1. Introduction

The prevailing philosophy among policy makers, planners and implementers is that developmental imperatives must be attuned to the needs of all sections of the population and should promote inclusion as against marginalisation. Experiences of development that have caused displacement and development that have made the poor more poorer has given rise to powerful voices that voted in favour of inclusive development. And the general consensus is that inclusive development can be attained through inclusive governance.

The United Nations Development Programme recognises inclusive governance as being critical to human development. Inclusive governance “means that governance institutions and policies are accessible, accountable and responsive to disadvantaged groups, protecting their interests and providing diverse populations with equal opportunities for public services such as justice, health and education.” Simply put, devising governance systems that cater to the requirements of the not-so-advantageous people is imperative to achieving inclusive development. There was also the felt need to design inclusive governance mechanisms across all possible systems. The 21st century brought with multitude possibilities of promoting inclusiveness through Information and Communication Technologies (ICTs). With the spread of ICT, the concept of inclusive E-government also started to take form. It means the employment of ICT to reach out to the underprivileged/
digitally excluded and to provide citizenry services. The advantage of E-governance is that it adopts technology to increase citizen’s knowledge of Government related services, thereby enhancing transparency and citizen satisfaction. E-governance thus informs, educates and empowers citizens through a host of services under the label ‘Government to Citizens’ (G2C). Besides being a powerful solution by itself, IT also created very citizen-friendly applications in sectors including health, agriculture and education, to name a few.

The growth and appeal of ICT also saw a communication boom via the mobile phone. The features of mobile phones like low-cost, portability, mobility and electricity independent, made it a much more viable communication device. The high penetration of mobile phones as a medium of communication has served to set right the phenomenon of ‘digital divide’, which has created two distinct groups of ‘haves’ and ‘have-nots’. The digital divide and the lopsided access to computers and Internet go against the very spirit of inclusive development. Mobile phone use in developing countries is growing fast. In 2015 there are more than 7 billion mobile cellular subscriptions worldwide, up from less than 1 billion in 2000. Globally 3.2 billion people are using the Internet of which 2 billion are from developing countries. Better network coverage, falling handset prices and fewer skills needed to use etc. are fuelling the adoption spree in developing countries and made mobile phone accessible. Thus the advent of mobile communication technology has served as a definite plus in the dissemination of information and citizenry services to the people who occupy the not-so-privileged half among computer and Internet users.

In this paper the authors describes the development of Dam Information Portal and allied water discharge alert system and how the mobile technologies have innovatively been used to update the underlying databases and how the farming community can interact with the Water Resource Department (WRD) for information regarding the water levels in dams and to request the release water for irrigating their crops as well as the government to push information SMS to the citizens. The value addition of the system is that the information generated serves as a knowledge management and decision support system for providing Early Warning Alerts to major stakeholder’s viz. (Farming community living on the banks of canals and near the catchment areas of dams etc), in the event of an impending natural calamity, during emergency or when dam shutters are opened.

It can be stated without a trace of doubt that since Independence, India, from being purely an agrarian economy, has made tremendous progress and has notched up remarkable achievements in several intellectually advanced sectors like space research, Nuclear technology, Information Technology etc. The Social and economic vulnerability of agriculture in developing countries is reflected in factors such as substantial contribution of agriculture to Gross Domestic Product (GDP), low level of commercialization and diversification of agriculture, low productivity, weak market orientation and linkages, prevalence of small and marginal uneconomical operational landholdings, underdeveloped or lack of adequate agro-infrastructure, heavy reliance on monsoon and failure to utilize water stored in dams optimally, susceptibility to natural calamities and dependence of a very large percentage of population on agriculture for their livelihood, etc.

