Local variation in the quality of public service delivery:

A tool for targeting social audits in India

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CS-171 Final Project Process Book

Contents

Overview and Motivation:

The Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) is the largest pay-for-work program in the world: last year, it provided 2.3 billion person-days of work to 50 million households in rural India (MGNREGS website, FY 2012-2013, URL). Under MGNREGS, any rural household that requests work is legally guaranteed a job card and 100 days per year of unskilled manual labor at a minimum wage determined by the state. MGNREGS requires huge public expenditures, and spending on MGNREGS projects constitutes over 75% of the budgets of local governments (MGNREGS website, Fund Flow Statement for FY 2012-2013, URL).

MGNREGS implementation is decentralized: local governments are responsible for identifying program needs, lobbying for funds for projects, and managing all aspects of the program in the village. As a result, the quality of local management of MGNREGS varies across villages. The line department that is responsible for the program, Ministry of Rural Development, has an ongoing interest in determining the extent to which quality varies across villages, and to improve implementation in the lowest-performing villages.

My final project uses survey data from a random sample of MGNREGS beneficiaries in three districts of the state of Rajasthan to estimate and predict the quality of program management at the village-level. The primary objective of the project is to develop a tool that policymakers can use to identify priority areas for social audits. In order to communicate the results of the model to policymakers effectively, I have created a visualization that shows area-specific estimates of performance, with further details about specific villages on demand. This project builds on prior research that I have conducted on the impact of specific aspects of MGNREGS, and on the interaction of MGNREGS with local political institutions in rural India.

Related Work:

The motivation for my final project comes from previous studies that estimate quality of public service delivery in local village governments in India, including:

Besley, Timothy, Rohini Pande and Vijayendra Rao (2012). Just Rewards? Local Politics and Public Resource Allocation in South India. World Bank Economic Review 26(2): 191-216.

Niehaus, Paul and Sandip Sukhtankar (2012),"Corruption Dynamics: The Golden Goose Effect", Working Paper, Dartmouth College.

Niehaus, Paul and Sandip Sukhtankar (2012),"The Marginal Rate of Corruption in Public Programs: Evidence from India", Working Paper, Dartmouth College.

My final project is a natural extension to these studies in that it uses estimates of public service delivery to visualize spatial variation in public service delivery across local village governments. The objective of my final project differs from these studies, in that the final product is not academic (i.e. a theoretical model supported by empirical analysis), but rather policy-focused (i.e. a tool that policymakers can use to target social audits).

Key Research Questions:

- Where is MGNREGS being managed well, and where is MGNREGS being managed poorly? This visualization enables policymakers to quickly identify the villages, and clusters of villages, where the program is poorly, and to direct auditing resources appropriately.

- What specific indicators contribute to performance scores? Providing information that will allow policymakers to dissect predictions for specific areas is an important part of the visualization. For instance, one village may be assigned a low performance score by the model since a large fraction of beneficiaries report paying bribes for program benefits, while another village may be assigned a low performance score by the model since the average wait time for program benefits is very long. This details-on-demand feature of the visualization enables policymakers to focus on specifics aspects of the program in each village, which may increase the effectiveness of audits.

Data:

Geographic data
Geographic data comes from the Census of India (2001), which I obtained from the online Harvard Geospatial Library. I relied on two datasets:

- A village-level dataset that includes geographic centroids of villages (points), with the names of the block and district that each village is found in.
- District-level shapefiles

In order to generate village-level polygons, I imported the village-level dataset into ArcGIS and constructed "nearness polygons" (also "Thiessen polygons") around each village centroid. I clipped this map using the boundaries of the three study districts from the district-level shapefiles. Block boundaries were obtained from aggregating ("dissolving") the village polygons by block. Hence, village and block boundaries are not exact but depend on the Thiessen approximations, whereas district boundaries are exact.

I exported the village, block and district maps from ArcGIS as shapefiles, then converted them to GeoJSON files using this website.

Surveys of program beneficiaries
Survey data was generously provided to me by researchers at the Abdul Latif Jameel Poverty Action Lab at MIT (J-PAL). The survey was conducted in February 2010 in 250 villages that are representative of all 750 villages in the three study districts in Rajasthan. The sample consisted of approximately 40 MGNREGS beneficiaries per village, for a total of 10,088 beneficiaries.

I cleaned the survey data in STATA, which included constructing indicators of performance based on survey responses, aggregating indicators to the village level, and adding geographic identifiers so that the data could be merged with the GeoJSON files. My .do files are available upon request.

MGNREGS administrative data
MGNREGS administrative data at the village-level is available on the program's website. I used Python to scrape data for the study area from block-level tables like this one. However, researchers at the Harvard Kennedy School have recently developed a data portal that facilitates downloading data from the MGNREGS website.

