Development of a GPRS Internet Based Data Management System for Effective Dam Operation in Zimbabwe

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Abstract

Efficient and effective management of dams depends on a data management system that facilitates easy collection, entry, storage, retrieval and analysis of data. In Zimbabwe, the national water authority (ZINWA) and sub-catchment councils use a paper-based system where data is logged onto sheets and transported to a receiving station where data processing is in theory undertaken. The system has been observed to result in inordinately long time lag between data collection, analysis and information dissemination, uses too much space, and is less amenable to executing data analysis that is suitable for different users. A study was undertaken to develop a data management system that would address these problems. The General Packet Radio Service (GPRS) was used as the general data transmission platform, using a GPRS enabled cellular phone as medium for data entry, and the internet for data storage, display and interaction. Data from Lake Chivero in the Manyame catchment, one of water sources for Harare, Zimbabwe's capital city, was used to test the designed water management system. The water management system that was developed was demonstrated to improve functional efficiency (reduced time lag and error) by expediting data entry and analysis in real time, and was cost effective when compared to alternatives such as a satellite-based system. The system can be used as a replacement for the inefficient paper-based system.

Key words: dam operation, data management, GPRS, internet, web application, Zimbabwe

1. Introduction

Zimbabwe is a water scarce country with an annual average precipitation of 675 mm that varies widely in time and space. Annual runoff has a high coefficient of variability (cv) ranging from 60 to 200%. The Eastern Highlands are reported to have the lowest cv of between 55 and 75% while the cv for the southwestern and central areas is estimated at between 120 and 160% (Mazvimavi, 2003). Even the low rainfall is not readily available for productive use; only 8% of rainfall forms runoff with the rest being lost as evapotranspiration. This is made worse by the fact that some rivers flow only for a few days in the year. Against such a background, storage facilities, such as dams, are an important means of ensuring that adequate water is available throughout the year for various purposes, such as water supply, mining agriculture and industry.

There are approximately 8 000 dams in Zimbabwe with a total capacity of 5 billion m^3 (ILECF, 1998). Just under two percent of these have a height greater than 15 m. These 'large dams' are managed by a quasi-government national water authority, known as the Zimbabwe National Water Authority (ZINWA). ZINWA succeeded the Department of Water Development (DWD) as the agency responsible for water management in the country. This came about as a result of the water reforms that are captured in the 1998 Water Act (Zimbabwe, 1998a) and the Zimbabwe National Water Authority Act (Zimbabwe, 1998b). ZINWA is responsible for the management of 146 dams which have a total capacity of 6155.827×10^6 m^3, which accounts for 47% of the total stored water in the country (Manzungu et al, 1999).[1]

[1]This is, however, a shared responsibility with popularly elected catchment councils (CCs) and sub-catchment councils (SCCs). Catchment councils are responsible for planning and managing water resources including the production of a catchment outline plan, as well as considering and granting applications for water allocation. Among other things SCCs regulate and supervise the exercise of permits, monitor water flows and use in the catchments and assist in data collection and participate in catchment planning.

These state-owned dams are found in all the seven catchments into which the country was divided when the country changed from an administrative-based to a hydrological-based water management system as a consequence of the water reforms (Chereni, 2007; Manzungu, 2004; Kujinga, 2002)[2]. ZINWA is solely responsible for managing water in these dams, including its allocation.[3] Catchment and sub-catchment councils do not have jurisdiction over water in state dams. This means that in drier catchments where most of water that is available is stored, catchment councils play a less important role in water management compared to ZINWA. Sub-catchment councils have jurisdiction over smaller dams within their sub-catchments and are known to have challenges collecting and processing data from these dams. There is therefore very little information concerning some of these dams.

Any water management system, however simple or sophisticated, depends on efficient and effective collection and availability of information. As far as dams are concerned, information relating to the capacity of each dam at any point in time, and the amount of water that is available for different uses at present and in the future, are some of the critical elements. In Zimbabwe, the problem is not just that such information is not always available due to a poorly developed hydrological network, (Nyabeze, 2005; Mazvimavi, 2003), but also because the methods that are used to capture and analyse data do not optimize the available human and financial resources. Water authorities in Zimbabwe use a paper-based system where data is logged onto specially designed log sheets and transported to a receiving station where data entry and analysis is in theory undertaken. The system has been observed to result in inordinately long time lag between data collection and analysis with sub-catchment councils sometimes guilty of taking months to release information to the public. It uses too much space and is less amenable to executing variable data analysis that is suitable for different users. Besides, the use of files makes referencing and record searching cumbersome.

Due to the uneven nature of the volumetric dimensions of the various dams, special tables were developed in the early 1990s (using a computer model) which allows the data logger to extrapolate the capacity of the dam at a particular level for state dams. Records are taken daily and are increased to three during peak rainfall periods. Due to the remoteness of some of the dams, records are submitted to receiving centres for processing after a long time. Some records have been reported to take as long as three months to reach their destination. ZINWA has realized the limitations of the current system, especially in the light of the remoteness of dams and dilapidated state of the road network, and is keen to change the system. For dams that are managed by sub-catchment councils the situation is more challenging as the tables may not be available. Besides the dams are located even in remoter areas.

Efficient and effective management of dams depends on a data management system that facilitates easy collection, entry storage, processing, and analysis of data. Capacities in themselves may only show snapshots of values. Further analysis is required to produce meaningful reports and assessments. Technological developments and an expanding knowledge base have opened up possibilities of easy data collection and processing through the integration of customized computer applications, Geographical Information Systems (GIS) technology, remote sensing (Hoffmann, 2005) and modeling (Jewitt at al, 2004; Symphorian et al, 2005). The use of such interventions, together with cellular technology, can cut down the delays in the time between data gathering and processing and information distribution. With the rapidly increasing cellular coverage in Zimbabwe, courtesy of the three network providers, General Packet Radio Service (GPRS) coverage is also expanding. There is the possibility that internet access will soon be available even in remote areas as is the case with Short Messaging Service (SMS). GPRS is a data transmission platform that allows GPRS enabled mobile phone users to access the internet. Incidentally ZINWA is in exploring the use of an internet based data management system. Efforts are also underway to develop an Information, Communication and Technology (ICT)-based system for managing small reservoirs (Mulengera, 2011). A study was undertaken to develop a data management system that would create a fast, efficient and centralized system for controlling, processing and distributing information about both government state dams and smaller dams to give a holistic water management system to aid water resource planning.

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[2] Three of the catchments, namely Manyame, Mazowe and Sanyati, account for 75% of the total net capacity. The other four catchments are Gwayi, Mzingwane and Save.

