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# Simulation of a Microcomputer-Based Reservoir Monitoring System

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***Abstract**: A reservoir is a storage facility for fluid and other substances like grains; in this particular study, fluid is considered and more precisely, water. Water reservoirs also serve many purposes like flood control, irrigation and low flow argumentation. Water is a major contributor to food security and production. Proper management of water resources leads to increased food production and food quality. This research involves the design/ simulation of a full – fledged microcomputer based reservoir monitoring system with critical high level and low level signaling; in a bid to eliminate the problems associated with managing reservoir activities. Such activities like performing irrigation, running out of water, spillage which leads to flooding and the stress of going about checking individual water levels in reservoirs could be reduced if not eliminated. The core of the research deals with the development, simulation and implementation of the monitoring software, which is written in clipper language to achieve the aim. The programme was successfully written and is able to take in values of water volume used for irrigation, perform irrigation, refill reservoirs, create more reservoirs, check water level and make necessary adjustments.*

***Keywords**: Reservoir, simulation, microcomputer, irrigation, clipper language.*

## I. Introduction

Irrigation is a very important process in agricultural development and farming. It is known as the artificial application of water into the soil for its growth and maturity. It is necessary to irrigate when the total amount of rainfall is less than the total required by the plant or when the amount of rainfall is sufficient but the distribution does not coincide with the schedule of supply required by the plant. In irrigation systems, it is evident that physical structures actually influence the social practice of water management.

Water is a basic need for irrigation. Obtaining water at a price the farmer can afford is one aspect of irrigation while determining how to use it in the most efficient way is another. In the light of anticipated water shortages, it becomes imperative to prevent waste of water and hence store water resourcefully.

Water for irrigation is normally stored in a reservoir; although large scale reservoir systems serve many other important purposes like water supply, flood control, irrigation purposes and low flow augmentation. Reservoir operations problem is how best to use the facilities that are available, with less stress, better prediction and improved monitoring methods. This brings about the need for automation in harmony with the benefits of computerization. Computing and computer technology has permeated every facet of life and as we presently live in a digital age, countries (both developed and developing) are turning to microcomputers for a wide range of applications.

Automation is microprocessor controlled. This provides for easy living due to low price of the microprocessor, high speed of job execution, automatic control, reliability, flexibility and ease of measurement.

In field related automation, a computer-based system consists of three main units, which are – a master control unit (which may be located kilometers from the field); the field units (which receives instructions from the control unit) and the communications link (an underground or overhead electric cables that carry both instructions and supplies power to the field unit if necessary). Reference [1] submitted that modernization of irrigation system operation is the key to success in increasing yield and productivity in agriculture and in enhancing the management of limited natural resources such as water. He, however, stressed that modernization should not be limited to the introduction of new hardware and software but rather should be seen as "a fundamental transformation of the management of water resources".

## II. Problem Definition

The identified problems that this research work focuses on to solve are:

- Difficulty in knowing the water levels in reservoirs (seepage and evaporation losses lead to shortage of water and thereby reducing water delivery, and spillage also results into drainage problems)
- Crude measuring methods

- Discrepancies between actual water level and that displayed by an analog meter.
- The inconveniences involved in having to walk down to the reservoir location to take readings on an analog / digital dashboard or on some other means; and lastly;
- The problem of running out of water unnoticed or of spillage which may lead to flooding.

## III. Design Objectives

The objective of this research work is to write a program to simulate a full-fledged microcomputer-based reservoir monitoring system with critical high-level and low level signaling and thereby eliminating the aforementioned problems.

## IV. Simulation

Reservoir simulation models have been used over the years by oil and gas companies in the development of new fields [2]. Also, models are used in developed fields where production forecasts are needed to help make investment decisions. As building and maintaining a robust, reliable model of a field is often time-consuming and expensive, models are typically only constructed where large investment decisions are at stake. Improvements in simulation software has lowered the time to develop a model. Also, models can be run on personal computers rather than more expensive workstations. For new fields, models may help development by identifying the number of wells required, the optimal completion of wells, the present and future needs for artificial lift, and the expected production of oil, water and gas.

Simulation has been used in this work because it provides a framework for learning the unteachable, allowing a mix of social economic and technical factors to be experienced. For example, farmer participation is a very important key issue in irrigation management, but how can this message be otherwise presented and how can its effects be demonstrated?

