Open Data Kit (ODK) applications in rural development

A case of National Institute of Rural Development and Panchayati Raj, Hyderabad, India

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Abstract

National Institute of Rural Development and Panchayati Raj (NIRDPR), Ministry of Rural Development, Government of India is an apex institute of the country for training, research and consultancy in the field of rural development. Field data collection in its various research studies and projects is an indispensable component. Collecting field data in hard copy format and digitising later attracts some errors and manual mistakes during data conversion along with extra time consumption. Open Data Kit (ODK), being an open source mobile based tool for collection of data in self designed customised forms with possibility of collecting geo-coordinates, time stamp and media/images simultaneously is a boon for research and project works of rural development sector. With the support of OSGeo India, NIRDPR has initiated use of ODK in its research and consultancy projects. ODK has been used in research studies of NIRDPR in key thematic areas like rural housing, rural roads, skill, sanitation etc under various relevant flagship schemes of Ministry of Rural Development, Government of India. ODK collect interface has been translated in Hindi using official 'Transifex' online platform. Visualisation of data is done using Open Source QGIS software and statistical analysis is done using other statistical packages/software. The data is being collected on NIRDPR's own server computer with dedicated work assignment to supporting staff for data collection and management. As an external utility 'ODK Briefcase' is used for data extraction/export along with media/images. Same utility is used for offline data backup and extraction of data if individual wants to extract their data locally. NIRDPR works in close coordination with State Institutes of Rural Development (SIRDs) at State level in 29 States of country and 90 regional institutes in down line of SIRDs. Further NIRDPR has a close association with international organisations working for developing countries for training and capacity building of their officials. NIRDPR can play a pivotal role in coordinating and extending the use of ODK tool among these organisations. It is observed that mobile based data collection tools are more suitable for the data collection when number of variables are lesser and number of respondents and/or geographical extent is larger. With the help of ODK forum and its wide development and user community ODK is growing and new wishes of users are being incorporated. Presently the access to the ODK is right based and one type of credentials gives universal rights which may be restricted to individual rights in future for distribution of user credentials to individual users in fullest manner. It is expected to adopt ODK 2.x tool suit in future for improvements over some present constraints. ODK is being used in NIRDPR in its research studies and consultancy projects for faster and efficient field data collection with geo, time, image stamping, negligible manual errors and reduction in time. With its unique rural connect with many national and international organisations, NIRDPR is ideal organisation for propagating ODK and other open source tools to grassroot level for societal benefits at large.

Keywords: NIRDPR, Open Source, Open Data Kit, ODK, Rural Development, NIRDPR, OSGeo India, Transifex

1. Introduction

Collection, storage and management of field data is an essential requirement in researches and project executions of various sectors. In resource constraint environment of rural development sector especially of poor or developing countries, need is there for technically sound and scalable

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solutions for data collection and management at low cost or at no cost.

"Open Data Kit (or ODK for short) is an open-source suite of tools that helps organizations author, collect, and manage mobile data collection solutions" (ODK Community, 2018-a, para. 1).

ODK is community driven tool produces free and open-source software for collecting, managing, and using data in resource-constrained environments (ODK Community, 2018-b). The operation of ODK is divided in three parts like build, collect and aggregate. Build comprises of generation of questionnaires and forms in ODK compatible formats using various tools like website, offline software and tools like MS Excel etc. Collect segment mainly comprising mobile operations including data collection, storing and managing in mobiles and sending to the server or extracting offline. Aggregate segment is for getting the data aggregated at online server which may be operated at large scale or limited to a laptop or desktop depending on resources available and extent of uses.

ODK is useful in other related sectors like agriculture, community health etc also, however the article will describe its practical applications in rural development sector in National Institute of Rural Development and Panchayatiraj (NIRDPR), Hyderabad, India. NIRDPR is and apex organisation of Ministry of Rural Development, Government of India catering the training and research needs of development sector. NIRDPR is involved in many consultancy projects also of Government of India and State Government. NIRDPR works in close coordination with Indian Technical and Economic Cooperation Programme (ITEC) (Ministry of External Affairs, 2015), African-Asian Rural Development Organization (AARDO) (AARDO, n.d.), Centre on Integrated Rural Development for Asia and the Pacific (CIRDAP, 2018) countries for fulfilling their training and research needs in Rural Development sector and plays a pivotal role in proliferation of latest tools and technics in these countries.

The article will explain the specific uses of Open Data Kit in rural development sector and its operationalisation in NIRDPR with a role of OSGeo India in supporting the development and execution.