[3] Water in these dams is allocated to various water users as Agreement Water, which refers to the amount of water requested by a user for a whole year as per agreement between the user and ZINWA.

GPRS was used as the general data transmission platform because of its expanding ability to allow access to the internet via a cellular phone from remote locations. The internet was used as the host for the system as it provides a centrally accessible platform for information processing, management and dissemination. Data from Lake Chivero in the Manyame catchment, which represents one of the water sources for Harare, Zimbabwe‘s capital city, was used to provide test data. The study sought to assess the nature and extent of data management problems and challenges in dam management, develop a GPRS based data management system for efficient dam operation and information management, test the system using data from a selected a dam, and illustrate how the system can address the problems outlined above.

2. Conceptual framework

2.1 Components of a data management system

A good dam management system is one where all the elements that make up the system are properly defined and all interacting elements are correlated in the desired manner. Fig. 1 shows the concept behind paper-based system similar to the one used by ZINWA.

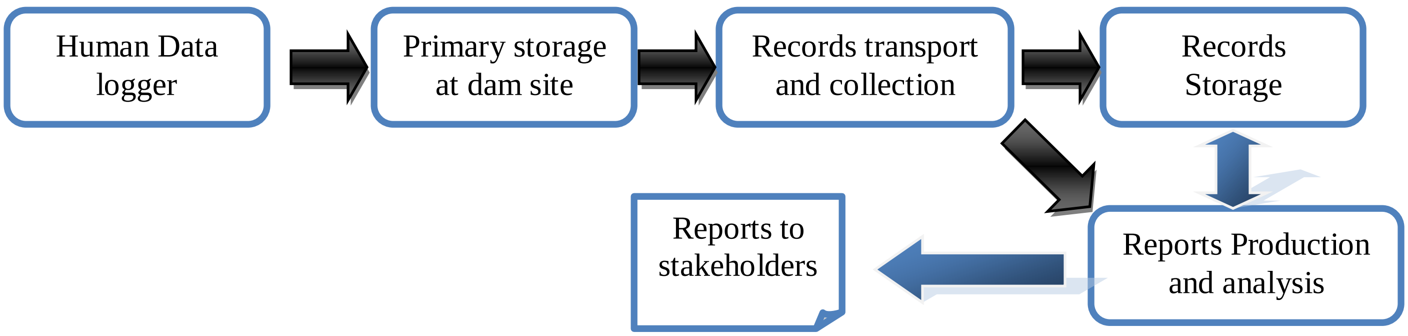


Fig. 1: Illustration of a paper-based dam information management system

The core element of any water management function is how the information is stored and arranged which is commonly referred to as a database. A database is primarily a store for information and can be manual, as is the case with a filing cabinet where data files are stored, or can be computer-based as is the case with many financial services systems. A good database should have a clear structure and must be consistent in the way data is stored and referenced. Due to the fact that over time data collection results in the accumulation of records that need to be managed expeditiously, it is imperative that ways and means to make this task easier are devised. The increasing availability of latest technologies makes this a realistic proposition. Since we are living in the computer age, it is important to explore whether and how alternative data management can be enhanced by advances in computer-based systems. In this regard interlinking the various data elements is critical to avoid a situation where the data elements are isolated. The worldwide reach of the internet has made it easier to use computers in such diverse fields as accounting and natural resource management. The internet is a network of electronic databases that offer services such as email, news and various downloads. Electronic databases are easy to automate, update and query to obtain specific information for customised needs. With respect to dam management the incorporation of electronic databases makes it possible for data to be entered and stored in a structured format, and also increases automation of recurring processes.

2.2 Applications

A data management system requires an application for it to allow the user to manage data. An application is a computer programme that is designed to carry out specific processes and tasks at the prompt of a user. Common applications include Microsoft Word for word processing, Excel for handling tabulated data, and Internet Explorer which allows a user to surf the internet. In general a user inputs data; the computer processes the data, and produces information that the user can understand (Fig .2).

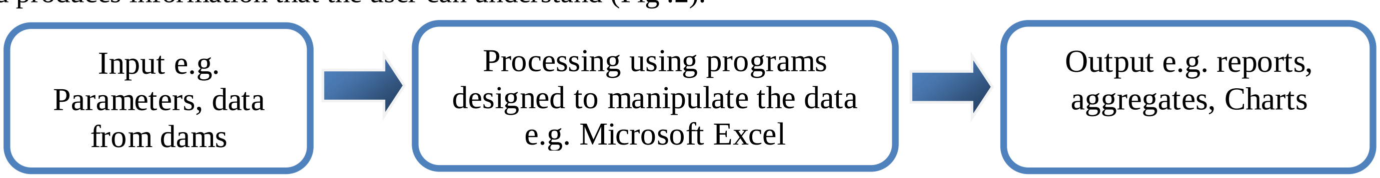


Fig. 2: Flow diagram showing how an application works

The internet plays host to Web applications (commonly referred to as websites) that are accessed via the internet such as language translators, social networking sites such as Facebook and Twitter. A user in any part of the world with internet access can use the web application hosted on a server in another part of the world, as well as retrieve information on request. Popular software for creating applications include Sun Java and Microsoft Visual Studio. For this study Visual Studio 2008 was used to produce the web application. The application acts as an interface that allows the user to communicate with the database to enter, delete, update and manipulate the records.

The advent of GPRS and 3G technology has made it possible to create mobile applications and also access web applications via a GPRS or 3G enabled cellular phone. This has opened up the possibility of by-passing physical transportation of data thereby allowing data to be transmitted from remote sites as long as there is GPRS or 3G reception available. Fig. 3 shows how the database, GPRS and application can be used to form a system that can be used for data management.