2. The M Route to Information Services

In spite of the changing face of the economy, the contribution made by agriculture and allied sectors is no less significant. According to the figures for the year 2014, agriculture contributed 17.9% to Indian GDP. In terms of labour force constitution, 53% of the country’s population is dependent on agriculture. Considering the cardinality of the sector towards overall growth and development of the economy, it was felt that the sector be oriented/re-oriented with best practices and equipped with adequate information. This thinking led to a creation of a new paradigm of agricultural development, viz. of employing Information and Communication Technologies (ICT) for transforming old ways and to enrich the agricultural sector with latest scientific knowledge for enhanced productivity. Even after many decades of Green Revolution and economic reforms and liberalization, the issues and rigidities plaguing the agriculture sector have not been resolved. Some of the major contributing factors include scarcity of water, improper supply of water from the dam, improper water saving systems and improper opening and closing of the dam gate according to the level of water in the dam. The dam shutters are opened to satisfy various purposes, including flood control, irrigation and drinking water supply and electricity generation. In order to securely carry out shutter openings it is imperative to
have a system which continuously measures and analyses the information feeds about rainfall, inflow and outflow, weather conditions and water quality etc. and must promulgate timely disaster warning alerts to the public in the neighbourhood of the dam and along the canal/river banks in advance to protect their lives and property, such implementations are very expensive and not affordable for developing countries. In an attempt has been made to assess the impact of flooding and development of flood hazard zone maps by combining satellite imagery with spatial data and analysing the same using digital elevation models. It is in this context a dual purpose innovative low cost system has been developed to invigorate the agricultural sector as well as provisioning an Early Warning System (EWS). By harnessing the potential of mobile ICT Dam Information Portal and allied information Systems was developed which facilitated two way information exchanges between the Government and citizens using mobile phones and establishment of an in-built Early Warning mechanism. EWS provides greater security to the lives, crops and livestock of the citizens by facilitating timely evacuation, during times of flooding and unexpected torrential rains, largely attributed to global climatic changes.

3. Dam Information through SMS

One of the problems identified for the declining levels of agricultural productivity has been the general shortfall in monsoons. Irrigation systems thus have a major role to play to provide year-round supply of water to the crops. Recognizing this several dams have been built across the globe to store water and to regulate the usage of water, by ensuring the right amount of water is available at the right place at the right time ensuring optimal utilisation. The vast quantities of water stored in dams are used for many purposes like irrigation to generate electricity, for the supply of water for homes and industries etc. and act as a buffer for providing effective and steady source of water for irrigation without any seasonal fluctuations. Worldwide statistics shows that 30 to 40 % of irrigated land relies on dams. Studies carried out by World Commission on Dams (WCD) a commission organized by the World Bank and the World Conservation Union (IUCN) to assess the effectiveness of large dams, revealed that dams built for irrigation failed to meet the target area planned to be irrigated initially due to management or organizational level failures rather than structural or engineering deficits, but through targeted interventions the performance improves over time.

Management and organizational deficiencies includes poor and insufficient water distribution networks, inefficiencies resulting from a centralized administrative system with unclear distribution of responsibilities, poor coordination within the system and lack of initiative to involve the farmers, who grow food are major local stakeholders. Involving those who run the dam and those in the community could greatly benefit the performance of the dams. The farmers need to ensure the timely and continuous supply of irrigation water needed to meet the demands of crops and livestock. Though dams are beneficial it also negatively impacts the populations living near it. It can result in disastrous consequences like loss of life and property of the citizens who resides in the vicinity of dams and banks of canals and rivers in the event of an unprecedented opening of shutter. Catchment area and adjoining regions spanning large areas are prone to floods in case of dam shutters are opened without notice and may affect millions of people downstream and may result in huge economic loss to the citizens. There is no doubt that irrigation systems are pertinent, but there is also the need to provide timely information to the community, especially the main stakeholder group of farmers on the water levels in the dams, schedule of opening of reservoirs etc. to facilitate planning and action. The dam information to the farmers is an innovative project developed for providing Multimodal access (Mobile phones, PC’s and Tablets) to the major stakeholders.