2. Use of ODK in Rural Development

ODK users include Google, World Health Organisation (WHO), Centre for Disease Control and Prevention (CDC), United States Agency for International Development (USAID) the Red Cross and Red Crescent, the Carter Center (The Carter Center, 2016), the Jane Goodall Institute, cited at http://opendatakit.org/ and many other studies are described and showcased in showcase section on ODK forum website at https://forum.opendatakit.org/c/showcase.
Showcase section of ODK forum is an official platform for discussing the issues and achievements regarding ODK with ODK users.

A detailed list of other research works in the form of papers, talks, posters, demos are available in Research section of official website of ODK at https://opendatakit.org/community/research/. A detailed list of press releases and country specific published use cases of ODK are available in History section of ODK website at https://opendatakit.org/community/history/.

In India organisations which are using ODK in their research studies or projects independently or in collaboration are described further.

Under Performance Monitoring and Accountability 2020 (PMA2020) project of Bill & Melinda Gates Institute for Population and Reproductive Health, Department of Population, Family and Reproductive Health, Johns Hopkins Bloomberg School of Public Health, ODK is being used extensively to collect data on various indicators related to hygiene, sanitation etc from countries of Asia and Africa. Working in 11 countries through a network of universities and research institutes (Johns Hopkins University, 2018). From India Indian Institute of Health Management Research (IIHMR) is partner for implementation of PMA2020 project (IIHMR University, 2018).

ODK has been used in Open Data Kit in Local Self Government Department, Govt. of Kerala, India in District Thrissur on pilot basis for mapping the Local Body Institutions. It is found suitable to be replicated in all Government Departments of Kerala State in future (ODK Forum, 2017-a)

Ministry of Health and Family Welfare, Government of India launched the National

Health Resource Repository (NHRR). Indian Space Research Organisation (ISRO) is the project technology partner and using ODK for survey work (based on personal communication on 10th August, with Dr. Nagaraja, presently working with CGARD, NIRDPR, after his visit to ISRO centre, Jodhpur, Rajasthan).

Foundation for Ecological Security (FES) a leading Non-Government Organisation is using the tool extensively in their projects. NIRDPR has also taken the benefit of their experience in use of ODK tool. Indian Rural Management Anand (IRMA) is also going to be partner in few ODK based studies with NIRDPR (based on current work of NIRDPR with FES and IRMA).

Individuals from Indian origin based in India or outside namely Rohit Chaudhri (ODK Community, 2018-c, para. 8), Shobhit Agarwal (ODK Community, 2018-d, para. 6), Akshay Patel, and Narendra Singh (ODK Forum, 2017-b) are working in core development groups or actively engaged with ODK Forum and contributing to the development of the ODK tool in various capacities.

The above use cases are not exhaustive and there are possible scattered and individual users and organisations around the world and in India also.

2.1. Ecosystem of Open Source Mobile Based Data Collection Tools

"An important goal of the Open Data Kit community is to enable users to select suitable components from an ecosystem of complementary tools. A thriving ecosystem means that organizations can use the tools that best suit their needs without worrying about vendor lock-in. The ecosystem members who openly collaborate to grow this ecosystem are *ELMO*, hosted server originally designed for election monitoring, *Enketo*, web application for filling forms in the browser, *Kobo Toolbox*, hosted server with graphical form builder, *Medic Mobile*, hosted server for frontline medical care, *Ona*, hosted server with graphical form builder, *SMAP*, hosted server with tasking" (ODK Community, 2018-e, para. 1, 3).

3. Operationalisation of ODK in NIRDPR

In NIRDPR Research Studies and Consultancy projects data were being collected in paper based survey forms. It was leading to more time and energy consumption with possibility of errors during manual data entries. It was initially thought by higher administration to have a separate dedicated in-house solution design and build with own resources of NIRDPR. With initiation of author, his presentations and demonstrations before higher administration and IT staff, it was decided to use ODK in NIRDPR. To train the NIRDPR faculty and research staff on the tool and for installation of local ODK server a three day workshop was planned with the help of OSGeo India team as OSGeo India chapter was keen and ready to provide technical support in the training workshop and installation of server.

3.1. Three days ODK Workshop on ODK in NIRDPR

Seeing the felt needs and wide scope of application of ODK in research studies of NIRDPR a three day workshop on 'Open Data Kit (ODK)' was organised during 2-4 November 2017 in NIRDPR, Hyderabad. First two days of workshop were mainly concentrated on introduction and use of ODK tools like building a form, uploading to the server, download to mobile, collection of field data, sending the collected data to server and downloading for analysis. Initially participants created the forms individually and then participants were divided in groups and they prepared the refined forms as per their areas of works. The collected data were demonstrated and plotted on Open Source QGIS software also for spatial visualisation. The method to prepare multi-lingual forms and creation of forms using Spreadsheet in offline mode were also described.