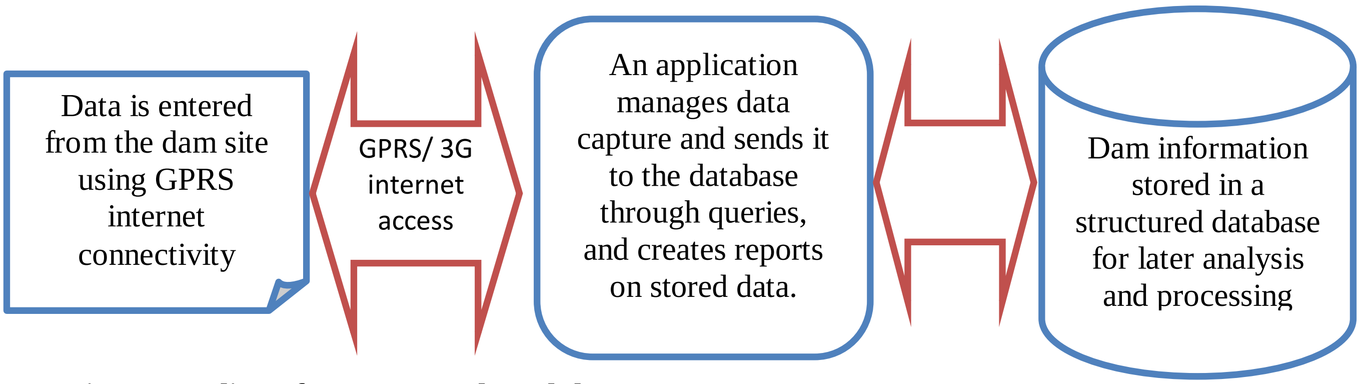


Fig. 3. Outline of a computer-based data management system

3. Methodology

3.1 Scope of data capture

The main parameters that are captured for basic dam management include the current capacity, current level (height) as well as the date and time when the record was captured. Other details including names, purpose, 10 % yield, Full Supply Level (FSL) and net capacity are largely constant and hence only change after long periods. Table 1 shows basic information for to Lake Chivero, which is the main source of water for Harare, the capital city of Zimbabwe. The table shows some of the information that is captured.

Table 1. Lake Chivero data

Latitude	17° 05’ S	Longitude	30° 05’ E
Altitude	1363.6 m	Surface Area	26 km^2
Max Depth	27.4 m	Mean Depth	94 m
Annual fluctuation of depth	4.3m (controlled)	Water Volume	250 million m^3
Water Residence Time	Unknown	Coast Length	74 km
Catchment Area	2227 km^2	Mixing Type	Monomictic
Solar Radiation	22.1 $MJ/m^2/day$	Sunshine Hours	2884 t/yr
Freezing Period	None	Fish Catch	87.3 t/yr
N load	190 t/yr	P load	80 t/yr
Land Use In Basin			
Agricultural Land	23 %	Natural Landscape	67.6 %
Others	9.4 %		

(Source: UNEP and ILEC, 1988-1992)

ZINWA and sub-catchment councils gather data from dams using a human data logger who is responsible for taking readings at a dam site periodically, usually once a day or more during cases of extreme events such as incessant rains. The records are analysed by ZINWA‘s Data and Research Department or at sub-catchment councils, which are in many cases far from the offices of the water management institutions. This means that the documents have to be physically transported for analysis, which results in time lags.

3.2 Data management steps

The following steps were used to design the data management system:

1. Design of database tables, setting relationships and maintaining referential integrity through primary keys using Microsoft SQL Server 2005,
2. Programming the web application for data entry, updating and reporting using queries and components found in Microsoft Visual Studio 2008, and
3. Testing the application.

3.3 Designing the database

The database was designed using sample data provided by ZINWA of Lake Chivero. Figure 4 shows the overall design of the database. Care was taken to separate fields that change regularly and those that do not need to be changed often. To achieve this attributes such as present level, present capacity, percentage fill and date/time were put into a table called Updates_tbl since these parameters are the main data captured on a daily basis. The table called Dam_tbl contains constant attributes such as the dam name, fill capacity and full supply level. Referential integrity of the database was maintained by creating unique ID's as primary keys for each record and using the unique ID as a reference for the records in other tables. For example, though the Updates_tbl does not contain information about the dam name. A unique dam_ID value identifies which dam the record belongs to. Further tables such as the Full_dam_Details, Dam_Details_tbl and Catchment_tbl were created to allow the capture of details pertaining to each dam. The dam_ID parameter was used as the main link to identify which dam each record belongs to as shown in the Fig. 4. The datasets used had the same structure.

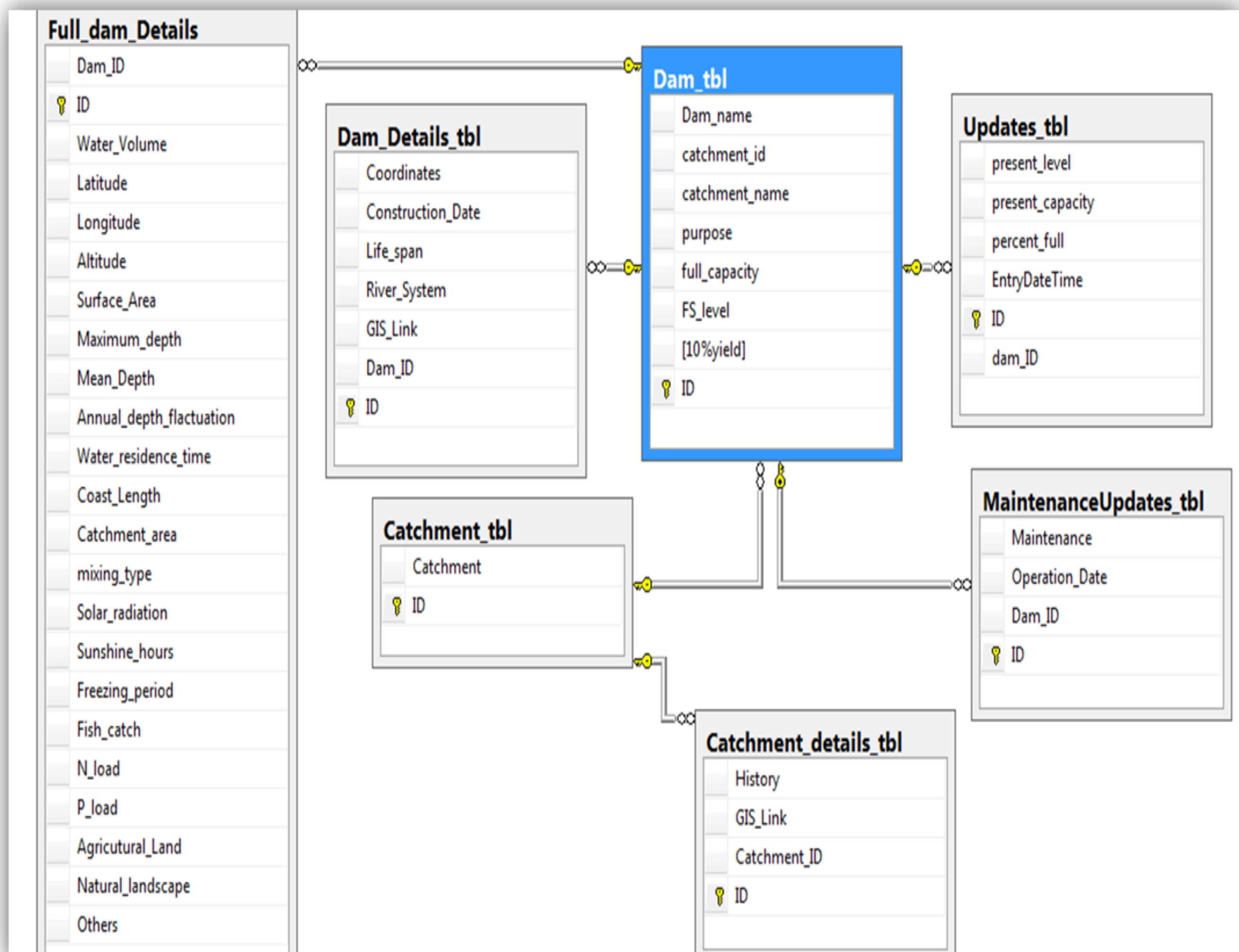
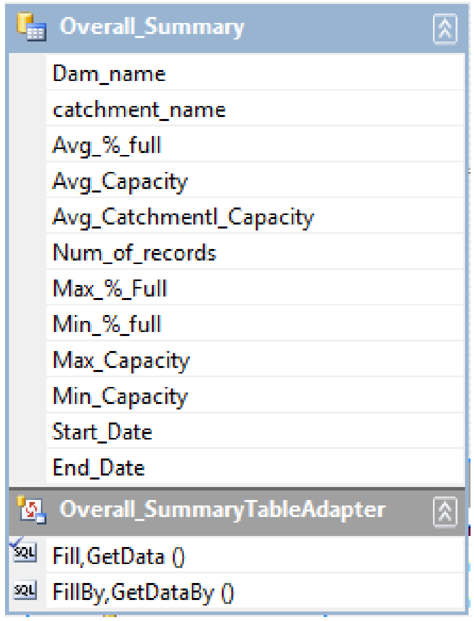