4. Objectives and Scope

The main objective of the project is to develop an integrated dam information system which serves as an information delivery tool to the citizen, farmers in particular and the decision makers and the district administration authorizes (Collectors). The novel, easy to use, affordable and accessible, two-way communication channel enables the farming community residing in the canal and river banks of major irrigation dam projects to interact round the clock with the government in any time anywhere fashion for receiving timely information about the availability of water in the dam, receive Early Warning Alerts when the shutters are about to be opened and for the farmer cooperatives to interact with the government.
for demanding the release of water for agriculture, utilizing multiple access channels and technologies.

The scope of the project includes:

- Collection and maintenance of water levels in major Dams at periodic intervals. Provide information like 1. The availability of water in the Dam - The farmers interested to know the water level, Volume of water in MM3 (Million Cubic Meters and availability of water for irrigation purpose. 2. Next opening schedule of shutters - The next opening schedule of the shutters (Date and Time) and the discharge details in Cusec will be provided. 3. The Schedule of opening of shutters at any particular day - The opening schedule of the shutters and the discharge details in Cusec for any particular day.

- Updating the change of schedule of water distribution and informing the farmers.

- To serve as an Early Warning System to notify the citizens about an impending natural calamity or disaster via alerts like: 1. Alert message on opening and closing of the canals, 2. Alert message whenever water level information is updated. 3. Alert whenever the water level reaches a specific level. 4. Alert message whenever there is a change in the opening schedule of shutters. 5. Cell Broadcast Messages in case of Natural calamities or disasters

5. System Architecture

As part of this project, a three-tier web application has been developed and in Step 1 backend databases are populated with details of dams, the threshold levels for normal, warning and emergency etc. the various officials who are in charge of each dam and the role based rights are mapped to the corresponding mobile numbers. This mapping enables the system to update the reading of the dam assigned to the owner of the mobile number. During Step 2 white listing of mobile number of the entire hierarchy of officials right from the watchman who monitors and reports the reading till the head of district administration – the district collector are done. This is done to ensure that only updates and approvals pertaining to a particular dam can be done by users whose mobile numbers have been white listed and access has been granted; all requests for update and approval from other numbers are just ignored. The vital cog which enables the seamless update and delivery of timely information is the encapsulated shared mobile ICT infrastructure - Government m-Gov Cloud (GMC). It is equipped with data centre class servers, load balancers, firewalls and operator grade connectivity to major Mobile Network Operators (MNO) in the region. SMS, MMS, WAP and Voice gateways are configured, it also supports Cell Broadcast and the short code number 537252 is also opened across all MNO. The integration of the developed application with the GMC is carried out by consuming the open APIs published as part of the GMC technical documentation.

6. The Application Data Flow

Once the reading of the water level is measured from the dam site the same is updated to the portal directly by way of sending an SMS in a predefined format (DAM WL <reading> ST <value> SP <value>) using mobile phones given to the dam monitoring personnel. In response to the SMS reading send, the portal will push an SMS with a 4 digit verification code similar to One Time Password (OTP) to the designated superior officer’s mobile phone who has been assigned with the privilege of approving the reading. The accuracy of the data is very significant as any wrong data will not only affect the farmers but citizen will lose faith in the system. In order to ensure accuracy of the system various validations are embedded in inbuilt logic to check the accuracy of the readings, the reading will be compared with the previous reading for any major variation. If the variation is beyond theoretical limit (e.g. greater than the maximum capacity of the dam etc.) the system will not accept the data. Any major variation within the theoretical limit will be notified to the watchman with a warning, who has recorded the reading to recheck and the approver is also notified with a warning and accepted only after the approval by competent authority. The water level thus measured and registered using mobile phones and SMS platform will be updated on the backend and the same is accessible to the farmers, department and the government either via the portal web interface or using a PULL SMS. The data flow is depicted in Figure 1.

7. Pre and Post Implementation Scenario

Before the implementation of system there was a time lag about four hours’ as the process recording process was
Figure 1. Schematic representation of the dataflow.