The workshop was unique to the institute that it not only provided an overview of technology but also make available the tools and techniques for data collection, visualization and analysis along with setting-up of dedicated server.

On third day of workshop NIRDs local server was configured on dedicated computer in server room of NIRDPR, by OSGeo India experts. The server was tested well by IT staff and faculty members.

Resource persons Dr. Venkatesh Raghvan, Professor, Osaka City University Japan; Shri. Ravi Vundavalli, Ex-Director, Geological Survey of India & Secretary OSGeo India; Shri Natraj Vaddadi, Charter member, OSGeo Foundation; Shri. Ramamurthy, Ex-Director, Geological Survey of India & Charter member, OSGeo Foundation; Shri. V. Balasankar, Faculty member, Aditya College of Engineering, Andhra Pradesh & author (HK Solanki) conducted the lectures, hands-on sessions, field data collections, server configuration and testing.

Fig 1: Picture showing workshop on ODK under progress on 02nd Nov, 2017

Programme was attended by 61 participants including faculty members and supporting staff of various centres of NIRDPR. The participants were able to create the forms and upload/download the forms from the server and data collection. Sample data were collected by the participants from NIRDPR campus.

Fig 2: Group photo of ODK workshop conducted during 02-04 Nov, 2017 at NIRDPR

3.2. Work Flow on ODK in NIRDPR

After the workshop it was decided by the NIRDPR administration to scale-up field data collection of all research studies to ODK mobile platform.

3.2.1. ODK Server Setup and Data Management

The sever computer is a normal working computer of IT division. For database, PostgreSQL is being used and for Operating system Ubuntu 16.04 is being used. A core team at Centre for Information and Communication Technology (CICT), NIRDPR is working towards management of ODK data and work flow in NIRDPR under the guidance of Director General, NIRDPR and Professor and Head, Centre for Research, Training Coordination and Networking. The following sections will describe the whole management and operational strategy for ODK in NIRDPR.

3.2.1.1. User Rights in ODK

ODK in its original form gives four kinds of rights to users; 1) Data Collector-by using these rights and related credentials (user ID, password and URL) one can only download the survey forms and send the data to ODK server. Further, surveyors can locally manage the data in mobile like edit, delete etc. However, surveyors can extract his data from mobile and copy it to desktop or on other media. From there it can be further extracted in usable formats (.csv and media) using ODK Briefcase utility (Open Data Kit, 2017). 2) Data Viewer- using this right and related credentials user can view the submissions and export the data to usable formats (.csv, .kml and JSON) without possibility of deleting any data or form at Aggregate site. As viewing data of other researchers without their will is found unethical in NIRDPR and this right and above are limited to the dedicated team of persons from CICT. 3) Form Manager- using this right, in addition to the rights of Data Viewer user can upload new ODK compatible forms in .XML format and can delete the submitted data of individual rows or complete data and complete forms. This right and above are sensitive rights and should be allotted very carefully. 4) Site Administrator- this right is highest right in ODK and in addition to the rights of Form Manager, user can add new users/credentials with restricting the rights of

them upto any level Site Administrator can delete the previous users and credentials.

As per research ethics and internal decision research team including faculty members are being provided with Data Collector rights only. Other rights are being managed by the core team of CICT.

3.2.1.2. Data and Process Management

Initially based on guidance of core CICT team, research team members convert the survey schedules/forms of research study in ODK compatible forms in .XML formats. This is being done for simple forms in ODK Build site (http://build.opendatakit.org) mostly online with individual's credentials.

Fig 3: Screenshot showing ODK Build website for generation of ODK forms Online

For complex forms XLSForm is used. "XLSForm is a form standard created to help simplify the authoring of forms in Excel" (http://xlsform.org/en/). Each Excel workbook usually has two worksheets: **survey** and **choices**. A third optional worksheet called **settings** can add additional specifications to the form. http://opendatakit.org/xlsform/ site provides a platform for online testing of these Excel sheets for any syntax error. An offline tool also can be downloaded to convert Excel to .XML format. On this site, one more open source utility 'Enketo' may be used to preview the created form as how it will look in mobile and it can be validated also.