### *A. Early Trends*

As early as 1963, hall and Howell described a procedure for the optimization of a single purpose reservoir, using a dynamic programming scheme. The scheme, which used return functions over intervals of time, was coupled with a Monte Carlo technique, possible in practice only through the use of a digital computer. [3]. [4] working on the MASSCOTE approach to modernizing irrigation management observed that irrigation modernization is often misunderstood and associated exclusively with high technology or costly automation. However, modern irrigation management is essentially concerned with responding to the needs of current users with the best use of the available resources and technologies as well as a sense of anticipating the future needs of the scheme. How to convert this into very practical, effective technical solutions is a critical question.

## V. Current and Future Trends

Notably, several reservoir simulators are being written in recent times and most of them address the oil and gas sectors of engineering. Modeling softwares like ECLIPSE, by SIS, a division of Schlumberger; REVEAL, by Petroleum Experts, Inc; CHEARS by Chevron and so on actually focused on oil exploration models which helps in improved oil recovery by hydraulic fracturing. Many reservoir simulators are part of a software suite that assists data input and results analysis. Separate systems that rely on reservoir simulators also exist. They assist the performance of such tasks as history matching, making multiple simulations and analysis of forecasts. [5] found out in their research that farmer's attitudes, particularly with respect to cost and lifestyle influenced the priority given to adopting automatic irrigation systems. Future trends in irrigation can be expected to be very different from those of the last few years looking at it from the trend in ICT development [6]. Irrigation technologies will become commonplace, and irrigation might enter the space age as satellites are used to monitor and feed back information on water management. At the same time, conservation of the earth's dwindling resources of water and energy will increasingly become the central motivation of technology design [7].

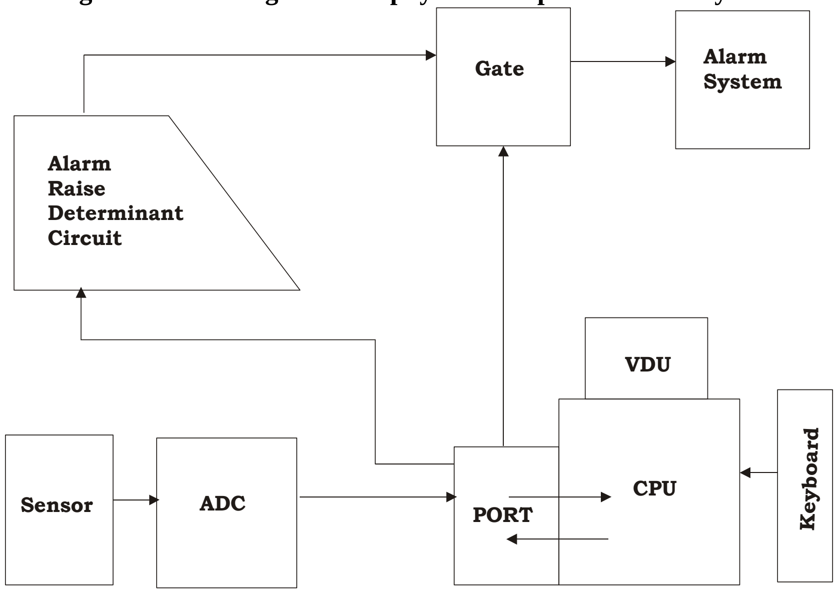
## VI. System Design, Methodology and Implementation

### *A. Overview*

The actual system design is under two specifications: Software specifications and Hardware specifications. Since this particular research focuses mainly on the software specifications, the hardware part of it will just be mentioned in brief. The hardware specifications will consist of the hardware modules that are required. It is also to be the physical components, which will be connected together to make up the physical design that is seen. Examples are the liquid or water level sensor, an Analog-to-Digital-Converter (ADC), an alarm system, a communication port, a computer system and other discrete electronic components. Fig. 1 shows the overview (Block diagram) of the physical components and the way they interact. Since this research focuses on software mainly, the electronic aspect will not be fully discussed.

