Final Report

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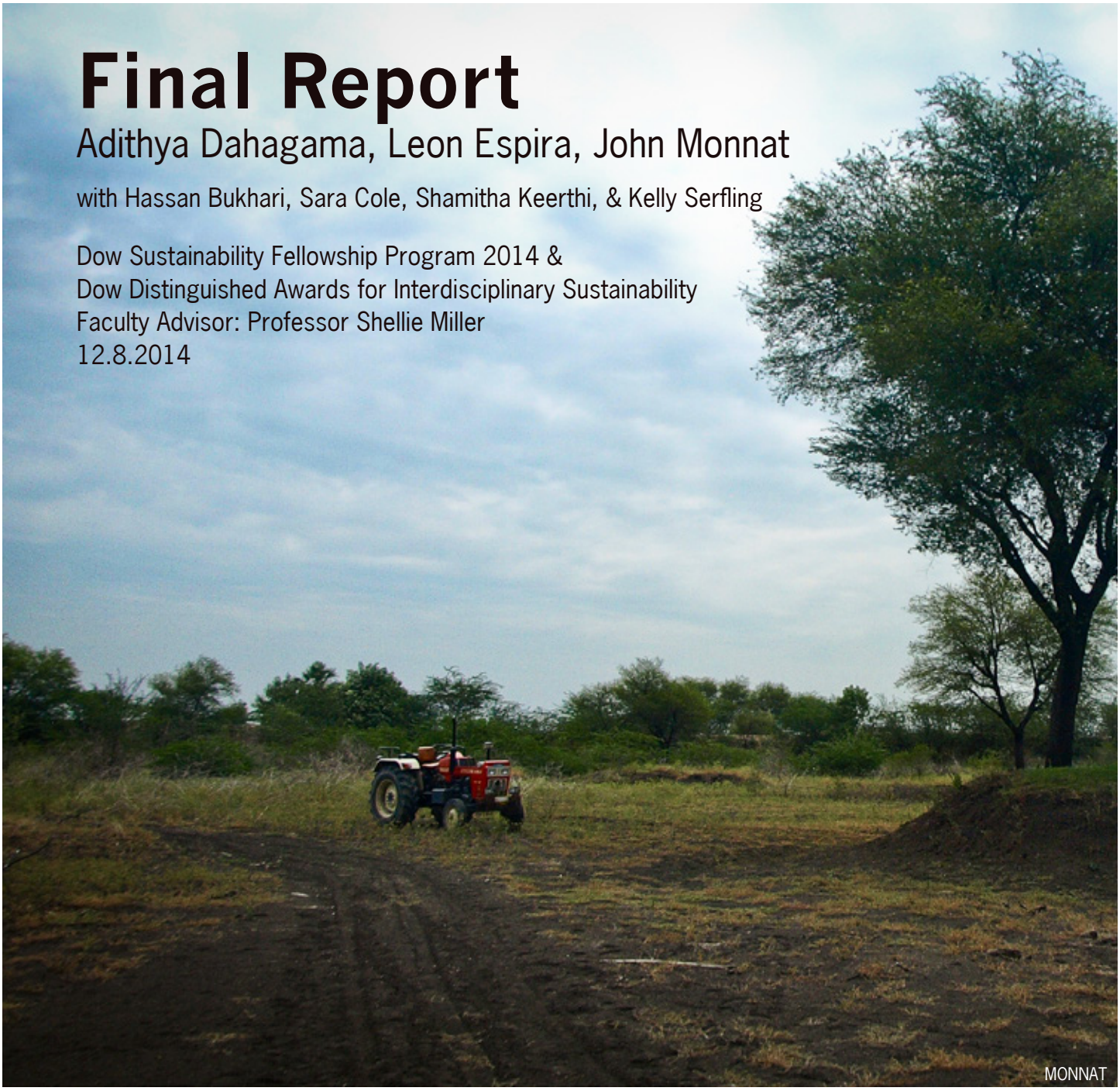
with Hassan Bukhari, Sara Cole, Shamitha Keerthi, & Kelly Serfling

Dow Sustainability Fellowship Program 2014 &
Dow Distinguished Awards for Interdisciplinary Sustainability
Faculty Advisor: Professor Shellie Miller
12.8.2014



De-silting Minor Irrigation Ponds in South India:

The Sustainability of Decentralized Resource Distribution

SCHOOL OF NATURAL RESOURCES & ENVIRONMENT
UNIVERSITY OF MICHIGAN

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architecture + urban planning
University of Michigan

SCHOOL OF PUBLIC HEALTH
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Silt spread on farm (left) contrasted with barren land common in the region (right).
Nalgonda, Telangana

De-silting Minor Irrigation Ponds in South India: The Sustainability of Decentralized Resource Distribution

ABSTRACT

Minor irrigation ponds are man-made banked earth structures that have been used for centuries to store rainwater in the region of Telangana, India. To maintain their storage capacity, ponds have to be periodically de-silted. This is traditionally done in the dry season when the ponds are dry. Our team analyzed if harvesting silt could provide a direct source of employment as well as serve as a potential replacement to artificial fertilizers in Telangana's farming matrix. The goal of the study is twofold: to more fully understand the effects of de-silting ponds on agricultural, hydrological, health and economic systems in South India, and to advise policy makers on sustainable use of this local resource.

INTRODUCTION

Minor irrigation ponds are man-made banked earth structures that have been used for centuries to store rainwater in the region of Telangana in the south of India. To maintain their storage capacity, ponds have to be periodically de-silted. This is traditionally done in the dry season, when the ponds are dry. A mix of manual and mechanical means are used to dig the silt out, load it on tractors for transport to fields. Once the silt is delivered to the fields, it is spread manually. Silt that is not used on fields is usually piled on the side of the ponds to raise and reinforce their banks.

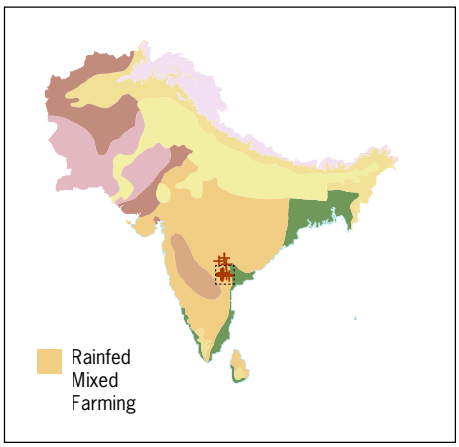
Telangana is newly formed state and the new state administration is keen on implementing sustainable use of silt as a renewable resource. To this end considerable funds have been allocated to the desilting effort. However, the government does not yet have clear and articulated plan of how to implement the desilting process so as to ensure both national and state development strategies are addressed. We, as a team, hope to be able to work with the both the national and state governments in developing a silt-exploitation matrix that will incorporate best-management practices into the project and serve as template for other regions, both in India and globally, for indigenous and grass-roots driven sustainability initiatives. This report details the progress on the project to date and outlines the direction which we wish the project to take.

Our base goals were twofold: to understand the effects of de-silting ponds on agricultural, hydrologic, health and economic systems in South India, and to advise policy makers on sustainable use of this local resource. Building off these findings we intend to work with partners and collaborators in India in developing policy framework that can be used by the state of Telangana.