Fig. 4. Database structure showing the tables making up the database and their relationships

3.4 Queries for manipulating data

Queries were designed based on sample reports required by water authorities such as ZINWA and their stakeholders. The query in Fig. 5 is used to fill a dataset that supplies records to produce the Overall fill summary report which contains different selected elements for display of a report in a custom format.



******** SQL Query used to fill the Overall_Summary dataset shown in Table 1 **********

SELECT Dam_tbl.catchment_name, Dam_tbl.Dam_name, AVG(Updates_tbl.percent_full) AS [Avg_%_full], AVG(Updates_tbl.present_capacity) AS Avg_Capacity, AVG(Dam_tbl.full_capacity) AS Avg_Catchmentl_Capacity, COUNT(*) AS Num_of_records, MAX(Updates_tbl.percent_full) AS [Max_%_Full], MIN(Updates_tbl.percent_full) AS [Min_%_full], MAX(Updates_tbl.present_capacity) AS Max_Capacity, MIN(Updates_tbl.present_capacity) AS Min_Capacity, MIN(Updates_tbl.EntryDateTime) AS Start_Date, MAX(Updates_tbl.EntryDateTime) AS End_Date FROM Dam_tbl INNER JOIN Updates_tbl ON Dam_tbl.ID = Updates_tbl.dam_ID GROUP BY Dam_tbl.catchment_name, Dam_tbl.Dam_name

******** End of SQL Query used to fill the Overall_Summary dataset shown in Table 1 **********

Fig. 5: The dataset for the Overall_Summary report and the query that picks the records from different database tables to fill the dataset

Several similar queries were designed to retrieve and supply data to meet the information requirements of different users.

3.5 Programming the application

The design of the application was based on the structure shown in Fig. 6. The management system had three main components, namely Data Entry, Records Management and Reports. The Data Entry component is responsible for capturing data from the mobile or internet platforms and posting it to the database. It consists of seven web pages for entering data via conventional internet access into each of the tables shown in Fig. 4 and a mobile page for entering data via mobile internet. The Records Management component consists of six web pages that handle updating and editing of records in each of the tables and are only accessible via conventional internet. The pages can only be accessed by someone with administrative rights via a password. The Reports component consists of three web pages that give the user the option of compiling reports using queries to find records for a specific dam, records between specific dates and percentage fill at a particular date and also charts and graphs that show a visual representation of custom information as compiled and requested by the user. The reports pages can be accessed remotely by stakeholders. By customizing what type of reports are accessible to which stakeholders the institution can control what information goes out while at the same time allowing stakeholders to access reports on current events without directly requesting the information from the institution. This reduces paperwork, and because information processing is automated, the time lag between data capture and sending out information is cut to within seconds.

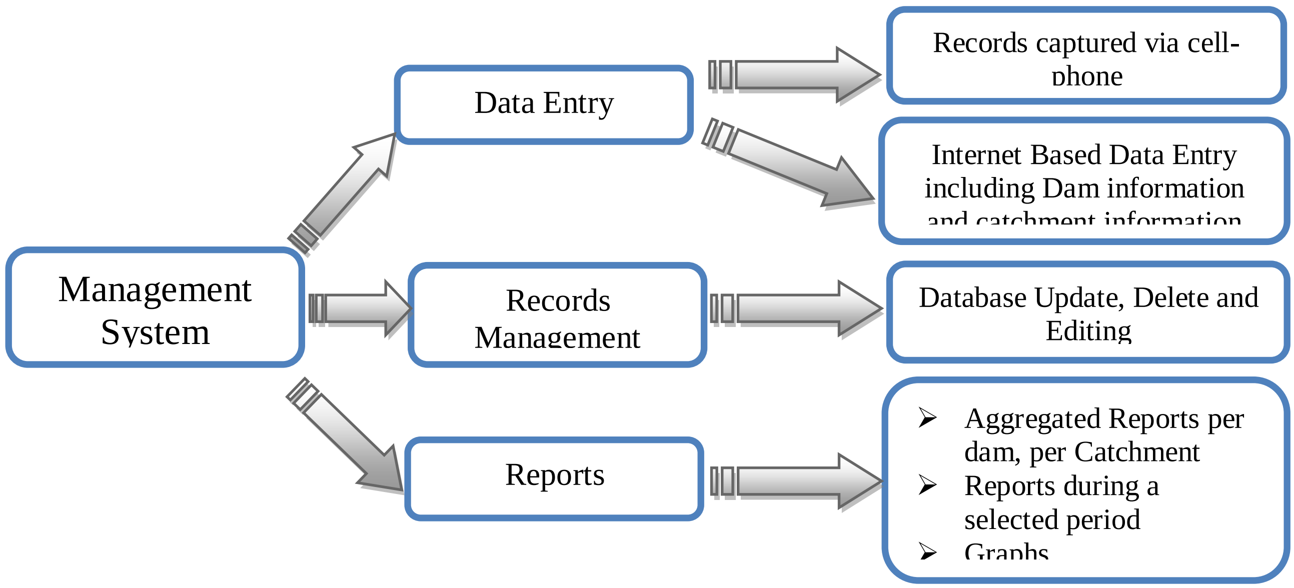


Fig. 6: An outline of the data processing system

Appendix 1 is a sample of VB.Net source code from the mobile data entry page of the website that allows a known user to enter data into the dam database with a method to handle errors using the "Try – Catch" method to "Try" to perform a task and "Catch" exceptions.

