the agricultural sector. Nonetheless, to achieve this goal, Noor and Nur Syamila (2023) believe that to attract the youth in this field, they should be given exposure and an overview of careers in agriculture early at the school level.

Challenges and Opportunities

Challenges

Addressing these multifaceted challenges requires a comprehensive and innovative approach that optimizes agricultural and hydrological processes and actively engages and empowers

the youth, laying the basis for a sustainable and prosperous future in Peninsula Malaysia. A few of these challenges are highlighted as follows:

- Equitable access to AHMS technology and training is needed, particularly in rural areas.
- Sustained funding and resources are required to support AHMS integration into educational curricula.
- Overcoming the challenge of planning scalable and enduring AHMS-focused youth development initiatives.

Opportunities

Amidst these challenges lie unique opportunities to harness the power of Agro-Hydrological Modeling Systems (AHMS) as a transformative tool for youth development in Peninsula Malaysia. By embracing the potential of AHMS technology, education, and collaboration, we can unlock a future where the nation's youth become champions of sustainability, innovation, and responsible resource management. A few of these opportunities are emphasized as follows when AHMS is implemented:

- There will be collaborative endeavors with government agencies, academic institutions, and non-governmental organizations to establish AHMS-based youth development programs.
- Technology and digital platforms enable remote learning and democratize access to AHMS.
- Public-private partnerships will be encouraged to secure essential funding for AHMS initiatives.

Application of AHMS in Peninsula Malaysia

The application of agro-hydrological models in Malaysia is still in its infancy, but these models have the potential to play a significant role in water management and agricultural planning.
The efficacy of the models specified varies depending on the application. Some models are more pertinent to specific problem types, while others are more accurate. For instance, deploying Soil and Water Assessment Tool plus (SWAT+) and Coupled Model Inter-comparison Project Phase 6 (CMIP6) in the development of an agro-hydrological model, Figure 1 demonstrate the flow chart of the SWAT+ model setup with a brief description of the procedure steps.

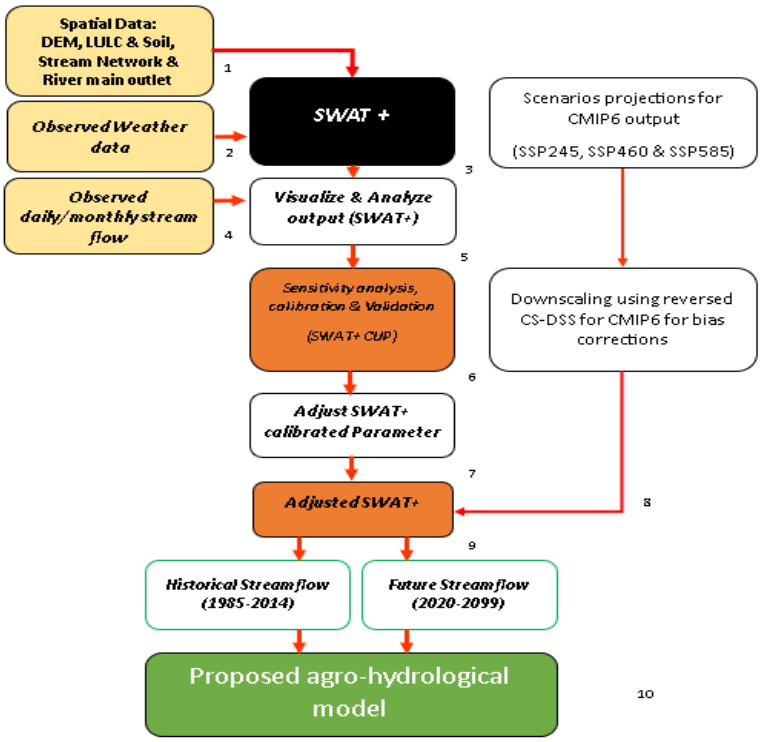

Figure 1: Flow Chart For SWAT+ Model Setup and Input Data

1. Spatial data collection and input
2. Observed weather data input
3. Running SWAT+ for simulation
4. Observed daily stream flow input for comparison with the simulated flow out
5. Visualize and analyze SWAT+ output.
6. Sensitivity analysis, calibration, and validation of SWAT+ parameters using SWAT+CUP
7. Adjust SWAT+ calibrated parameters for daily stream flow simulation
8. Downscaled and bias-corrected CMIP6 data input
9. Simulation of historical (1985-2014) and future (2020-2099) stream flow, respectively.
10. Running the agro-hydrological model for agricultural water needs, crop production, crop yields, etc.

Findings

Based on this study, the following are deduced:

1. Peninsula Malaysia has a bountiful agricultural heritage, yet it grapples with pressing issues, including climate change, water scarcity, and demographic shifts.
2. Despite the global recognition of the need for sustainable farming practices and resource management, integrating youth into these efforts remains a substantial challenge in the Malaysian context.
3. The agricultural sector is perceived negatively and viewed as less prestigious by society. The youth lack interest in working in the agricultural industry; hence, it is now monopolized by foreign workers.
4. The agricultural sector imports have increased, reaching RM98.0 billion in 2020, up from RM93.5 billion in 2019.
5. Studies have shown that most farmers are in their old or advanced age, while the young rarely engage in farming activities.

6. Despite the efforts and successes achieved in Peninsula Malaysia's agricultural sector, smallholders with an average age of over 55 continue to dominate the industry.
7. Only 15% of Malaysia's youth, who comprise 44% of the country's overall population, work in agriculture. Farmers who are getting older may be less receptive to implementing contemporary technology necessary to boost output and minimize environmental harm.
8. Low-skilled foreign workers comprise 31% of the agricultural workforce, and farming is primarily a labor-intensive industry with little farm technology and automation adoption.
9. Preliminary findings from this multifaceted approach indicate that AHMS enhances farm productivity and resource management, actively engages youth in innovative techniques, and fosters sustainability awareness, marking a promising pathway for youth development in Peninsula Malaysia.

Conclusion

Agro-Hydrological Modeling Systems are pivotal in Peninsula Malaysia for addressing agricultural and hydrological challenges and fostering youth engagement, education, innovation, and sustainable agricultural practices. Investment in education, innovation, and sustainability by government, private sector, and Non-Governmental Organizations (NGOs) is essential to unlock this potential. By nurturing a generation of environmentally conscious, data-driven agriculturalists, Peninsula Malaysia is poised to embark on a sustainable and prosperous trajectory.

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