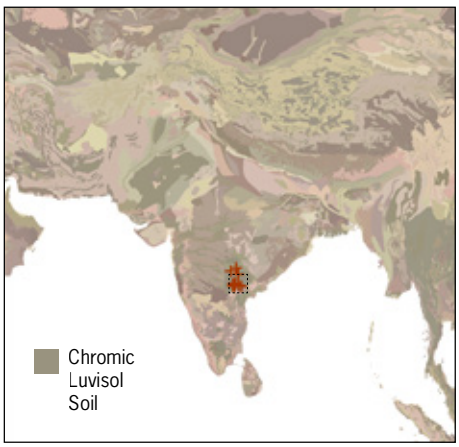
PROJECT BACKGROUND

The state of Telangana located in the semi-arid plateau region that receives an annual rainfall of 700 to 800 mm. 50% of landuse in the region is agriculture, with Cotton, Paddy, and Maize being the major crops. As a result, the region's agricultural landowners are dependant on various sources of water including minor irrigation ponds, borewells and centralized dams for their irrigation needs.

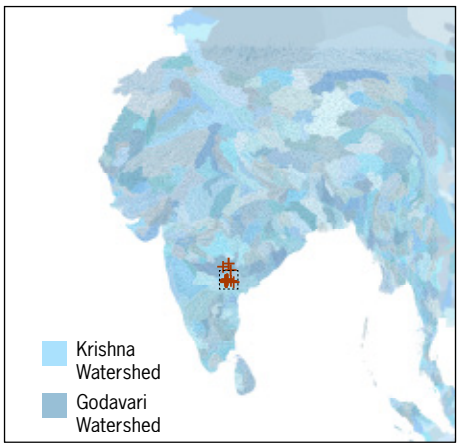
Minor Irrigation Ponds



Predominant Farming System



Soil Type



Watershed

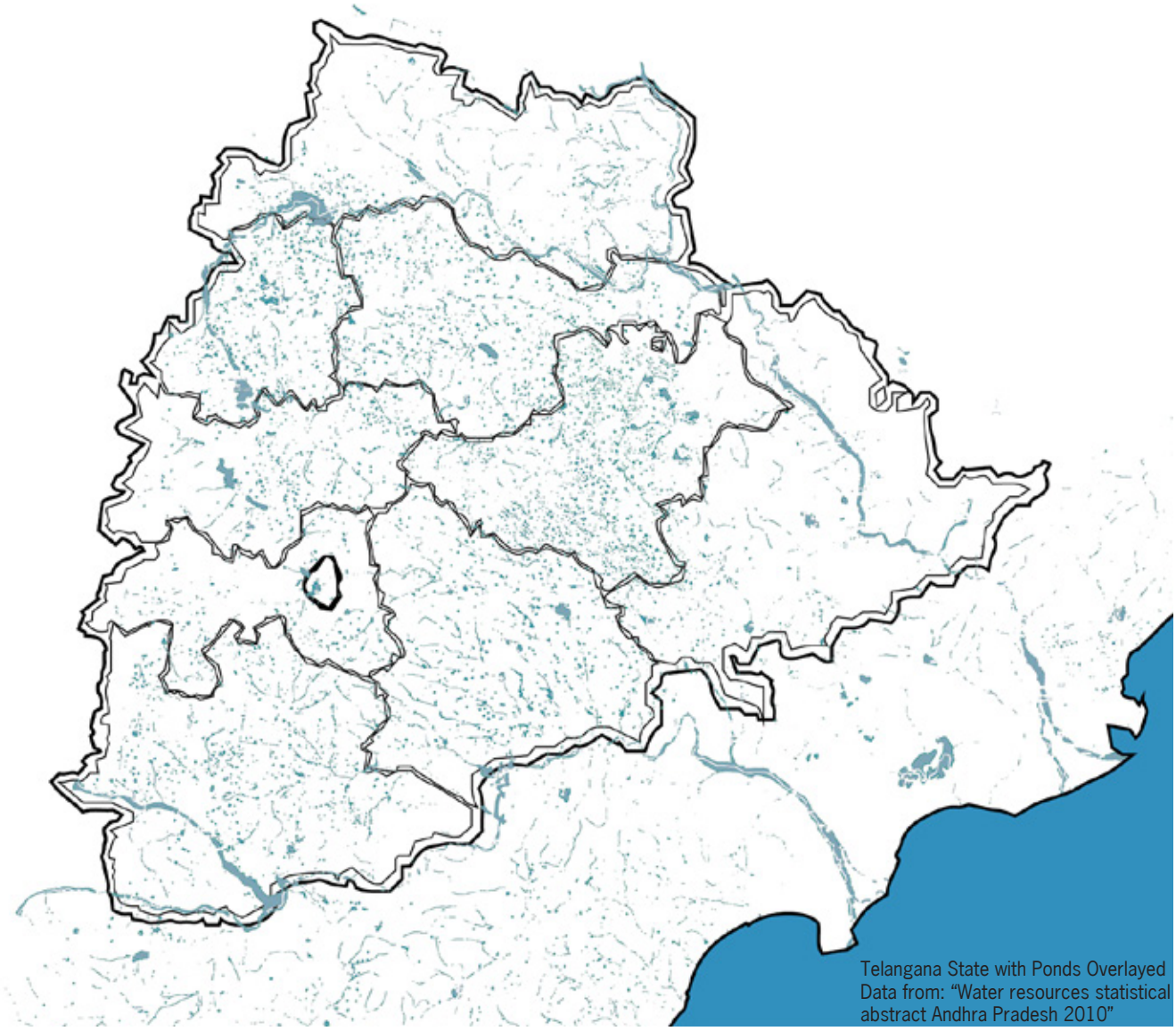
General Conditions in the Telangana Region. Data from: FAO, FAOHydrosheds

Minor irrigation ponds have been used in the Telangana region since at least the 13th century. Built to store rainwater during the monsoons, they have evolved to be an integral part of the farming matrix in the region, especially when the monsoons are not adequate and supplementary irrigation is needed. To date, there are more than 45,000 ponds in the region.

A typical pond covers an area between 50 to 200 acres and irrigates anywhere between 500 and 2000 acres of agricultural land in its command area. The catchment area of a pond usually covers an area between 200 to 5000 acres and consists of mixed use areas with both forest cover and barren land.

Silt Use and the State of Telangana

With the state's economy being predominantly dependent on agriculture, the state government recognizes the need to ensure that the development of local farming economy is as equitable as possible.



Telangana State with Ponds Overlayed
Data from: "Water resources statistical abstract Andhra Pradesh 2010"

The state also wants to ensure that farming families can see a future around farming, reduce farmer suicides due to debt and slow the movement of people into urban areas because of a lack of opportunities in rural areas. The state government also wants to work the Mahatma Gandhi National Rural Guarantee Act (MGNREGA) framework.

The employment guarantee act was launched by the Government of India in 2005. It aims to ensure that any adult in rural India able and willing to do manual work is able to work for at least 100 days and get compensated. To date over $25 billion dollars have been allocated to the scheme.[1] Its overarching aim is to reduce rural poverty without resorting to handouts while also harnessing labor that would otherwise be idle. To date the scheme has been used to fund the construction of roads, community buildings such as schools as well as in land reclamation projects such as irrigation schemes. It has been hailed by some as a stellar example of government driven rural development that ensures non-exploitative working conditions while redistributing national wealth to some of the poorest.[2]

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1. MRD Government of India, 2014 "Water-related Diseases: Fluorosis" http://nrega.nic.in/netnrega/writereaddata/Circulars/MGNREGA_SAMEEKSHA.pdf (accessed 12/7/14)
2. Economic Times of India, 2014 "World Bank Calls NREGA a stellar example of rural development" http://articles.economictimes.indiatimes.com/2013-10-10/news/42902947_1_world-bank-world-development-report-safety-net (accessed 1/12/2015)

Team Members and Farmers Examine Pond Silt
Nalgonda, Telangana

The scheme has not been without its detractors. A common criticism is that it distorts the rural labor market since some argue that labourers would rather just work on the scheme rather than seek paid employment with landowners.[3] This drives up the cost of labour, making agriculture more expensive.[4] It has also been pointed out that the scheme is too narrowly focused on generating manual employment rather than seeking to build a longer term economic alternative that could absorb rural labour.