The software specification consists of the control/monitor program modules specification that is required to control the hardware modules. It is a control program written in Clipper that monitors the water level through a port. The control program was made an executable program (.exe) and made resident in the system's hard disk (TSR). The water level or tank condition could be determined whenever required by invoking the control (.exe) program at the dos prompt, or as a windows based program file with personalized windows icon for aesthetics and cosmetics. The program will then come up with the main menu - Create More Reservoirs, Perform Irrigation, Refill Reservoir, Check Water Level and Exit. All these are accompanied with error, default messages and values displayed graphically on the VDU. It is assumed that the reservoir will have a floater attached to it in the actual design implementation, and that a transducer (variable resistor or rheostat) is attached to the floater for capturing the liquid levels.

**Figure 1 Block diagram f the physical components of the system**




The system design will make use of the computer system as its display unit. The computers system could be placed in a place of convenience where it could also be used for other jobs. The P.C. could be remotely placed from the tank and so eradicating the stress of having to walk down to check the water level. This saves time and energy.

Lastly, the system design incorporates the fact that the system does not leave the environment where it is set up. Events like, irrigating from any of the tanks, refilling of tanks, checking of water levels and creation of more reservoirs could be monitored from the P.C. In an event of an overfilled tank, going to spill over, or of a critical low level of water (water running out), an alarm is raised.

The steps to be taken from inception of the design are:

1. To create a model/prototype of the reservoirs, the quantity of water stored, amount or volume of water used for irrigation and volume left; displaying all these in certain colour modes and codes.
2. To write a software program in Clipper that will do all the aforementioned.

***B. Software Design***

In designing the system, the top-down modular approach was employed in which the whole system is successfully broken down to modules until the whole task is eventually performed. Each module could be developed and tested separately to accomplish a specific task: this results in reduction of the complexity, easy understanding and maintenance of the system. After the development of all the modules, they are then interpreted together for an overall implementation.

It is intended that the programme would be user-friendly; hence it should be very interactive. Basically, Clipper supports structured programming which ensures easy understanding of a program, and allows for further expansion and modification of the programme.

The program has about eight modules. It has:

(1) A "main menu" module: this invokes the main heading screen and the menu;
(2) A "Reservoir Creation" procedure: this creates additional tanks needed for irrigation;
(3) A "Perform irrigation" Module: this allocates the quantity or volume of water needed for irrigation and subtracts it from the existing volume in any of the tank accessed.
(4) A "Refill Tank" Module: this refills any tank that is exhausted to critical level.
(5) A "Water Level Checking" Module: allows for a verification of each reservoir water level;
(6) A "show-level module": displays the meter level in percentage of volume of tank.
(7) A "Tank-Draw" procedure: Draws the tank for filling with water; and lastly
(8) A module for the environment setting routine which has a data base operational setting.

### *C. Software Operation*
The control program, being a simulated software design is simply interactive. If it is to be implemented, then signals have to be acquired from the port, displaying equivalent water level. The control program flowchart is as shown in Fig. 2.