3.6 Testing the application

The application was tested using random data supplied to the system via conventional internet to test overall system functionality. The mobile path of data entry was later tested to ensure that it was as reliable as conventional internet data entry.

4. Results and Discussion

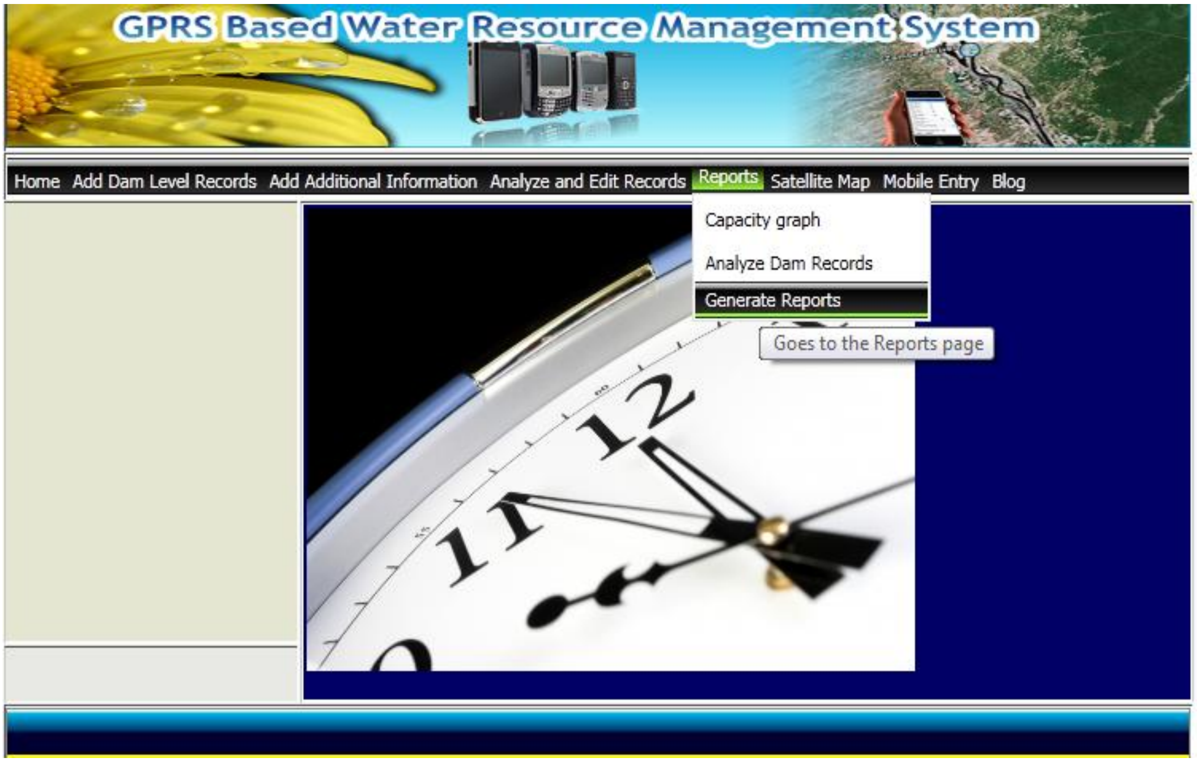


Fig. 7: Screen capture of the web application home page with logo and main menu

Fig. 6 shows the result after data was captured using the data entry screen for cellular GPRS entry and the subsequent data entered into the database. When the dam name, present level and present capacity are captured, the submit button is clicked and the record is processed depending on whether the right password has been supplied. In the specific case shown in Fig. 8, a new record from the Chivero dam was entered with a present level of 81m, present capacity of 379.2 * 10^{6} m^{3} and a calculated percent fill of 78.9612 %. The captured record is shown as it is stored in the database table called Updates_tbl with the above parameters as well as the date and time of capture, and the dam_ID to identify which dam the records belong to.

	present_level	present_capaci...	percent_full	EntryDateTime	ID	dam_ID
	80	213	44.3532	7/13/2010 17:21...	29	2
	90	234	94.6675	7/14/2010 09:41...	30	1
	80	150	90.3851	7/14/2010 09:42...	31	3
	80	100	86.5901	7/14/2010 09:42...	32	3
	96	230	93.0492	7/14/2010 14:16...	33	3
	98	241	97.4994	7/16/2010 11:48...	34	1
	89	211.12	85.4111	7/3/2010 12:26:26	35	1
	89	220.12	89.0522	7/18/2010 12:28...	36	1
	89	220	89.0036	7/7/2010 12:33:01	37	1
	96	231.23	93.5468	7/8/2010 12:50:45	38	1
	99.77	338.46	98.4528	7/12/2010 13:29...	39	4
	91.01	404.55	84.2398	7/10/2010 13:54...	40	2
	99.01	404.34	84.1961	7/14/2010 14:02...	41	2
	81	379.34	78.9903	7/19/2010 14:05...	42	2
▶	81	379.2	78.9612	7/19/2010 14:29...	43	2
*	NULL	NULL	NULL	NULL	NULL	NULL

Fig. 8. Data entry screen for GPRS data input and the highlighted entry into the Updates_tbl table of the database

There may be need to analyse the database regularly to correct errant entries or enter details that were not previously captured or were captured late. A tabular representation of the database in grid format is provided on the data management pages to allow the user to Edit, Delete and Update records in the database as per requirement as shown in Fig. 9. This is only available to users who are provided with the security privileges that allow them to edit the data.