As the State of Telangana formulates its agricultural and development scheme around the MGNREGA framework it is crucial that the state take a more nuanced and long term assessment of its needs and how best to serve the people within the employment framework guaranteed by MGNREGA. As we detail in this report, we believe that as team we are well placed to be part of this assessment and help with policy formulation that will not only promote more efficient farming practices but also hopefully start building a new economic dynamic in the state that is less reliant on past practices but rather is focused on sustainable, societally conscious and market anchored development solutions.

PROJECT OBJECTIVES

As outlined before, the project had 2 broad goals: to fully understand the effects of de-silting ponds on agricultural, hydrological, health and economic systems in South India and then to use the data from

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3. MRD Government of India, 2014 “Water-related Diseases: Fluorosis” http://nrega.nic.in/netnrega/writereaddata/Circulars/MGNREGA_SAMEEKSHA.pdf (accessed 12/7/14)
4. IZA, 2014 “The Impact of Indian Job Guarantee Scheme on Labor Market Outcomes: Evidence from a Natural Experiment” http://ftp.iza.org/dp6548.pdf (accessed 1/12/2015)

Team Members Adithya and John meeting with Local Farmers
Nalgonda, Telangana

these analyses and studies to liaise with partners and collaborators to develop policy frameworks that encourage the sustainable use of this local resource.

Economic Objectives: Generation of employment

A life cycle analysis matrix was developed that compared the number of employment generated by the manual silt harvesting and against the number of days of employment generated by mechanized silt extraction. The aim of this exercise was to assess the most efficient use of the rural labor pool. Though at first glance it may seem that the use of manual labor will no doubt result in the generation of more employment, in the long term this is not the case as our data showed. The use mechanical diggers results in more downstream, long-term employment generation rather than seasonal labor, as is the guess with the employment scheme. This is attributed to a vastly increased amount of silt which could be dug, creating spreading jobs and covering barren lands for farm land creation.

Hydrology: Influence of upstream land-use on sediment loading and quality

Currently only 23% of Telangana is covered by natural vegetation. The rest is mostly used for growing Cotton, the major cash crop in the region. The rate of natural vegetation has resulted in a change in the hydrological characteristics of the region with attendant changes in erosion and deposition rates.

If silt harvesting is to be a sustainable practice, erosion rates in catchment areas have to be determined. These catchment areas act as buffers in the regional hydrological system. During, intense monsoons they control erosion rates, ensuring that the ponds don't silt up over the course of a single season. During the drier monsoons, well maintained catchment areas will ensure that more the water drains into the ponds rather than simply percolating into the bedrock.

Silt samples from a 33 ponds have been collected and are in the process of being analyzed and input into a geospatial database. The end goal of this exercise is to establish possible links between silt parameters and the state of each ponds catchment area. This could be used to better plan reforestation projects, in terms of both location and the species make up. The goal would be develop a system of interdependent ponds and forest resource systems that can be exploited by the local community.

Public Health Objectives

Fluorosis, the darkening of tooth enamel due high fluoride levels during tooth development, is major public health issue in the Telangana region. It is often caused by high fluoride levels (> 1.5 mg/litre)[1] in drinking water. Skeletal fluorosis, the accumulation of fluoride in bone, can result from chronic exposure to high levels of fluoride in drinking water. Severe cases can lead to skeletal deformities.[2] Possible reasons for excessive fluoride levels in Telangana include the over exploitation of aquifer resources due to water extraction for irrigation uses. This results in a water table that is increasingly difficult to reach and also has higher concentrations of flouride than would normally be present.

We hypothesize that by harvesting silt, local water tables would be recharged because a larger volume of water would be allowed to infiltrate through the de-silted pond. The ponds are distributed, and this dispersed network would slowly recharge the sub-surface aquifer in the region. To this end, the team is in the process of organizing a survey based study that will assess the change in ground water fluoride levels in the the district of Nalgonda and then see if there is an association between the lower groundwater fluoride levels and the harvesting of silt from local ponds.

PROJECT PARTICIPANTS

University of Michigan

The team currently consists of 7 team members. They are as follows; Mr. Adithya Dahagama, a graduate student in Sustainable Systems at the School of Natural Resources and the Environment. Adithya has first hand knowledge of the study area, making him the ideal person to examine the socio-economic aspects of the project as well as act as the liaison between our team and local, state and national government officials. Ms. Sara Cole a recent UM School of Natural Resources graduate with a professional background in human dimensions of environmental issues, will improve our survey instruments and communicate our research conclusions for implementation and to other local and international

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1. WHO, 2014 “Water-related Diseases: Fluorosis” http://www.who.int/water_sanitation_health/diseases/fluorosis/en/ (accessed 12/7/14)
2. Ibid

Member of Legislative Assembly speaking at the Community Symposium.
Munugode, Telangana

stakeholders involved. Ms. Shamitha Keerthi, a PhD candidate at the UM School of Natural Resources & Environment with expertise on agricultural practices and the utilization of water resources. She will evaluate the impact of the ponds on soil quality and area hydrological characteristics. Mr. Leon Espira, is an epidemiology graduate student at the School of Public Health. Leon has experience with carbon management projects as well as the licensing process for accessing carbon credit markets. Leon will also explore ways of creating metrics that would evaluate the public health impact of using small pond irrigation. Mr. John Monnat is an architecture graduate student at the Taubman College of Architecture and Urban Planning. John has both national and international experience in resource management, water system utilization, and architectural design. John would take the lead in examining demographic and geographic relationships between pond catchment, nearby villages, and utilization areas. Ms. Kelly Serfling, an environmental health science graduate student from the UM School of Public Health with experience at the U.S. Environmental Protection Agency (EPA) and U.S. Food and Drug Administration (FDA), will evaluate the health impacts of de-silting including issues related to fluorosis in the district of Nalgonda. Professor Shelie Miller, PhD, from the UM School of Natural Resources and Environment is our faculty advisor. Mr. Hassan Bukhari is a Fulbright Scholar and graduate student in Sustainable Systems at SNRE and is returning to the subcontinent in 2015. Hassan has experience in interacting with the Base of the Pyramid farmers through creating micro ventures in rural Sindh; he is interested in exploring market based

mechanisms and business model research and development to create a high impact social venture around tank silt application on agricultural lands of poor farmers.

FREEDOM

Our project team continues to network with local farmers via Flame-thrower for Rural Education, Environment, and Development Oriented Movement (FREEDOM), a non-profit, non-governmental organization that promotes the use of silt in district of Nalgonda.

Government of Telangana

The newly formed Government of Telangana understands the benefits of de-silting irrigation tanks and has already pledged $4 Billion over the next five years to revive the 45,000 plus irrigation tanks in Telangana. We will continue to interact with Irrigation, Agriculture, and Rural Development ministries to understand their priorities and coordinate research interests to maximize the benefit out of the government spending for rejuvenation of irrigation tank system.