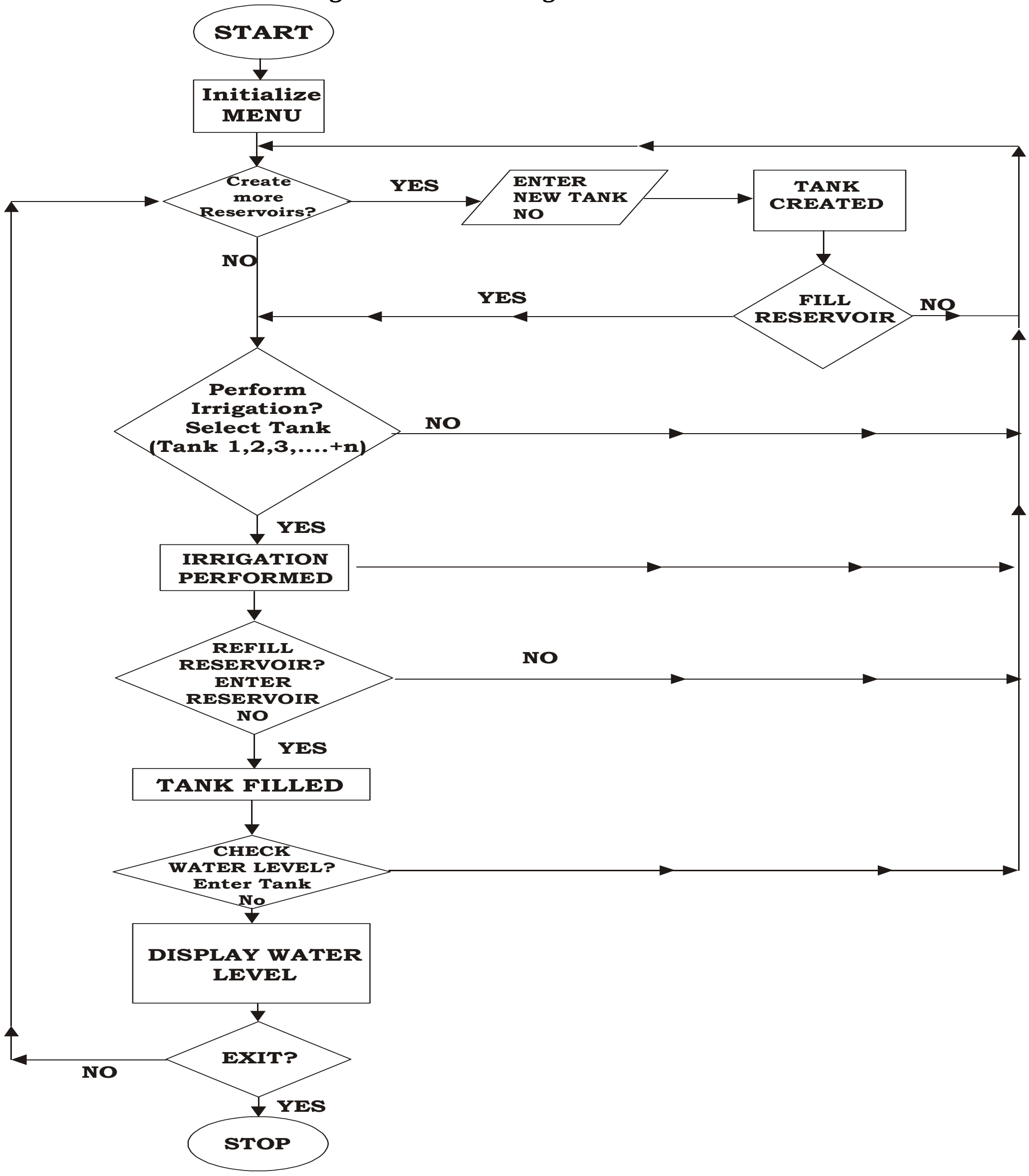
### *D. Hardware Requirement*
The list of the Hardware requirement is as follows stating the minimum specifications: A complete Pentium III processor or above (with 700 MB Memory or above) and a colour monitor, keyboard and mouse.
It is also advisable that common hardware support should be provided namely

- a voltage regulator/stabilizer
- a U.P.S.
- a generator
- an air conditioner in the environment where the system is placed.

### *E. Software Requirement*
For the software requirement, any window based or DOS based application/system could access the executable programme (.exe).

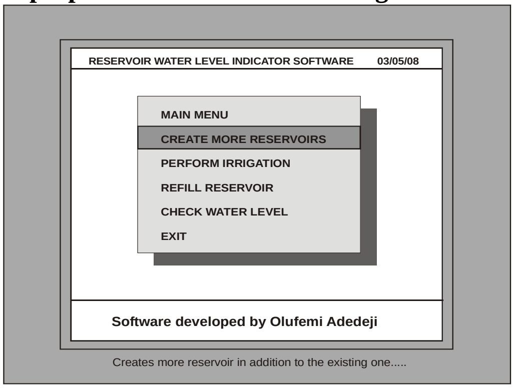
### *F. Using the Software*
The software is basically menu driven and user-friendly. The menu is implemented as a pop-up menu so that options are made or chosen by pressing the up or down and (enter) key.

**Figure 2 Control Program Flowchart**



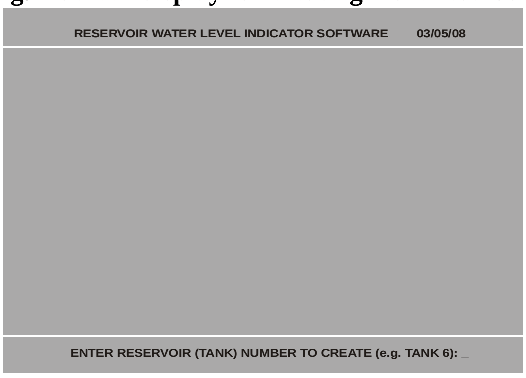
In using this package, the user should pay extra attention to the lower parts of the screen, as most of the prompts would be written on this part of the screen. The messages are intended to guide the user in the course of using the software. The message may tell you what to do next or explain the choice of a menu (e.g. "Irrigation performed. Press (Enter) to continue..." or "Alarm!... Reservoir Existing, please Retry again (Enter) to continue..", it sounds an alarm on an illegal entry or on error detection. All these messages are simple to understand. On start up, the screen is as shown below:

**Fig. 3 Pop-up Screen Menu for Creating More Reservoirs**



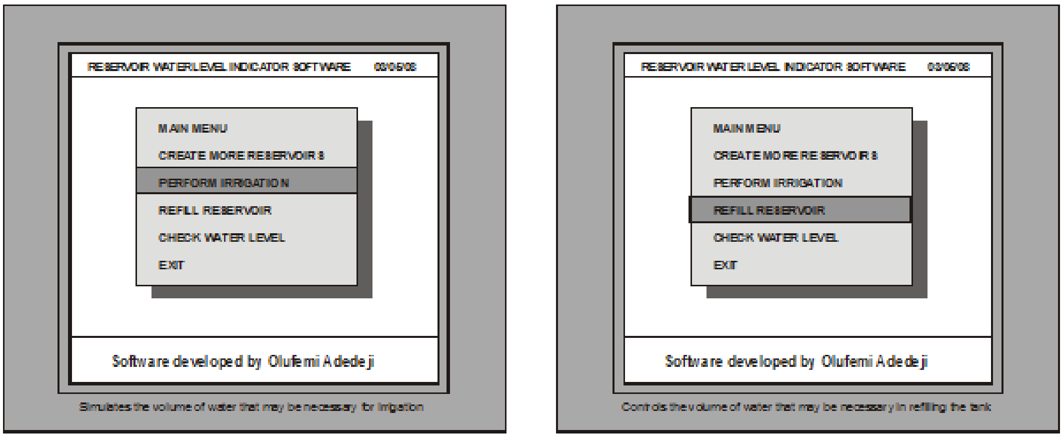

This is called the "main Menu" and it gives the main divisions of the Reservoir System Organizational Structure. The first option is the "create More Reservoir" option. If chosen it displays a screen (Fig. 4) which has a message down the screen "ENTER RESERVOIR (TANK) NUMBER TO CREATE (e.g TANK 6): ___ "It blinks for a prompt. If an existing reservoir name is entered, an alarm is sounded and the screen displays the message "Alarm!... Reservoir Existing please retry (Enter) to continue…" if a non-existing tank number is entered, a new tank with the new name is created and signaling an empty tank.

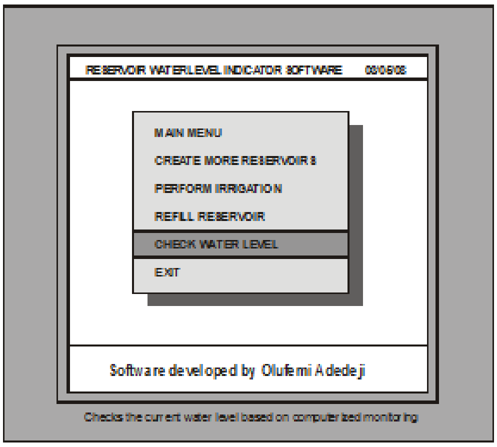
**Fig. 4 Screen display for creating more reservoir**

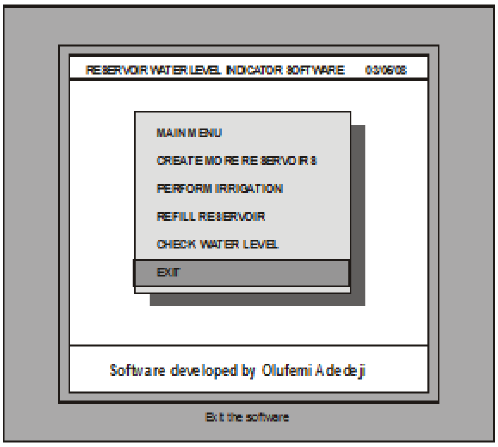



There is a prompt: "DO YOU WANT TO FILL THE RESERVOIR (Y/N)? : "N" A "N" (No) takes you back to the main menu environment while a "Y" Z(Yes) leads you to the "fill reservoir" condition asking the user to enter the volume of water to fill the tank. The other options on the main menu are the "perform irrigation", "refill Reservoir", "Check Water Level", and the "Exit" choices. If highlighted, it displays a screen as shown in fig. 5.