Edit Dam Fill Records

	present_level	present_capacity	percent_full	EntryDateTime	ID	dam_ID
Edit Delete Select	90	201	80.9124	15-Jun-10 10:11:54	20	1
Edit Delete Select	70	151	31.2346	15-Jun-10 10:19:22	21	2
Edit Delete Select	85	150.5	31.2346	15-Jun-10 12:29:55	22	2
Edit Delete Select	90	210	84.958	21-Jun-10 14:18:39	23	3
Edit Delete Select	90	230	93.0492	22-Jun-10 13:15:43	24	2
Edit Delete Select	90	200	80.9124	22-Jun-10 13:23:52	25	1
Edit Delete Select	90	200	80	06-Jul-10 00:00:00	26	3
Edit Delete Select	88	210	84.958	13-Jul-10 16:58:47	28	1
Edit Delete Select	80	213	44.3532	13-Jul-10 17:21:31	29	2
Edit Delete Select	90	234	94.6675	14-Jul-10 09:41:13	30	1
1 2						

Fig. 9. Screen capture image of the edit page of the Update_tbl data table showing Edit, Delete and Select options

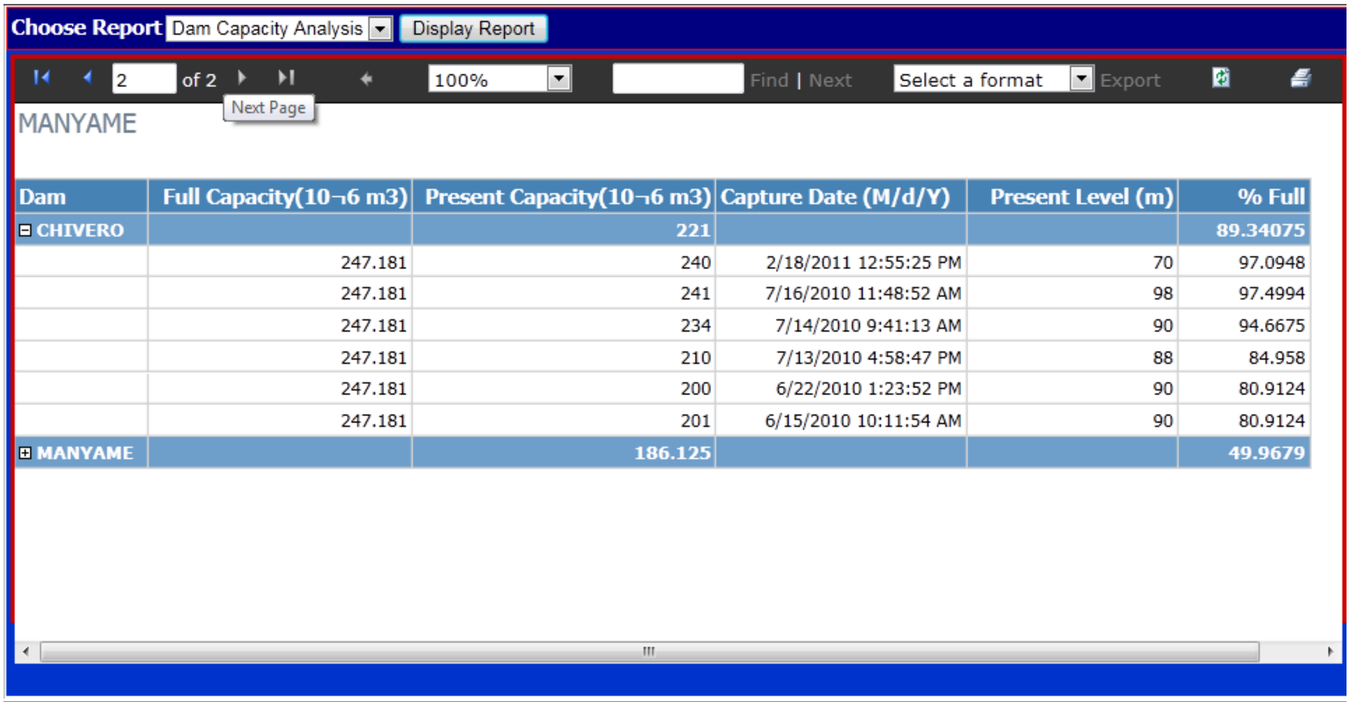
Fig. 10 shows the result of the Custom_Summary query presented before which gives an overall summary of a dams average capacity, average fill, maximum fill achieved, minimum fill achieved and maximum and minimum capacity achieved between selected dates. Such reports are useful in providing a summary of events in a given period to help to trace the performance of a dam and the effects of rainfall events over a period.

MANYAME

Dam name	Avg Full Capacity	Avg Capacity (10¬6 m3)	Avg Catchmentl Capacity (10¬6 m3)	Num of records	Max % Full	Min % full	Max Capacity (10¬6 m3)	Min Capacity (10¬6 m3)	Start Date	End Date
⊞ CHIVERO	88.4403777777778	218.718888888889	247.181	9	97.4994	80.9124	241	200	6/15/2010 10:11:54 AM	7/18/2010 12:28:42 PM
⊞ MANYAME	65.782375	288.99125	480.236	8	93.0492	31.2346	404.55	150.5	6/15/2010 10:19:22 AM	7/19/2010 2:29:33 PM
⊞ MAZVIKADEI	98.4528	338.46	343.779	1	98.4528	98.4528	338.46	338.46	7/12/2010 1:29:39 PM	7/12/2010 1:29:39 PM