CRIDA

We are actively collaborating with Dr. Mohammad Osman, Principal Research Scientist at the

Farmers Participate in Symposium.
Munugode, Telangana

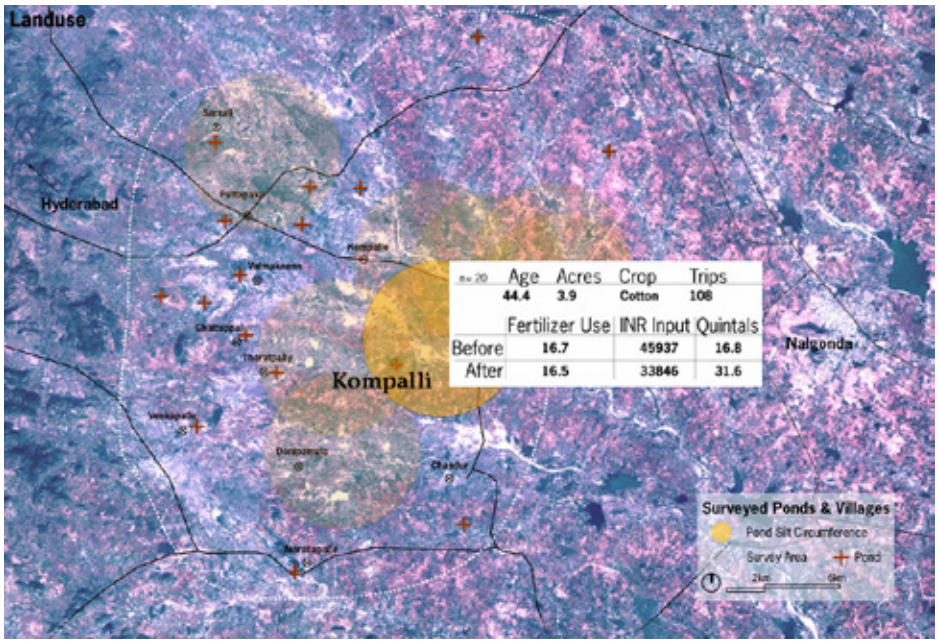
Central Research Institute for Dryland Agriculture (CRIDA). He has been assisting in project development through soil testing & analysis and his experiences in pilot studies to assess crop productivity enhancement via silt application. We will continue use his expertise in creating best practices for tank desilting to better inform the government policy.

PROJECT OUTREACH

Prior to the summer field season, Dow Fellow Adithya Dahagama produced a series of reports on the effects of de-silting ponds by analyzing associations between desilting, employment generation, and greenhouse gas emission mitigation potential. Leon Espira created a report on local fluorosis and its impacts on health, while John Monnat conducted geospatial research at the local and regional scale to assess the scope for de-silting. We also sent about 45 letters from the Graham Sustainability Institute, signed by Professor Don Scavia, to various Ministers and Administrators of the concerned departments - Agriculture, Finance, Irrigation, Rural Development, and Water Resources - in Telangana and Indian governments.

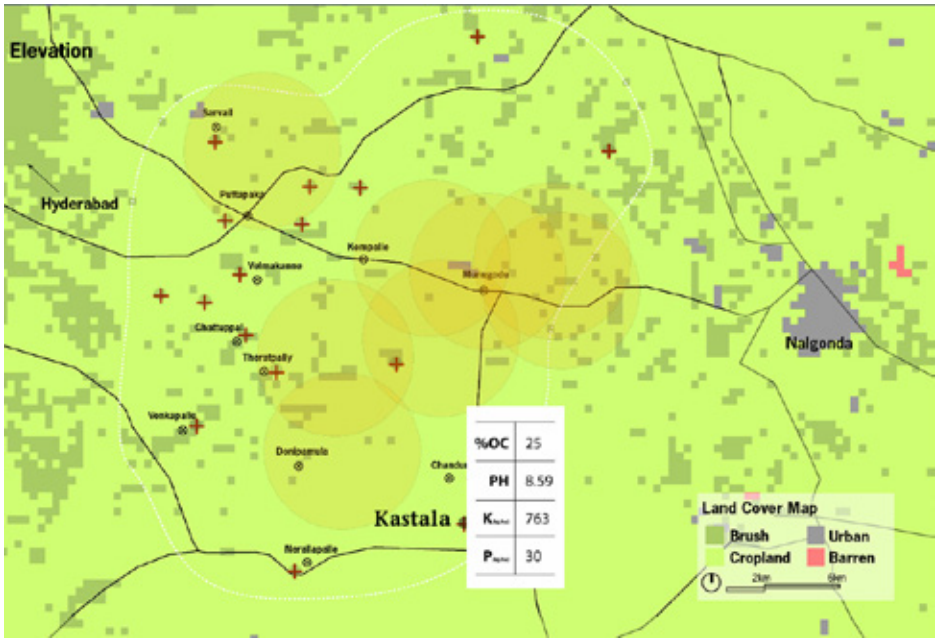
During the summer, two members of the team spent three weeks in the Nalgonda District of the South Indian state of Telangana completing Phase One of this project. Working together with community partners, the team organized and hosted a community symposium where they interacted with beneficiary farmers and collected data through surveys on the local use of pond silt in the district. The event brought out 700 beneficiary farmers from 10 nearby villages, and 100 school children from the village of Munugode to discuss the practice of pond silt removal and its effects with scientists, administrators, community organizers, journalists, and poets. The symposium was followed by fieldwork in the villages of the Nalgonda region involving interviews with local farmers and families, and survey of the region's irrigation ponds in preparation for Phase Two.

While in Nalgonda, our team was interviewed by several local media channels who highlighted our work in newspapers, on television, and online. We will continue to communicate and disseminate our findings through these established channels and others as the project grows. There is a strong interest

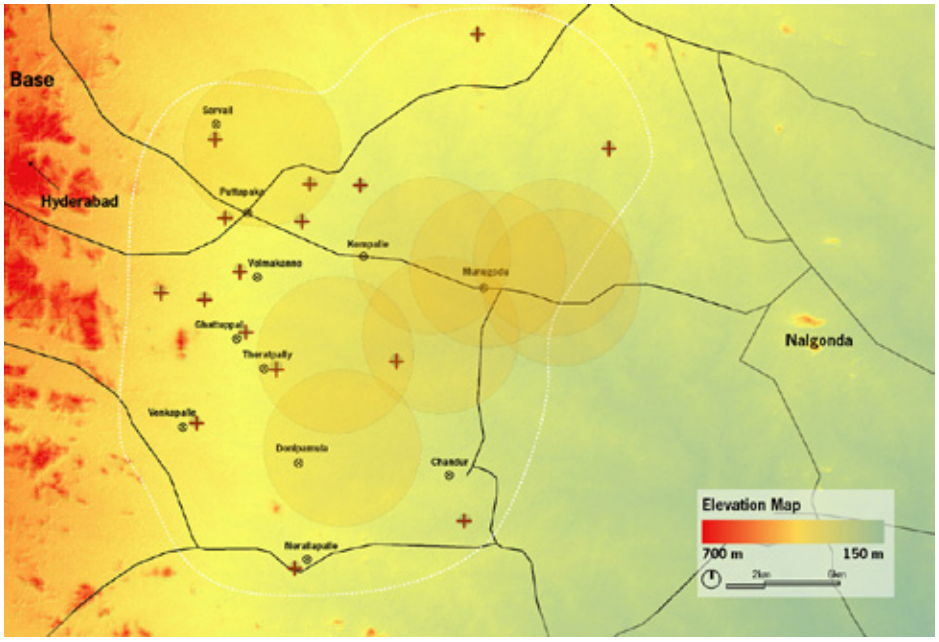


Geospatial Mapping Database With Web Interactivity. This is the start to an interactive web ready database where survey, soil test, and satellite data can be spatially located and accessed by anybody interested in the project.

Satellite Imagery with Survey Data Results
Data: ESRI, USGS, DCW roads



Landuse Map with Soil Test Results
Data: ESRI, FAO, DCW roads



Elevation Map with Test Regions
Data: ESRI, CARTOdem, DCW roads

in water and water issues in Telangana, as the state was formed over previous access to water conflicts. The irrigation department at the local and national level have commited money and time to minor irrigation projects, as they are the center of rural communities on the Deccan Platteau. The government and ordinary citizens are eager to see water improvement projects in the region.