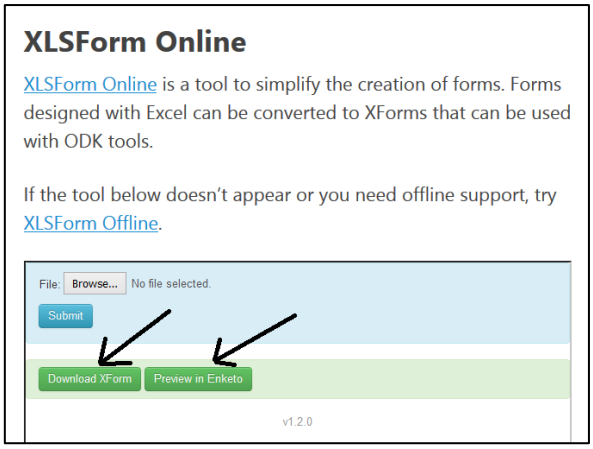

Fig 4: Screenshot showing XLSForm Online for preview of Excel form in Enkento or download in .XML format online

Once the form is generated and converted to .XML using above online or offline tools, these .XML file are copied from PC and pasted in Forms folder inside ODK Folder available in mobile internal memory, if ODK Collect is installed already. Then this form is visible in ODK Collect App and it is tested in mobile taking dummy data or by doing pilot survey for testing of schedules or questionnaire. If any correction is found necessary after testing, the original blank form and data collected are deleted using 'Delete Saved Form' option in app. After sufficient iterations, the final .XML form is sent to CICT team through email for uploading on aggregate server.

From ODK server surveyors download the blank form of relevant studies using the Data Collector credentials and using Get Blank Form function in app. Then they can collect and sent data to Aggregate each day after survey. During survey internet connectivity or mobile network is not required and to save the battery mobile can be put on Aeroplane mode also. During sending of data to server computer, internet connectivity is required. The data of particular relevant studies are taken in consolidated manner time to time by research coordinator from CICT team. This data is supplied by CICT team using ODK Briefcase utility in the form of .csv file and media folder which contains photographs. Seeing the limited use and limitation of internet one image file is suggested to be taken of each response and more questions related to taking video and audio files are generally avoided. Once the survey is

completed final data in the form of .csv and media is provided to the research coordinator or principal investigator. This data is used in GIS environment using QGIS and other statistical analysis are done on this data in other statistical software. These choices remain limited to the research team.

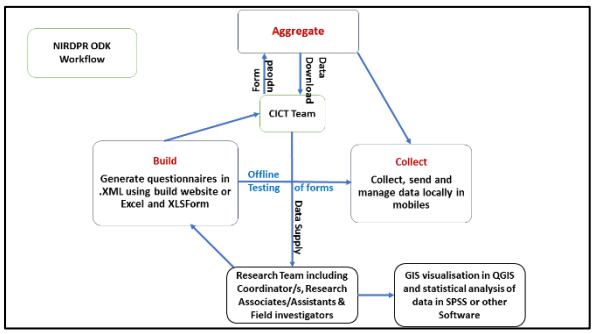

Fig 5: ODK operationalisation and workflow in NIRDPR

3.3. Achievements and Impact

The use of ODK has been started in NIRDPR immediately after the workshop and NIRDPR by faculty members and research staff. ODK use has been mandated for new research studies of NIRDPR. Few consultancy projects of Centre for Geoinformatics Applications in Rural Development (CGARD) are also being monitored on ODK. About 7 studies are completed or ongoing of six months to one year duration. The studies and projects include thematic areas/schemes of Rural Roads, Pradhan Mantri Awas Yojna (PMAY), Sanitation, Open Defecation, Manual Scavenging, Skills etc. The data collection part under these studies completed at much faster pace with nil or less manual mistakes which ordinarily happens during data transfer, conversion and entering in systems from paper based survey. More studies are coming on ODK system of NIRDPR and due to administrative support and confidence in tool, it has become an essential part of all field based research studies of NIRDPR.

Apart from using the tool in research studies and projects, CGARD, NIRDPR has started giving training on the tool in its regular domestic and international training programmes. Participants are taught to use the tool offline for collection of data with extraction of data using ODK briefcase utility along with showcasing the possibility of installing an ODK server at institution level. Till their institution adopts and installs the server, they are using it locally for small geographical extents. After training of CGARD, NIRDPR, in Department of Forests, Government of Rajasthan, few Forest Officers have started using it in their day to day work as per requirement. In longer duration international training programmes, few participants are preferring to complete their end week project on ODK practical applications.

