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Progressive Web Application for Suitability Mapping of Small Farm Reservoir in Isabela using Soil and Water Assessment Tool

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ABSTRACT

The Philippines, as a part of Southeast Asia, situates into the zone categorized with agricultural areas prone to drought. To mitigate this concerns, rainfall harvesting with the use of agricultural structures called Small Farm Reservoir (SFR) could be implemented. However, SFR could be challenging to implement due to geographical suitability, catchment appropriateness, and high cost of field survey. In this study, a Progressive Web Application was developed for identifying ideal locations and potential capacity of SFR. The Soil and Water Assessment Tool was utilized in creating the suitability map for SFR in Isabela Province. The generated SFR suitability map was integrated into the development of the application. The external qualities of the developed application were tested using ISO25010 software standard to ensure that the application works as intended. It was assessed by the respondents to be "Very Good" such that it is functionally suitable, efficient, compatible, usable, reliable, secure, maintainable, and portable.

Key words : Agriculture, Progressive Web Application, Small Farm Reservoir, Soil and Water Assessment Tool.

1. INTRODUCTION

Information Communication Technology (ICT) Applications in agriculture offer opportunities for food security and sustainability [1]. However, various challenges remain. One of the major challenges in agricultural production is mitigating the effects of climate change [2],[3]. To alleviate climate change impacts such as extreme drought and flooding, farmers practice indigenous techniques such as rainwater harvesting [4],[5]. This technique in the form of Small Farm Reservoirs (SFR) makes major contributions in mitigating the effects of climate change, making an entire range of crops viable in an otherwise unreliable climate [6]. These structures are used for rainwater embankment to avoid flooding in the rainy season and conserve water during the dry season. However, SFR implementation poses environmental concerns since it involves location-specific management knowledge including geographical suitability and reservoir design appropriateness. To provide stakeholders a tool to respond better to various challenges in implementing small farm reservoirs and to maximize the technological advancement, an attempt has been made in this study to develop a Progressive Web Application [7] using Soil and Water Assessment Tool (SWAT) [8]. Test the functionalities of the developed application based on the identification of suitable locations of small farm reservoir, computation of potential capacity of small farm reservoir, and identification of potential economic benefits of small farm reservoir. Evaluate the extent of compliance of the application in terms of ISO 25010 [9] software standard**.**

2. METHODOLOGY

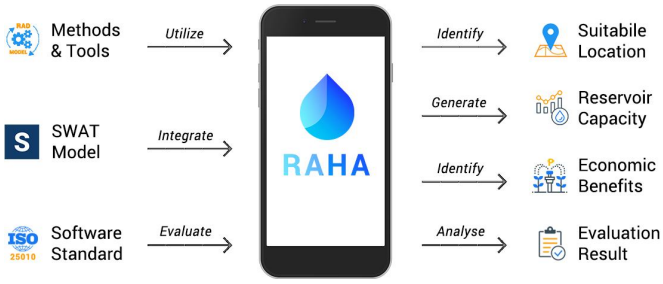

Figure 1: Conceptual Framework of RAHA development

Figure 1: Illustrates the procedures to accomplish the objectives of the study.

2.1 Methods and tools

The Rapid Application Development (RAD) model [10] was utilized to guide the development of the application. The model focuses on minimizing the planning stage and maximizing iterative prototyping. This results in fast and efficient software development. The first phase of the model is Requirements Planning. This phase determines the scope of the application. User Design is the second phase of the model which includes prototyping and refining the initial process, concepts, and critical components of the application. The development phase translates the of application design into computer code. Then, the performance assessment of the application.

2.2 Model integration

Soil and Water Assessment Tool (SWAT) model was used for predicting the effects of alternative management decisions on water resources. Digital elevation model, soil type, slope map, land use; annual precipitation, and SFR suitability guidelines were acquired. These datasets were simulated in the SWAT model. The SWAT Weighted Overlay Tool was utilized to generate the suitability map of small farm reservoir in Isabela. Identified highly suitable locations for small farm reservoir were integrated in the application's development.

2.3 Software evaluation

The ISO 25010 software standard was adopted to formulate a survey questionnaire to evaluate the functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability of RAHA. Stratified Random Sampling was implemented to generate unbiased data. The first group were the Field Experts from Enhancing Ecosystem Services On Food and Freshwater in Rainfed Agricultural Areas of Cagayan Valley – A Commission on Higher Education Project. The second group consisted of the Academe IT Specialists from Isabela State University – Ilagan Campus. The third group was the Industry IT Experts from the Department of Science and Technology – Central Office. Slovin's Formula was adopted to compute the needed sample size.