**Fig. 5 Pop up screen for different choices of the main menu**

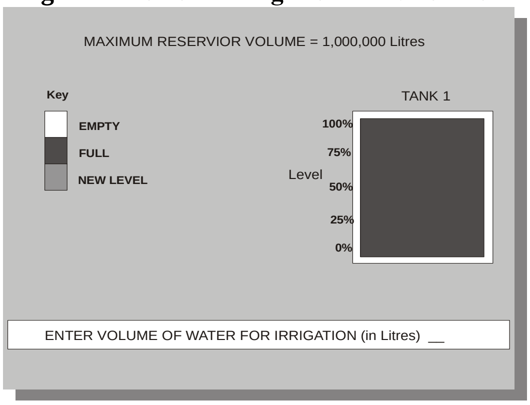




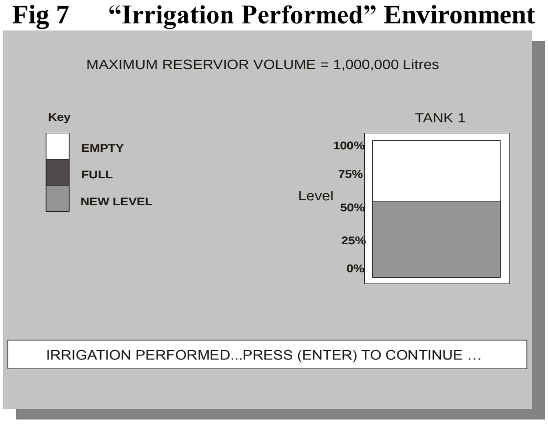

The second option on the main menu is the "Perform Irrigation" option. If selected and the enter key is pressed, it displays a screen as shown in fig. 6.

**Fig 6 "Perform Irrigation" Environment**




The tank is expected to be full already as invoked in the data base environment. If the volume of water is entered and the (enter) key is pressed, a new message below the screen is seen "IRRIGATION PERFORMED… PRESS (ENTER) TO CONINUE…" as shown in Fig. 7 below:

**Fig 7 "Irrigation Performed" Environment**




If a volume greater than the present content of the reservoir is entered another message erupts: "ERROR!.. WATER LEVEL TOO LOW PRESS (ENTER) TO CONTINUE…" If irrigation was successfully done, a new water level will be displayed on the simulated reservoir.

The third option on the main menu is the "REFILL RESERVOIR" option. When this is entered, the program takes the user to the next available empty tank and prompts for the volume of water to add to the tank. If no tank is empty, another message is displayed saying "ALARM! …no tank is empty. No need for REFILL. [ENTER] to continue".

The "CHECK WATER LEVEL" is the last processing option on the main menu. If accessed, it prompts for the tank No and entering the number takes you to the particular tank condition. If by error, no tank name was entered, an error message is generated: "ALARM!....................... Tank Name must not be Empty, Please retry (Enter) to continue…." Or if a non-existing tank name is inputed, another error message come up saying "ALARM!.................. Reservoir name not existing, please Retry (ENTER) to continue…………."

Lastly, the EXIT module takes you out of the software environment back to your windows environment.

## VII. Conclusion and Recommedations

This is a simulation programme, which offers value for the cost of its utilization whenever it is needed. Simulation can show individual water managers the consequences of his actions. In a real situation, a manager may be unable to see any visible benefit or demerit from any increased or improved efforts on his part. The simulation provides a means to do this and can give managers confidence in their actions. In practice, an irrigation expert or personnel may rarely have either enough time or all the information he needs to make a fully - informed decision. Simulation exercises are useful in demonstrating such constraints. In conclusion, this project work has focused on the design and simulation of a reservoir monitoring system with critical low-level and over-filled signaling. This was realized having considered its objectives. With the program, more reservoirs could be included in the system, irrigation could be performed, tanks could be refilled with water and the water levels could be deduced at will by involving the program from the main menu. The programme shows that reservoir management and use could be automated; thereby reducing the stress of physically managing water resources. The recommendation will be that this programme could be invoked with hardware devices that will make the ideas work out perfectly. It could also be made microcontroller based by placing the control/monitoring program on a chip.

## VIII. References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