3.4. Language Localisation of ODK in Hindi

Open Source gives the freedom to user to be involved in all spheres of development cycle of a project. Getting involved in language localisation is also an opportunity to the users. Taking the experience of involvement of author in QGIS language localisation in Hindi, ODK interface has also been translated in Hindi at NIRDPR using official online Transifex (Transifex, 2018) platform. Presently ODK has total 619 source strings and 2.68 thousand source words to translate for any language.

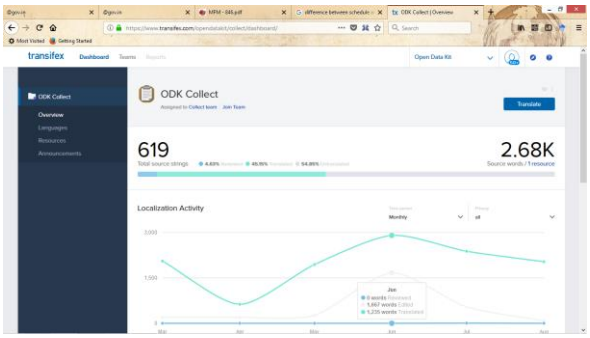

Fig 6: Screenshot showing language localisation page of ODK project on Transifex website

Translation was done at the level of 100% when translation started and it requires constant involvement to keep it 100% level with the growth of software.

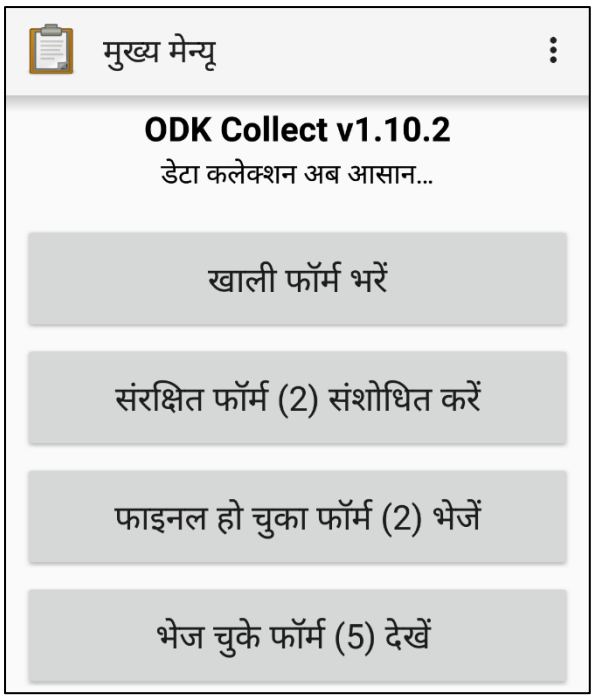

Fig 7: Hindi language interface of ODK Collect

Additionally for getting the survey forms translated and entering the survey responses in different languages, 'Google translate' and 'Google Input Tools' utility is being used.

3.5. Future Directions

With the increase in number of studies a dedicated team/administrator may be hired for giving expert guidance on making complex survey forms and overall management and dissemination of research data and data analytics. The team may decide to scale-up or customisation of operations for seamless flow of work and information to reduce the tasks at the part of research team. This may include giving the facility to the researchers to provide form specific credentials to have a full control over the form and data without interfering or viewing the data of other studies. Based on data flow and quantum of data the hardware may be scaled up with more storage capacities. Surveys are done with available Android mobiles of field investigators and surveyors. Based on quantum of work, purchase of tablets for survey for increase in screen size and dedicated availability of data collection tools.

In NIRDPR, presently ODK 1 is being used which include Collect, Aggregate, XLSForm, Build, and Briefcase. Most of the future requirements can be solved by adopting the new ODK 2 tool suit, which is a recently released tool set for advance uses when organisation want to scale up for higher operations (ODK Community, 2018-f) (Open Data Kit, 2017-b). As NIRDPR has started using ODK officially for its researches and studies, migration to higher tools and exploiting the full potential of the tool is important. With dedicated and appropriate man-power using ODK 2 tool in future will be advantageous for research environment of NIRDPR and rural development.

A data visualisation platform linked with ODK Aggregate is also conceptualised in future for internal use to see near real time display of data point's locations on various kinds of base maps for wider understanding of data.

Specific and dedicated training programmes of short or long durations from users' or developers' perspective are being planned in CGARD, NIRDPR for application of tool in various thematic areas of rural development in coming future for overall benefit of community.