DATA COLLECTION

The team visited two types of villages: those with ponds that had undergone rapid and large-scale de-silting and those that had no recently de-silted ponds. By undertaking this fieldwork, the team was able to accomplish its goal of defining a region of study and building trust within a network of local farmers and their surrounding communities.

Following the fieldwork, the Fellows organized successful meetings with administrative officials and other stakeholders at the local, state, and national level to discuss future policy implementation. They presented their findings and policy suggestions to the Telangana's Ministers of Agriculture, Finance, Irrigation, and Rural Development. All expressed interest in further collaboration with the Dow Fellows team. The team then met with the Joint Secretary of Rural Development and the Commissioner of Minor Irrigation the National Government in New Delhi, who has also expressed a desire to collaborate.

CURRENT PROJECT RESEARCH AND OUTCOMES:

Employment Generation:

Analysis of the current silt harvesting mechanism shows that in an average village with 100 persons available to dig silt, the use of manual labor provided 8,000 man-days of direct employment (to dig and spread silt). The use of machinery for digging completely eliminates direct labor employment generated in digging, but results in overall increase in employment of 6,000 man-days in direct spreading employment and 58,000 man-days of secondary productive farming employment per year, as a result of farm lands being covered with silt. Furthermore, current policy would only harvest sufficient silt for 150 acres of agricultural land - over the sixty day window of hot summer days during which the ponds are dry - compared to enough silt for 720 acres that machine digging would facilitate.

GHG Emissions Reduction

Our analysis, based on data from CRIDA, shows that the use of silt has significantly cut down fertilizer/pesticide consumption; the use of silt results in a 95% GHG reduction; from 2070 kg C02/acre (just accounting for the GHG emissions associated with manufacturing) for artificial fertilizers to 92 kg C02/acre for silt application (digging and transportation). (See Page 23)

Survey Findings

Survey data and interactions with farmers also show that on average farmers report a 50% increase in crop yields the following year when using silt, while cutting down on the use of artificial fertilizers by %36.

Tank Sediment Soil Analysis & Results

These are results from preliminary analysis and are being used in the construction of a geo-spatial database that will link sediment analysis to pond locations.

Geospatial Database of Tanks & Sediment Analysis

The production of a geospatial database has been an important part of the project in terms of quickly understanding all of the issues involved in tank silt quality, land use, and the relationship of ponds and villages. Using arcGIS and Processing, the geospatial team has created a comprehensive map of land use, elevation and satellite imagery, in combination with survey results and pond silt. Our results from the mapping have shown that while there is a strong correlation of high P (phosphorus) and K (potassium)

Newspaper clippings from local newspapers in the Nalgonda area about the ongoing research. August 2014. Nalgonda, Telangana

Meeting with Finance Minister of Telangana to discuss de-silting.
Hyderabad, Telangana

Meeting with Farmers and Organizers in a de-silted pond.
Nalgonda, Telangana

numbers downstream, and generally higher organic content upstream, closer to forest lands.

Continued research in this open, public database could provide deeper sets of information to policy makers, and have so far helped the team understand the scope and depth of de-silting ponds. Work with local mapping agencies, as well as continued mapping in the region by the team will yield a stronger set of results to base future policy off of.

Overall our findings suggest that de-silting is beneficial to both small and large scale systems, promoting both short and long term employment while lowering farming input costs and reducing overall greenhouse gas emissions from agriculture. The opportunity here is incredible, as there are more than 45,000 ponds across the 11,000 plus villages in the Telangana region.

PROPOSED PROJECT RESEARCH AND OUTCOMES:

Broadly, our goals consist of data collection, field tests, a literature review, policy analysis, and stakeholder engagement. These are outlined below:

Data Collection:

We have a developed data collection plan that will more broadly inform on the study area's characteristics. We intend to expand out of our current focus area from the Nalgonda district and as much as possible focus on the state of Telangana as as whole. To this end, local collaborators will be actively engaged. State and national governments will also be included, especially to facilitate access to databases. Data sources will include existing databases and newly collected field data on the following:

+ Crop quality
+ Irrigation networks and volumes
+ Geospatial data from remote sensing

+ Census data from state and local governments

+ Groundwater Levels, Fluoride concentration, and other chemical composition

Ecologic Analysis

Onsite field tests will carried out to assess environmental variables in real-time. These field tests will be used to complement legacy data from records. This will also allow us to explore possible temporal trends by comparing current data with legacy data. Tests will be conducted to assess soil characteristics including organic content and nutrient availability.

We will increase focus on the ecological aspects of our project. A plan for analyzing sustainable silt harvest rates, with an emphasis in analyzing any attendant changes in local hydrologic characteristics, will be developed. In addition, a detailed survey of several upstream catchment areas will be carried out. The goal of these surveys is would to establish the state of the catchment areas, with a focus on the number and type of plant species and any management practices in place.

Fluoride Levels and Fluorosis

The team will examine any publicly available regional data about fluorosis levels in the residents of Telangana state. This data will be compared to baseline fluoride levels in groundwater for the respective regions examined, before and after de-silting, if possible. In addition, measurements of the groundwater

Children in the Region Suffer From Skeletal Fluorosis. Ref. 5.

table levels and their variability by year and season should be obtained.

To monitor the changes in groundwater chemistry, and particularly fluoride concentrations, after de-silting has taken place, data should be for these parameters should be obtained. Previous studies of tank desilting and fluoride levels in India have taken groundwater samples from bore wells and dug wells over the course of several months, and examined the changes in groundwater chemistry between measurements.[3456] Ideally, we will arrange to have samples taken from wells in villages where tank de-silting has been carried out, and others where it has not, during each season of the year. Samples will be analyzed locally for fluoride content, pH, and other chemicals. If sampling is not feasible to carry out, then we may analyze data measured by farmers or a regional natural resources authority. This data will help the team assess the impact de-silting has on groundwater recharge and fluoride concentration.

One of the long term goals of this project is to reduce fluoride concentrations in drinking water, ideally to < 1.5 mg/l, in regions of Telangana where it is currently found in excess of this reasonably safe standard. Routinely drinking and cooking with groundwater contaminated with < 1.5 mg/l is considerably less likely to result in dental or skeletal fluorosis.[7]

Literature Review

A meta-analysis of the current literature will be carried to not only inform the team of the latest developments in the study areas of interest, but also for manuscript preparation. Topics of focus will be:
+ GHG emission intensity variation due to offsetting artificial fertilizer use and employment generation potential of increased farming practice through silt application

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3. Ramaraju, H.K. et al., "Impact of Tank Desilting on Flourosis Control - A Case Study in Bagepalli, Kolar District" http://ces.iisc.ernet.in/energy/water/proceed/section6/paper1/section6paper1.htm

4. Rao, N.S., 2003. "Groundwater Quality: Focus on Fluoride Concentration in Rural Parts of Guntar District, Andhra Pradesh, India" Hydrological Sciences Journal. Vol. 45 No. 5.

5. Dar, M.A., et al., 2011. "Fluoride Contamination in Groundwater: a Major Challenge", Environmental Monitoring and Assessment. 173: 955-968.

6. Sharma, et al., 2011. "Emerging Challenge: Fluoride Contamination in Groundwater in Agra District, Uttar Pradesh," Vol. 2, No. 1.

7. WHO, 2014 "Water-related Diseases: Fluorosis" http://www.who.int/water_sanitation_health/diseases/fluorosis/en/ (accessed 12/7/14)

Ref. 8

Clarification of Machine Support from Joint Secretary of Rural Development, R. Subrahmanyam

No. 11011/09/2014- RE-I
Government of India
Ministry of Rural Development
Department of Rural Development
(Mahatma Gandhi NREGA Division)

Krishi Bhavan, New Delhi
Dated: 25th August, 2014.