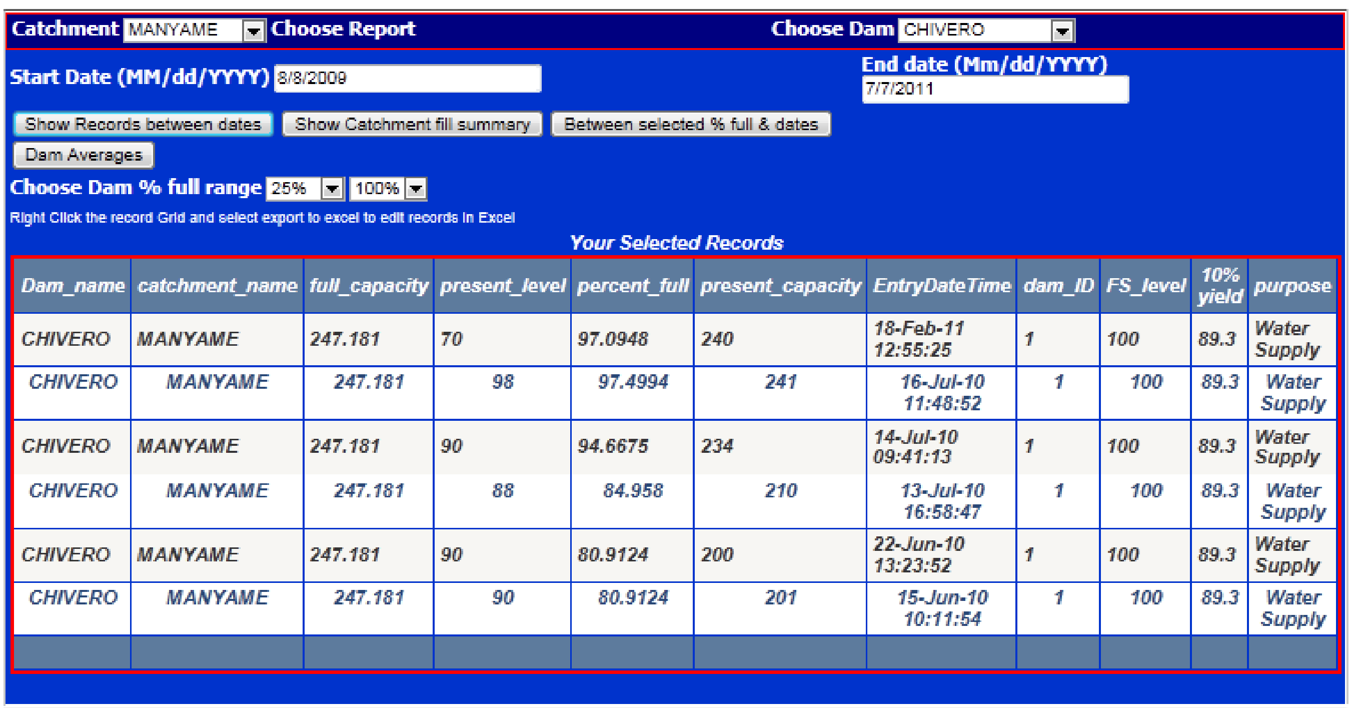
Fig. 10: Report generated by system showing variation summaries for percentage full and capacity

By allowing stakeholders access to such information, the stakeholders can use the information in their planning such as farmers wanting to know whether there may be enough water for a winter irrigated cropping. These reports can be exported to popular formats like PDF format or Excel for customized distribution.



Dam	Full Capacity(10¬6 m3)	Present Capacity(10¬6 m3)	Capture Date (M/d/Y)	Present Level (m)	% Full
⊟ CHIVERO		221			89.34075
	247.181	240	2/18/2011 12:55:25 PM	70	97.0948
	247.181	241	7/16/2010 11:48:52 AM	98	97.4994
	247.181	234	7/14/2010 9:41:13 AM	90	94.6675
	247.181	210	7/13/2010 4:58:47 PM	88	84.958
	247.181	200	6/22/2010 1:23:52 PM	90	80.9124
	247.181	201	6/15/2010 10:11:54 AM	90	80.9124
⊞ MANYAME		186.125			49.9679

Fig. 11. Screen capture of report generator programmed to show reports of selected dams. In this case Chivero records were expanded t show captured records



Dam_name	catchment_name	full_capacity	present_level	percent_full	present_capacity	EntryDateTime	dam_ID	FS_level	10% yield	purpose
CHIVERO	MANYAME	247.181	70	97.0948	240	18-Feb-11 12:55:25	1	100	89.3	Water Supply
CHIVERO	MANYAME	247.181	98	97.4994	241	16-Jul-10 11:48:52	1	100	89.3	Water Supply
CHIVERO	MANYAME	247.181	90	94.6675	234	14-Jul-10 09:41:13	1	100	89.3	Water Supply
CHIVERO	MANYAME	247.181	88	84.958	210	13-Jul-10 16:58:47	1	100	89.3	Water Supply
CHIVERO	MANYAME	247.181	90	80.9124	200	22-Jun-10 13:23:52	1	100	89.3	Water Supply
CHIVERO	MANYAME	247.181	90	80.9124	201	15-Jun-10 10:11:54	1	100	89.3	Water Supply

Fig. 12. Screen capture of database analysis page showing options such as filtering records between dates, percentage fill or customized summary for catchments.

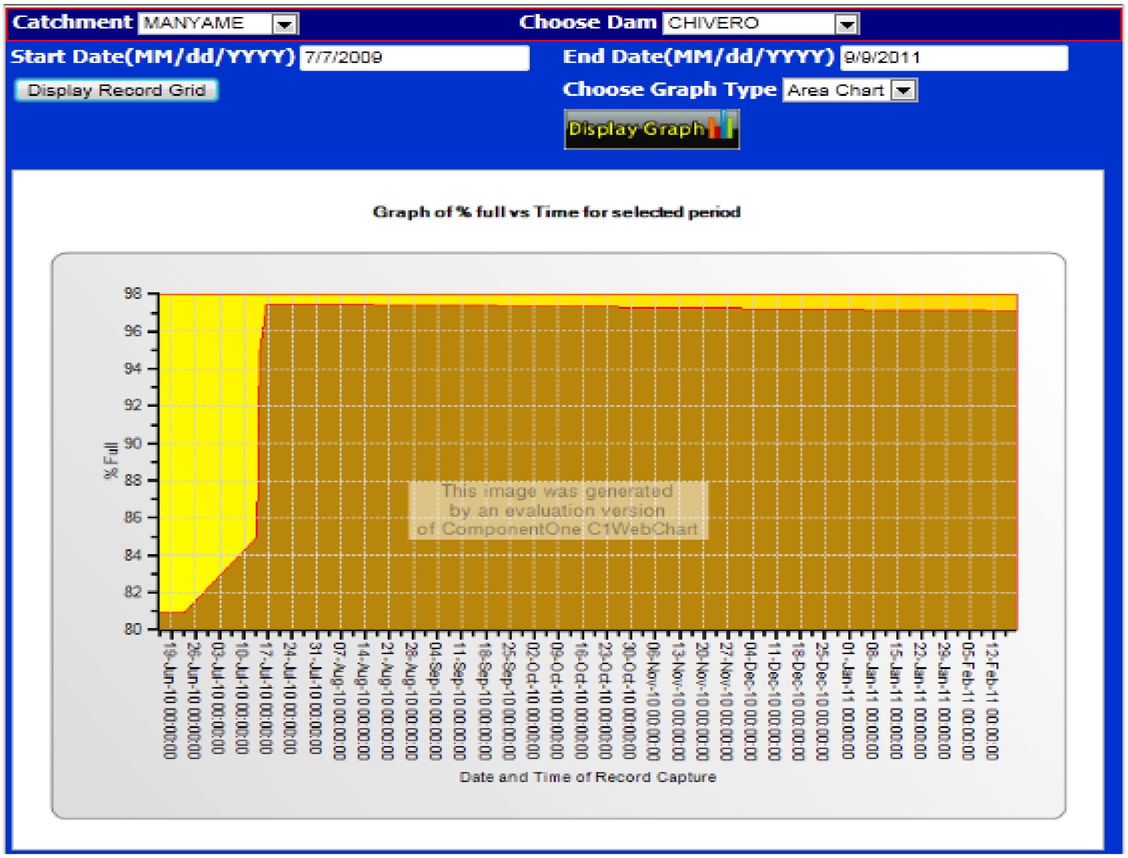


Fig. 13. Screen capture of graph engine generated to plot % fill against date and time of record capture

Fig. 11 shows the report generator used to select different reports to process and export while Fig. 12 shows a web page that allows one to analyse records in the database to pick out specific values between dates and/or in a certain range of percentage fill capacity and an overall catchment analysis. Fig. 13 demonstrates the ability to create graphs to graphically trace the change in aggregate capacity of a specific dam over an interval. The user can also use different chart types depending on which type best suites their requirements.