3. RESULTS AND DISCUSSION

3.1 Application development

The core architecture of the application are Js, HTML, and CSS. Firebase served as the backend database and web host of the progressive web application.

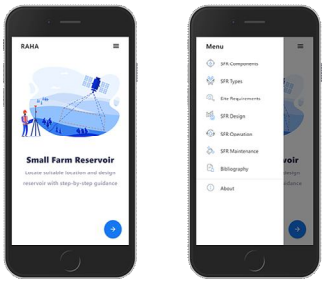

Figure 2: RAHA primary user interface

In Figure 2 the primary interface of RAHA is shown. It includes a menu which open a list of other related information and a right arrow button for the reservoir design.

3.2 Application functionalities

The developed progressive web application has three core software features. The first feature is the identification of small farm reservoir suitable location.

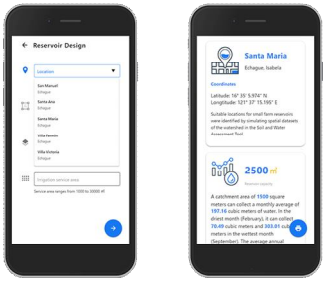

Figure 3: RAHA reservoir location result interface

Figure 3 shows the selection of reservoir location. The selected area will include the coordinates, monthly and annual precipitation. The second feature of RAHA is the computation of potential reservoir capacity.

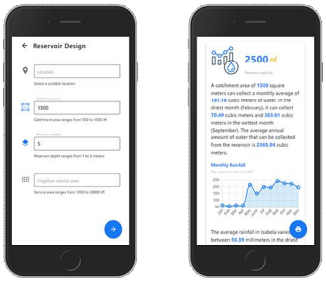

Figure 4: RAHA reservoir capacity result interface

In Figure 4 the computation of the reservoir capacity is exhibited. It estimates the potential water that can be collected during the driest and wettest months of the year. The third feature of RAHA is the identification of small farm reservoir economic benefits.

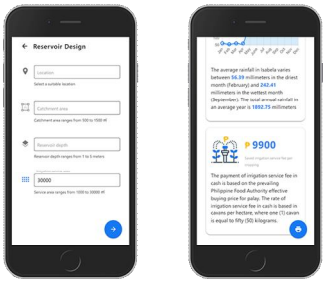

Figure 5: RAHA economic benefits result interface

Figure 5 demonstrates the computation of saved irrigation fee. The calculation is based on the on the prevailing Philippine Food Authority effective buying price for palay. The rate of the irrigation service fee is based in cavans per hectare, where one cavan is equal to fifty kilograms.

3.2 Data Interpretation

The data gathered from the respondents through the questionnaires were summarized and statistically treated. This information is vital for the interpretation and analysis.

Table 1 highlights that the respondents assessed all indicators as "Very Good" with each indicator registering a weighted

mean of 3.9; 4.0; 3.4; 3.8; 3.6; 3.6; 3.7; 3.6 respectively and had an overall weighted mean of 3.7.

Table 1: RAHA Software Evaluation

Indicators	Weighted Mean	Interpretation
Functional Suitability	3.9	Very Good
Performance Efficiency	4.0	Very Good
Compatibility	3.4	Very Good
Usability	3.8	Very Good
Reliability	3.6	Very Good
Security	3.6	Very Good
Maintainability	3.7	Very Good
Portability	3.6	Very Good
Average Weighted Mean	3.7	Very Good

4. CONCLUSION

This paper presents the Rainwater Harvesting (RAHA) software that addresses the needs and challenges in implementing small farm reservoir. The RAHA, a Progressive Web Application (PWA) was developed using the Soil and Water Assessment Tool.

The functionalities of the application were tested to ensure that it works as intended. It was found that it could efficiently identify highly suitable locations for small farm reservoirs in Isabela, compute the potential reservoir capacity based on the selected catchment area and reservoir depth, and identify potential economic benefits of small farm reservoirs based on the selected size of the service area.

The RAHA application was assessed by the respondents to be "Very Good". It means that it is functionally suitable, efficient, compatible, usable, reliable, secure, maintainable, and portable. With this, it can be concluded that the developed application could serve as a tool in implementing small farm reservoir in Isabela.

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