To
The Spl CSs/Prl Secretaries/Secretaries of Rural Development (In charge-MGNREGS)

Subject: Clarification regarding use of machines in MGNREGS works

Sir/Madam,

As per Para 23 of Schedule-1, MGNREGA, "As far as practicable, works executed by the programme implementing agencies shall be performed by using manual labour and no labour displacing machines shall be used". This provision protects the basic objective of the Act i.e. provision of employment. However, there may be activities in executing works which cannot be carried out by manual labour, either due to the nature of the work or the timing for execution. Several State Governments have been requesting clarification in the matter so that the quality of execution of works should not suffer.

2. The matter has been considered in consultation with State Governments and it has been decided that where use of machine becomes essential for maintaining quality and durability of the works, machinery can be used subject to adopting the machine rate, as per the prevailing SOR of the line departments in the area (and not unskilled manual wage rate) in the estimate. A suggestive list of such tasks and type of machines to be used is enclosed.

3. Apart from the above, works which have to be executed within a very short period, where speed of execution is most critical (like the works in a flood prone area), the decision to use machines can be taken by the State Government while ensuring that the job card holders are not deprived of their work.

4. Further, all MGNREGS works in which machinery has been used shall be put through a mandatory Social Audit conducted in accordance with the provisions of Audit of Scheme Rules 2011. Any cases of deviation shall be dealt with seriously.

Yours faithfully

(R. Subrahmanyam)
Joint Secretary to Govt

Ref. 9

Clarification of MGNREGS Works from Joint Secretary of Rural Development, R. Subrahmanyam

No. 11017/41/2012- MGNREGA (UN) (Pt-II)
Government of India
Ministry of Rural Development
Department of Rural Development
(Mahatma Gandhi NREGA Division)

Krishi Bhavan, New Delhi
Dated: 17th September, 2014.

To
The Spl CSs/Prl Secretaries/Secretaries of Rural Development (In charge- MGNREGS)

Subject: Clarification on MGNREGA works directly linked to agriculture and allied activities through development of land, water and trees.

Sir/Madam,

The Sub Para (1)of Paragraph 4 of Schedule I of MGNREGA modified as on 21st July, 2014, lays down that "Provided that the District Programme Coordinator shall ensure that at least 60% of the works to be taken up in a district in terms of cost shall be for creation of productive asset directly linked to agriculture and allied activities through development of land, water and trees".

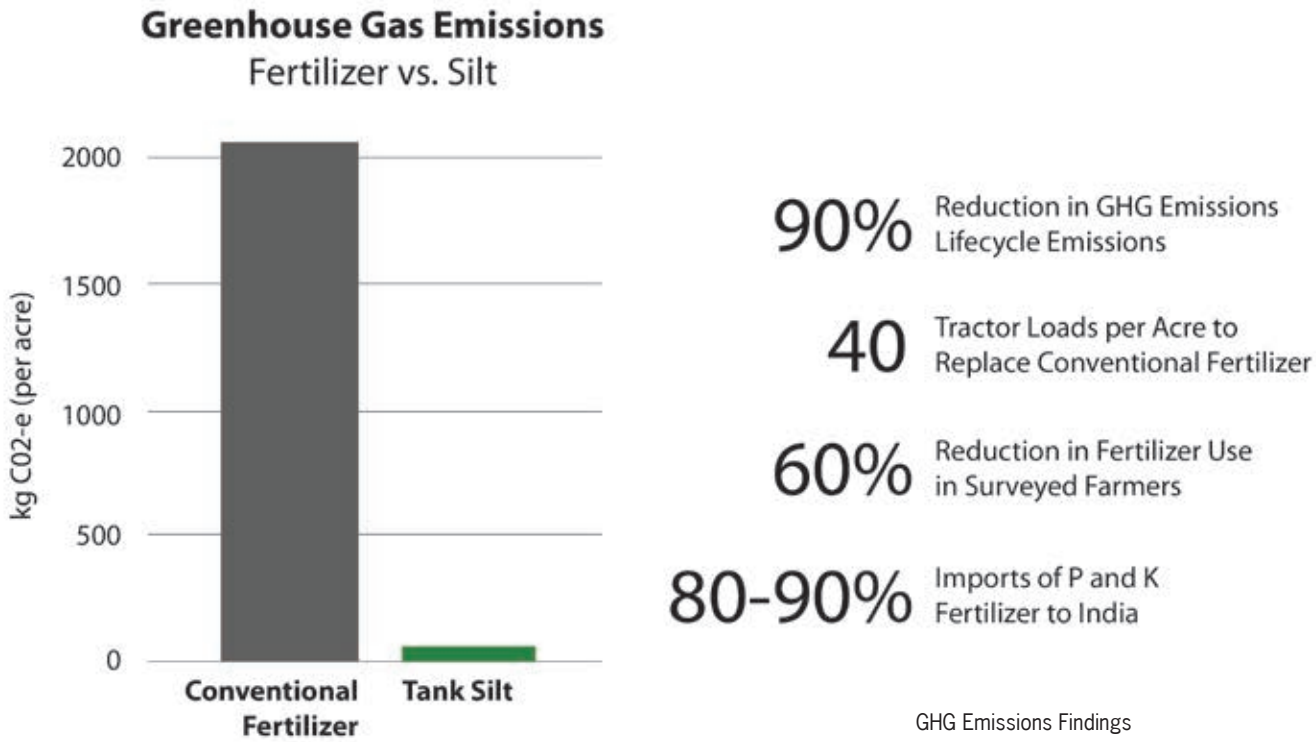
2. It is necessary for all States to monitor the works sanctioned in the districts so that investments as per the Statute are made for improving productivity of agriculture and allied activities. To clarify the matters further, the works that are directly linked to agriculture and allied activities are listed in the Annexure.

3. You are requested to disseminate this widely and specifically to functionaries of MGNREGS; and ensure that the provisions of the Schedule are followed without fail.

Yours faithfully

17/9

(R. Subrahmanyam)
Joint Secretary MGNREGA



GHG Emissions Findings

+ Environmental health impacts of pond de-silting by assessing water tables and other hydrological parameters; with a focus on fluorosis mitigation

+ State-of-the-art geospatial analysis methods to properly link and evaluate data

+ Comparable projects globally and sustainability assessments of energy and environmental inputs in the current program matrix.