5. Conclusions

The objective of this study was to develop a prototype data management system for dams that would result in effective dam management in Zimbabwe or elsewhere where such a need exists, to facilitate effective decision making based on the most recent and accurate information. This was justified on the grounds that current systems used by water authorities such as ZINWA and sub-catchment councils were ineffective in meeting the demand for the latest information on the state of dams. The GPRS system illustrated the ease with which records can be captured and analyzed in real time and how reports can be generated within seconds. The ability to capture records from remote dams enables the standardisation of records management to ensure that the latest information is available from any dam at any point in time. All the information becomes centralized and easy to manage.

Sub-catchment councils need to create timely data collection processes to allow for the creation of a centralized database which both ZINWA and sub-catchment councils can access. This would improve the time it takes to make information available to the public. The needs of different stakeholders such as farmers and industry can be met more effectively. Disparate data can be integrated so that trends that are buried in the details can become more evident. Such benefits are important for strategic planning for a resource as critical as water in Zimbabwe. The system was shown to be capable of reporting events such as delays in record capture, sharp rises in daily dam capacity, and reduction or rises in dam capacity below critical threshold levels. Geographically dispersed stakeholders can also be given access to this information via the internet so that they can generate reports relevant to them in their chosen format.

Dams can be protected from the risk of collapse in the case of excessive runoff through analyzing trends in the filling of the dams and creating alerts when water rises beyond defined thresholds The study has shown that water management authorities can use currently available technologies to address the problems caused by the inefficiencies in their current systems. This was characterised by inordinately long delays between data collection and analysis. By merging data and automating processing, complex analysis can be performed at the click of a button. Since the system would be web based, access to the data would only depend on internet availability and security access. The GPRS technology is spreading fast and is already in use by many cellphone users for email and general internet access. Futhermore, the same platform can be used to access the internet the conventional way through using a GPRS or 3G modem. This means that information can be accessed remotely. By allowing remote data collection the system can be expanded to allow collection and quick processing of flow data from monitoring stations in remote areas. It is an effective and cheaper alternative to satellite based systems.

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Appendix 1: Net source code from the mobile data entry page

***** VB.Net source code for entering data into the database via a mobile internet webform/page*****

```
Imports System.Data
Imports System.Web.Mobile
Partial Class MobileNewData
   Inherits System.Web.UI.MobileControls.MobilePage
   Private newCatchmentAdpt As New DataSet1TableAdapters.Catchment_tblTableAdapter
   Private newDamAdpt As New DataSet1TableAdapters.Dam_tblTableAdapter
   Private newdetailsAdpt As New DataSet1TableAdapters.Updates_tblTableAdapter
   Private damtable As New DataSet1.Dam_tblDataTable
   Private catchmentTable As New DataSet1.Catchment_tblDataTable
   Private catchmentStr As String
   '******** Declaration of datasets to be used in to query and retrieve data from database *********
   Protected Sub Command1_Click(ByVal sender As Object, ByVal e As System.EventArgs) Handles
Command1.Click
      If TextBox5.Text = "datalogger" Then
         Try
            newDamAdpt.Fill(damtable)
            Dim myfoundrows() As DataRow
            Dim filterstr As String = "Dam_name <> '" + TextBox1.Text.ToUpper.ToString + "'"
            myfoundrows = damtable.Select(filterstr)
            For Each dr As DataRow In myfoundrows
               damtable.RemoveDam_tblRow(dr)
            Next
            SelectionList2.Items.Clear()
            '********* The above code selects the specific dam chosen by the user *********
            For Each dr As DataRow In damtable.Rows
               Dim mylistItem As New MobileControls.MobileListItem
               mylistItem.Text = dr.Item("full_capacity")
               mylistItem.Value = dr.Item("ID")
               SelectionList2.Items.Add(mylistItem)
               Dim time As New DateTime
               time = DateAndTime.Now

               Dim RowID As String
               RowID = mylistItem.Value
               Dim valo As Decimal = mylistItem.Text
               Dim pin As Decimal = TextBox3.Text
               Dim frac As Decimal = pin / valo * 100
               Dim perc As Decimal = Math.Round(frac, decimals:=4)
               TextBox4.Text = perc.ToString
```

```
                newdetailsAdpt.Insert(present_level:=TextBox2.Text, present_capacity:=TextBox3.Text, percent_full:=perc, EntryDateTime:=time, dam_ID:=RowID)
                '********* The new data input from the user is captured into the database via a tableadapter that temporarily stores the data in memory before writing to the database. Helps maintain database integrity *********
                Label6.Text = "New Data saved successfully. Click Clear Screen to continue!!"
                ' ********** Confirmation of database entry **********
            Next
            SelectionList2.Items.Clear()
            SelectionList2.Items.Clear()
        Catch ex As Exception
  ' ******** If error occurs the message below is shown, ie no entry made to the database **********
            Label6.Text = "Save failed. Ensure all parameters are of correct type"
            TextBox1.Text = ""
            TextBox2.Text = ""
            TextBox3.Text = ""
            TextBox4.Text = ""
            Label6.Text = ""
            SelectionList2.Items.Clear()
            SelectionList2.Items.Clear()
        End Try
      Else
        ' ********* If the person entering data does not a datalogger then they will not be allowed to enter data to the database *********
        Label6.Text = "You are not Authorised to enter data."
      End If
   End Sub


   Protected Sub Command2_Click(ByVal sender As Object, ByVal e As System.EventArgs) Handles Command2.Click
      ' ******** This code clears all textboxes for new entry ********
      TextBox1.Text = ""
      TextBox2.Text = ""
      TextBox3.Text = ""
      TextBox4.Text = ""
      Label6.Text = ""
      SelectionList2.Items.Clear()
      SelectionList2.Items.Clear()
   End Sub
End Class
```

******** End of code **********