4. Findings and Discussion

Tool has been widely accepted by NIRDPR faculty, research staff and being used in the research studies and projects. With improvement in knowledge and practical success cases more confidence is raised in general user community of organisation.

The tool has been considered useful in comparison to commercial tools seeing the customisation possibility and in-house availability of knowledge resources.

As part of overall ecosystem it will be advantageous to couple the ODK tool with other compatible tools to supplement each other. For field research combination of navigation feature or using other open source navigation tools for reaching to the survey sites will be useful.

Based on the internal discussions with users of the tool within organisation, it has been observed that mobile based data collection tools are more suitable for the data collection when number of variables or questions are less and number of respondents and/or geographical extent is larger. More swipes are to be done in more number of

questions, and less number of respondents limit the usability of the tool commensurate to the efforts made on development and design of ODK compatible forms in comparison to paper forms. What are the optimal number of questions suitable for mobile survey and above how many respondents these kind of tools are suitable can be assessed through research in this direction. However when the research ethics and data validation is a concern, application of ODK is always advantageous.

It is observed that more command over workflow is required by the research team. Presently due to limitations of ODK 1.x, data viewer and above rights are not provided to research teams and they can only send the data and collect the data as depicted in Fig 5 above in workflow.

It is expected that by the use of ODK 2.x in future above limitations may be minimised. For other limitations engagement of dedicated and appropriate staff form programming side may be useful for customising the tool as per local needs.

For development of complex forms, engagement of an expert with proper knowledge of Excel and data management for giving exclusive support to research staff in organisations like NIRDPR is appropriate.

5. Conclusions

In the resource constraint environment of developing countries, collection and management of the data is a crucial aspect. In that scenario, having the easy, readily customizable, scalable, free and open source tools is a boon to the developing countries. Organisations like NIRDPR, being pivotal and in lead role in development sector can be ideal to proliferate the technology and knowledges to the sister organizations, partner countries and organizations in the downline. Apart from training programmes conducted for countries associated with AARDO, CIRDAP and ITEC, NIRDPR is closely associated at national level with 29 State level institutes called State Institute of Rural Development (SIRDs) and 90 Regional Institutes under SIRRDs called Extension Training Centres (ETCs) or Panchayat Training Centres (PTCs). This kind of tools and technologies can be adopted by these institutions based on NIRD experience and with the help of NIRDPR. The tool is being widely promoted by NIRDPR. NIRDPR as a strong supporter and promoter of Open Source is actively using and promoting other Open Source GIS tools like QGIS etc also in its regular training and researches. With the support from user community and administration, NIRDPR is ready to adopt new technological advancements for betterment and improving agility of research studies and project works.

6. Acknowledgements

The operationalisation of ODK in NIRDPR was possible due to perpetual encouragement, support and guidance of OSGeo India team. Author acknowledges the supports and approvals of Director General, NIRDPR Dr. W. R. Reddy, IAS, on actual adoption and implementing ODK in NIRDPR. Director General is constantly promoting and reviewing the use of ODK tool in organisation. Author acknowledges the support of CICT team of NIRDPR especially Sh G V Satyanarayana, and Sh. K Rajeshwar, faculty members, CICT who are taking care of guiding the research teams and Sh. Chinna and Pravin, members of IT support team who are taking care of data upload, dissemination and other server side operations. Author acknowledges the support of Dr. P. Kesava Rao, Associate professor and Head, CGARD for continuous support and encouragements to author. Author is acknowledges support of Sh. Narendra Singh Shekhawat, Data Manager, IIHMR, Jaipur, Rajasthan, India on various technical aspects. Author is indebted to all faculty members and colleagues at NIRDPR for giving feedbacks for better operationalisation of tool. Author is grateful to members of ODK forum whose discussions are keeping the knowledge of author updated.

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Mr. H K Solanki has worked 12 years in field of Watershed Management at Government of Rajasthan, India as an Engineer. He prepared numerous Detailed Project Report Reports of Watershed projects and got the work executed in field in various Blocks of Rajasthan State. He has been working for last 10 years on Training/Research and Consultancy projects in Geo-informatics Applications in Rural Development and Natural Resources Management. His current area of interests are use of latest GIS tools and technologies, mobile based GIS, Open Source GIS and UAV in Rural Development. He has conducted about 90 training to Rural Development functionaries of 2-5 days duration on applications of GIS in thematic areas of Rural Development using Open Source GIS and Mobile Mapping tools. He has delivered 85 expert sessions in other reputed organizations. He is a charter member of OSGeo. He is a constant learner.