Policy Development

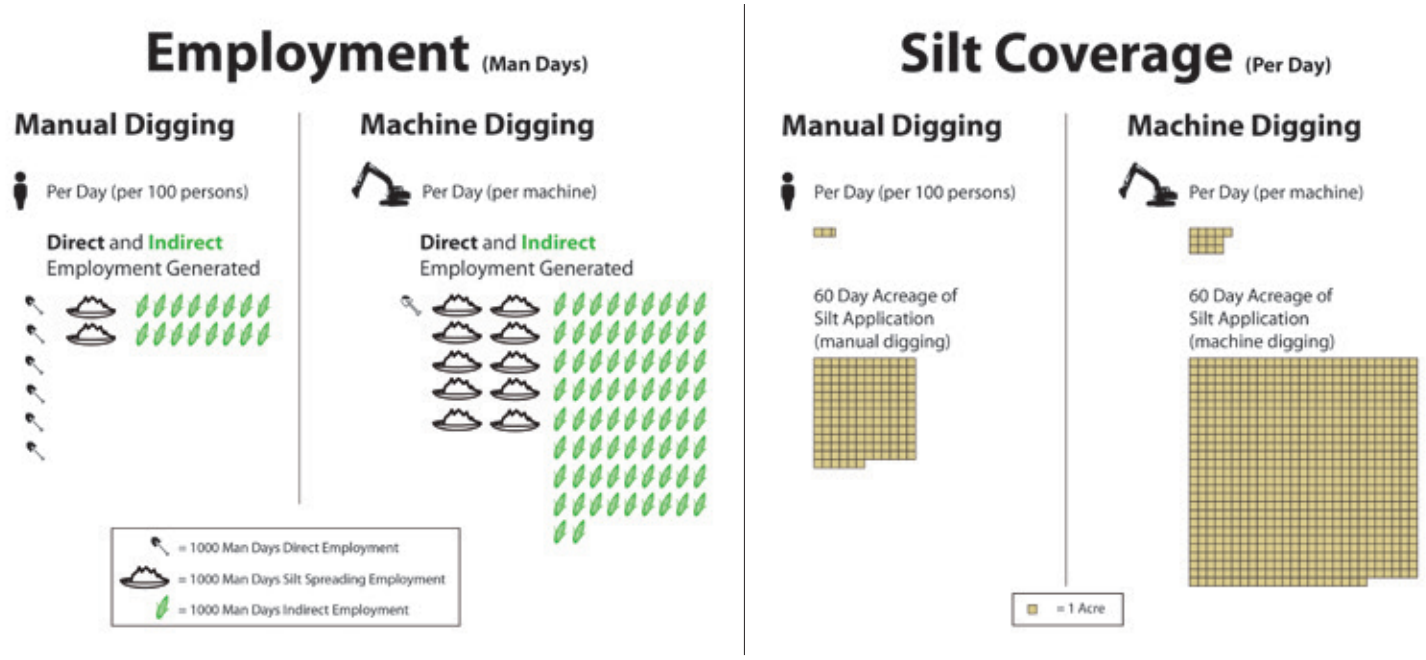
We will assess the policy implications of the project. These will be implemented to coincide with government development goals to ensure that the project has the necessary administrative backing in critical areas of operation.

Stakeholders will be engaged to ensure that the policy goals outlined above are met. Both local, national and international policy and government bodies will be engaged to solicit their input into the project. We anticipate to engage with the following offices:

+ Administrators and Ministers in Hyderabad and New Delhi

+ Indian and South Asian experts at the World Bank

+ The United Nations Environmental Program (UNEP) office in Washington D.C.



We plan to involve other research centers at the University of Michigan such as the Center for Sustainable Systems, the Graham Sustainability Institute, and the Sustainability Without Borders student organization. These collaborations would help us to continue dialogue, even beyond this project, between UM and all the stakeholders involved; academia, beneficiary farmers, administrators, and the governments at the state and central levels.

Business Model Research & Development and Social Venture

The current de-silting efforts are highly dependant on the government motivation. We feel that the process generates enough positive benefits to pursue as a social enterprise.

The farmers in the area are already under severe stress and stakeholder interviews indicate that the process must be subsidized. However, instead of solely banking on government we will attempt to diversify the source of funding for de-silting and silt application.

+ Under the MGNREGA framework the government only subsidizes farmers who own fewer than 5 acres. Larger scale farmers who are interested in silt have to negotiate with crane and tractor operators on an

individual level, resulting in a higher cost as compared to large scale operations. Anecdotal opinion is that 30% of villagers can afford the entire cost of the desilting process.

+ The prospering city of Hyderabad lies at the center of Telangana. It hosts both national and multinational companies that are interested in CSR opportunities.

+ We will look into monetizing credits from carbon offsets.

+ The government provides free electricity to farmers for pumping water and the drop in the water table has increased the demand for electricity. We will attempt to negotiate a return depending on the feet rise in the water table after operations.

+ Other health and environmental impacts that can be quantified for stakeholders.

We are in the process of developing relationships with people involved in Base of the Pyramid ventures at University of Michigan, such as the William Davidson Institute. We also sent in a submission to the Global Social Venture Challenge organized by the Haas School of Business at the University of California in Berkeley that helped further our thinking.

Political and Administrative Analysis

We are also working on political and administrative analysis of tank de-silting in Telangana. This includes the assessment of various important factors such as the motivations of the local elected representatives, implementation and administrative analysis of outsourcing the tank desilting operations to third party private contractors. We plan to include this analysis in our recommendations to the government of Telangana.

CONCLUSION:

Findings from our technical reports (completed before the site visit) and preliminary analysis of our interviews (conducted during the site visit) strongly suggest that de-siltation, when integrated into standard agricultural practices, has positive impacts on the health and economic status of local farmers as well as the environment. Further surveying is needed to clarify the impacts of de-siltation on the region and the local communities.

This Dow Fellows team continues to network with local farmers via Flame-thrower for Rural Education, Environment, and Development Oriented Movement (FREEDOM), a non-profit, non-governmental organization that promotes the use of silt in the district. The team is also guided by Dr. Mohammad Osman at the Central Research Institute for Dryland Agriculture (CRIDA) who is assisting in project development and data collection. Our goal in the region is to enable the stakeholders to better understand the impact of de-silting, to stay in communication with policy makers and scholars, and to transparently operate in Telangana.

As a program designed to tackle poverty and ensure rural employment, MGNREGA stipulates that any work performed under its umbrella by it's associated implementation agencies be done using manual labor and actively discourages the use of machinery. However as our analysis has shown, the strategic use of machinery can actually enhance MGNREGA's goals of by ensuring more efficient work patterns. In the case of pond de-silting, machinery use would lead to the creation of long-term farm employment in the villages by increasing total arable acreage. In addition, using tractors to deliver the silt actually increases the overall labor required for applying it.

On August 25th, and on September 18th, of 2014; Mr. Reddy Subrahmanyam, the Joint Secretary of Rural Development for the Indian National Government, issued two government orders (see GOs in Appendix) on behalf of the MGNREGA to clarify the use of machines as part of the act. These government orders were released a week after we met with Mr. Reddy Subrahmanyam and suggested this policy change to facilitate pond de-silting. We take this as evidence of a new more responsive and adaptive government in India that is willing to formulate data driven policy. The new orders allow local officials to allow machine use if the timeframe of the project is critical, and to ensure no one loses their ability to work because of machine use. This is a huge step forward for the de-silting process. Concomitantly, Mr. Reddy Subrahmanyam and Mr R. Vidyasagar Rao, the advisor to the Government of Telangana in Hyderabad have consented to provide us with the irrigation spatial data, remote sensing data, and census data. We hope to continue to work with the national and local governments to more efficiently and effectively use governmental resources to directly help rural and underserved populations who would benefit the most from this program.

The Future

To complete our future goals, we are hoping to continue working until late 2015 on research, analysis, and publication of documents for international journals, as well as for beneficiary farmers. This program marks a shift in resource distribution and sustainable development in the Telangana area, and the long-term effects need to be studied, so we are also proposing to continue collaboration with Dr. Osman and other local contacts well into the future. We also plan to meet the regional (South Asia/India) experts on the subject matter at the World Bank Headquarters and UNEP regional office in Washington D.C to present our research findings, receive feedback, and discuss implementation strategies.

Our project is part of a long-term commitment to Telangana State. Preliminary research so far has shown that pond silt is a viable alternative to artificial fertilizers. Project success will be measured by

Schoolgirl at the De-Silting Symposium
Munugode, Telangana

how effectively the collected data will be able to drive policy - both in the long and short-term. An initial metric of success would be a change in the use of machinery in silt extraction, while longer term success would have to be measured through the government's drive to take up de-silting across all the districts of Telangana. With an implementation framework, this local resource has immense potential to drive paradigm shift in farming methods. Furthermore, what we propose is a systems approach to examining the effects of de-silting on rural Indian farmers. De-silting cannot be examined in isolation from the surrounding eco-systems, be they anthropogenic or natural. In a world as rapidly changing as ours, compartmentalization and isolation of problems will obscure the true picture. It is by examining a system wide impact of a sustainability challenge, as we are proposing, that inclusive, local and long lasting solutions can be developed so that we can all better share the planet's resources.