Figure 2. Flow chart of the Early Warning Alert System.
manual and the same have to be telephonically reported to concerned jurisdictional office and receive oral approval for displaying the same in the Notice board fixed at the dam site. The schedule of opening of dam shutters, the next opening schedule etc. was published in leading dailies and publicized through local radio stations, which did not reach the intended people and at times have resulted in causalities. The farmers residing far off have to visit the dam site to view the water level reading, before they can request to release, say 100 Million Meter cube water for irrigating their crop. Accordingly if the water level is above the reserve value, the request will be fulfilled and the dam shutters are opened allowing 100 Mm$^3$ water to be released to the canal and may have to wait for days or weeks for water to reach crop site. In the new system portal data update happens within minutes as data collection, approval and updating takes place in real-time resulting in providing timely and accurate information. The citizens/farmers residing near a specific dam site or canal/river bank associated with the dam can register themselves into the system by sending and SMS in a pre-designated format to a Short Code number ‘53725’ spelling of Kerala in non qwerty keypad, DAM <space> [R/r]egister <Dam Name> [W/w]ater/[O/o]pen /[D/d]ischarge: (e.g. DAM R DAMNAME W O D ) – will register the mobile number into the system to receive alerts on W-ater level, changes in shutter O-pening schedule and D-ischarge associated with the Dam with name ‘Dam Name’. The various G2C SMS based pull services that can be availed by citizens are listed in Table 1.

8. Conclusion

The project, now, serves as a timely help to three main stakeholders. It is especially of benefit to the farming community, who see this as relief-cum-response mechanism. The fact that such information is provided through the mobile phones, a low-cost portable device, which has now acquired a ubiquitous nature in the developing world, with nearly 100% mobile penetration and a fairly short learning curve will definitely contribute to the success replication of the same in other developing countries as well. The project can be enhanced by applying sensor networks in the future, since the powering the sensor node is a challenge in the existing scenario, the use of solar grids etc. may help deploy sensor networks and application of business analytics tools can help in unearthing more insights.

| Table 1. SMS Service request format and corresponding response messages |
|---------------------------------------------------------------|
| **SMS FORMAT** | **RESPONSE MESSAGE** |
| To Register a Citizen Mobile to get alerts Dam <space> [R/r]egister <Dam Name> [W/w]ater/[O/o]pen /[D/d]ischarge. Eg: DAM R DAMNAME W O D | This will register the mobile number into the system to receive alerts on W-ater level, changes in shutter O-pening schedule and D-ischarge associated with the Dam with name ‘Dam Name’. |
| To Know the Current Water level of the dam Dam <space> water<space> Damname Eg:Dam waterMalampuzha | SMS reply the current water level of the dam in Meters and corresponding capacity - “Water Level in MALAMPUZHA DAM on 09-04-2016 at 11 AM is 115.00 Meters & 218.870Mm3 Capacity.” |
| To Know the next shutter opening date and time of the dam. Dam <space> open <space> Damname Eg:Dam open Malampuzha | Next shutter opening of MALAMPUZHA DAM is on 05-10-2009 at 11 AM - “SMS reply the next shutter opening date and time of the dam.” |
| To know the No of days water can be supplied for Irrigation Project from the dam. Dam <space> days <space> Damname Eg:Dam days Malampuzha | SMS reply the no of days water is available on the dam for irrigation project. “90 Days Water Can be Supplied for Irrigation Project in MALAMPUZHA DAM” |
| To make complaints. Dam <space> complaint <space> Damname<space>description Eg: Dam complaint Malampuzhawater leakage | SMS reply that complaint is registered. “Your Complaint for MALAMPUZHA registered Successfully-Token no is MLPHA203” |
| To know the dam water discharge. Dam <space> discharge <space> Damname Eg: Dam discharge Malampuzha | SMS reply the status of dam. Either opened or not opened. “Malampuzha Dam is not opened now” |
9. References

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