Examining a Tank
Munugode, Telangana

Acknowledgements:

UM Affiliates:

Gregory Keoleian, Shelie Miller, Don Scavia, Marie Lynn Miranda, Ted London, Dave Brenner, Steven Yaffee, Gregory Bond, Anne Wallin, Pavel Azgaldov, Bharadwaj Mantha

Class project team members, Faculty and GSIs of:

NRE 574 and NRE 597 courses, Fall 2013

ARCH 551, NRE 562, and BA 612, Fall 2014

Support Network in India:

Mohammed Osman & Central Research Institute for Dryland Agriculture, Ravindra Kumar Chintapalli, Mohammed Basheer & FREEDOM Organization, Pratap Reddy & Jawaharlal Nehru Technological University, Hyderabad

Ambassador Rajasekhar Chinthapally, Joint Secretary Reddy Subrahmanyam & the Ministries of Rural Development and Water Resources, Government of India, Vidyasagar Rao, Adviser to the Government of Telangana

Ministers of Agriculture, Education, Finance, Irrigation, and Rural Development, Government of Telangana, Nalgonda District Collectorate and District Water Management Authority

Press personnel of Andhra Jyothi, Eenadu, Namasthe Telangana, and Sakshi newspapers

Umamaheshwar Dahagama & Adithya's Family, Yeshwanth Reddy Gade, Babu Rao Kalapala, Gopal Reddy, Sowmithri Srivatsav, Bharathi Vadapalli

Financial Support from: DOW

Thanks to Anne Wallin, Greg Bond, and Neil Hawkins for their continued support

Farmers Talk to University of Michigan Team About Fluorosis, Debt, and Drought In The Region
Nalgonda, Telangana

Farmers sharing their personal experiences at the community symposium.
Munugodu, Telangana

Table 1: Summary of variables from the farmer's survey

	Mean	SD	P value	Number of data points
Famers age	46.25	11.30		78
Acres farmed	4.40	2.19		74
Tractor trips per acre	67.81	66.90		59
Bags of Fertilizer before silt application	12.38	14.17	-	71
Bags of Fertilizer after silt application	7.81	7.81	<0.0001	57
Crop output before silt application (100's kgs)	13.33	15.58	-	60
Crop output after silt application (100's kgs)	17.80	17.92	<0.0001	53
Farm expenditure before silt application (Indian Rupees)	31836.21	26858.21	-	58
Farm expenditure after silt application (Indian Rupees)	21274.51	17828.72	<0.0001	51

Table 1 Analysis:

70 of the farmers exclusively grew cotton, 7 farmers grew cotton and rice and 1 farmer grew exclusively chilies.

Except for Farmers age, none of the variables passed the Shapiro-Wilk test for normality. We therefore used the Wilcoxon Signed-Rank test for differences in means. In all 3 cases (fertilizer usage, crop yields and farm expenditure), there was a significant difference the means before and after the use of pond silt. Crop yields for example improved by an average of 447 kilograms.

We plan on stratifying the data on acreage and the number of tractor loads used and check for associations between crop yields and farm expenditure. Along with this, other data transformation will used to address the skewed nature of our data. For future work, we are in process of drawing up detailed data analysis plans as we pilot and design new surveys.

We have also analyzed soil characteristic across 33 sample points in the silt ponds. Data was collected on soil pH, organic content and potassium content (Figure 1). In the next phase of analysis we will geo-link these sample locations to their locations in the ponds and looks for associations between geo-spatial location and soil characteristics.

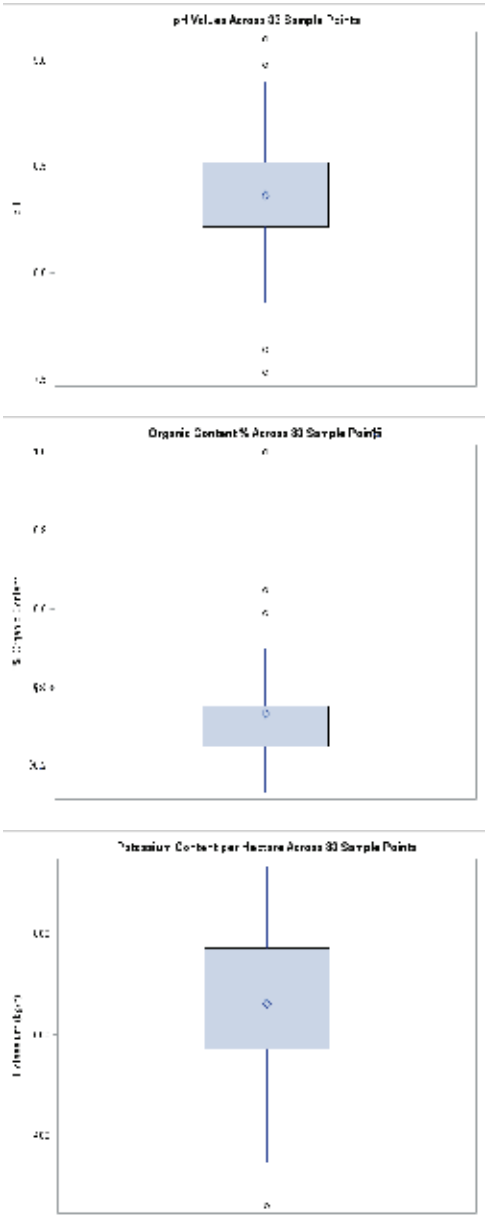


Figure 1: Box plots showing soil pH, organic content and potassium content. Soil pH was 8.36 (SD 0.35), soils organic content was 33.19% (SD 16.28%), and soil potassium was 661.60 kg/h (SD 155.50)

Project Goals	Nov-14	Dec-14	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15
Hiring Student Researchers									
Feedback from experts at World Bank & UNEP in Washington D.C									
Meeting with Ministers and Policy Makers in Hyderabad and New Delhi									
Survey Design									
Survey Execution									
Survey Analysis									
Soil Quality and Nutrient Assessment Tests									
Symposium with Farmers and Officials									
Aerial Surveys									
Manuscript Preparation									
Economic, Employment, and Political Implications Analysis									
Environmental Health Impact Evaluation									
Energy and Environmental Impact Assessment									
Integrated analysis of Geographic Information and Silt Parameters									

School Children Created A Series Of Earth Models of Irrigation Tanks at Symposium To Visualize The Silting and De-Silting Process. Munogode, Telangana

Cotton Crops Grow In A Field Near Nalgonda. Nalgonda, Telangana

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Letter of support from Joint Secretary of Rural Development,
R. Subrahmanyam

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No. L-11012/08/2014-RE-I/336994
August 7, 2014

To

Professor Don Scavia,
Director, Graham Sustainability Institute,
University of Michigan,
Ann Arbor,
Michigan, USA.

Dear Professor

This has reference to the letter sent to the Hon'ble Prime Minister of India regarding taking up evaluation study of desilting of minor irrigation ponds in the state of Telengana. This is to confirm that Government will be interested in the study and would like if the results of the study are shared for further policy improvements, if necessary.

In this connection, we would be intimating Shri Raymond Peter, Principal Secretary, Rural Development, Government of Telengana for providing suitable support for this study.

With regards,

Yours sincerely,

(R. Subrahmanyam)

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WWF
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Using: ARCmap 10.1, ESRI, 2012