I cleaned the administrative data in STATA, which included merging datasets by village (different indicators were provided in different tables), filtering the data by year, and adding geographic identifiers so that the data could be merged with the GeoJSON files. My .do files are available upon request.

Other data

Village-level data from the most recent Census of India (2011) was used in the prediction model. This data is available here.

I considered using another J-PAL dataset to construct performance indicators, which consisted of reports on visual inspections of MGNREGS worksites. However, I decided not to use this dataset since it included fewer indicators that were clearly related to the quality of local management of the program.

Exploratory Data Analysis:

Program beneficiaries

Within each sampled village, 20 households were selected at random, and two members from each household (one adult male and one adult female) were selected to participate in the survey. Since all survey respondents were familiar with MGNREGS and lived in villages with MGNREGS infrastructure projects, and since 80% of households had at least one member who had worked on a MGNREGS project, all surveyed households were identified as program beneficiaries.

Components of performance scores

The village-level performance scores were constructed from aggregating responses to the following survey questions:

1. Performance indicator: Unmet demand = Wanted to work but did not.
   Calculated from the following survey questions:

1.D.1	Did you work for NREGA in the last 12 months?	1. Yes **(Go 1.D.6)** 2. No
1.D.2	Did you want to do some NREGA work in the past 12 months?	Yes No **>> Go to next section**

2. Performance indicator: Low wages = Less than Rs 100 per day.
   Calculated from the following survey question:

1.D.3	How much money were you getting per day?	_____ Rupees

3. Performance indicator: MGNREGS ranking = 1 (worst) to 5 (best).
   Calculated from the following survey question:

1.E.1	How would you rate NREGA implementation in your village?	1. Very bad 2. Bad 3. Neither bad nor good 4. Good 5. Very Good

4. Performance indicator: Pay a bribe for benefits = Give money for job card.
   Calculated from the following survey question:

1.E.2	What do you need to do to get a job card?	1. Get registered at the Panchayat office 2. Give a family picture 3. Give money 98. Any other answer 99. Don't know

5. Performance indicator: Delay in benefits = Days wait for job.

Calculated from the following survey question:

1.E.3	How long should it take to get a job after you apply?	1. ___days 2. ___months 99. Don't know

I collapsed the dataset to the village-level to obtain village-level averages for each indicator. These values were standardized for comparability (de-meaned and divided by its standard deviation), then the average of the five standardized indicators was calculated for each village. These values were ordered from lowest to highest, and each decile received a performance score, ranging from 1 (the decile of villages with the lowest values) to 10 (the decile of villages with the highest value).

Predicting performance scores in non-surveyed villages

The survey was conducted in 250 of the 750 villages in the three study districts. In order to obtain performance scores for the 500 non-surveyed villages, I constructed a linear prediction model using administrative data from the MGNREGS website and from the Census of India. The prediction model includes the following village-level indicators for all 750 villages for the year 2009:

- Indicators from MGNREGS website
  - Number of projects in village
  - Budget allocated to village
  - Number of households employed
  - Number of person-days worked by members of all households in village
  - Fraction of person-days worked by women
  - Fraction of person-days worked by members of Scheduled Caste or Scheduled Tribe households
  - Average village wage
  - Program expenditures on labor
  - Program expenditures on materials
  - Program expenditures on administration
  - Delays in projects
  - Delays in payments

- Indicators from Census of India
  - Total population in village
  - Fraction of population that is Scheduled Caste or Scheduled Tribe
  - Literacy rate
  - Unemployment
  - Fraction of population engaged in agricultural labor
  - Fraction of population engaged in marginal labor

In order to obtain the most precise predictions from the model, I used stepwise regression to omit variables that did not provide any explanatory power (p-values > 0.2). The model was trained on data from the 250 surveyed villages, then the coefficients from the model

were used to predict performance for the 500 missing villages. The results from the linear, with the indicators that survived the stepwise regression process, are as follows:

Linear prediction model

VARIABLES	Performance Score (1 = worst, 10 = best)
MGNREGS: Number of person-days worked by members of all households in village (thousands)	0.096
	[0.056]
MGNREGS: Fraction of person-days worked by women	4.381
	[2.906]
MGNREGS: Fraction of person-days worked by members of Scheduled Caste or Scheduled Tribe households	-2.008
	[0.892]
MGNREGS: Average village wage	0.023
	[0.014]
MGNREGS: Program expenditures on labor	0.056
	[0.041]
Census: Fraction of population engaged in marginal labor	-1.744
	[1.232]
Census: Fraction of population engaged in agricultural labor	-2.765
	[1.848]
Constant	6.388
	[2.567]
Observations	247
R-squared	0.379

Notes:

1. Robust standard errors are in brackets.
2. Block fixed-effects are included in the regression

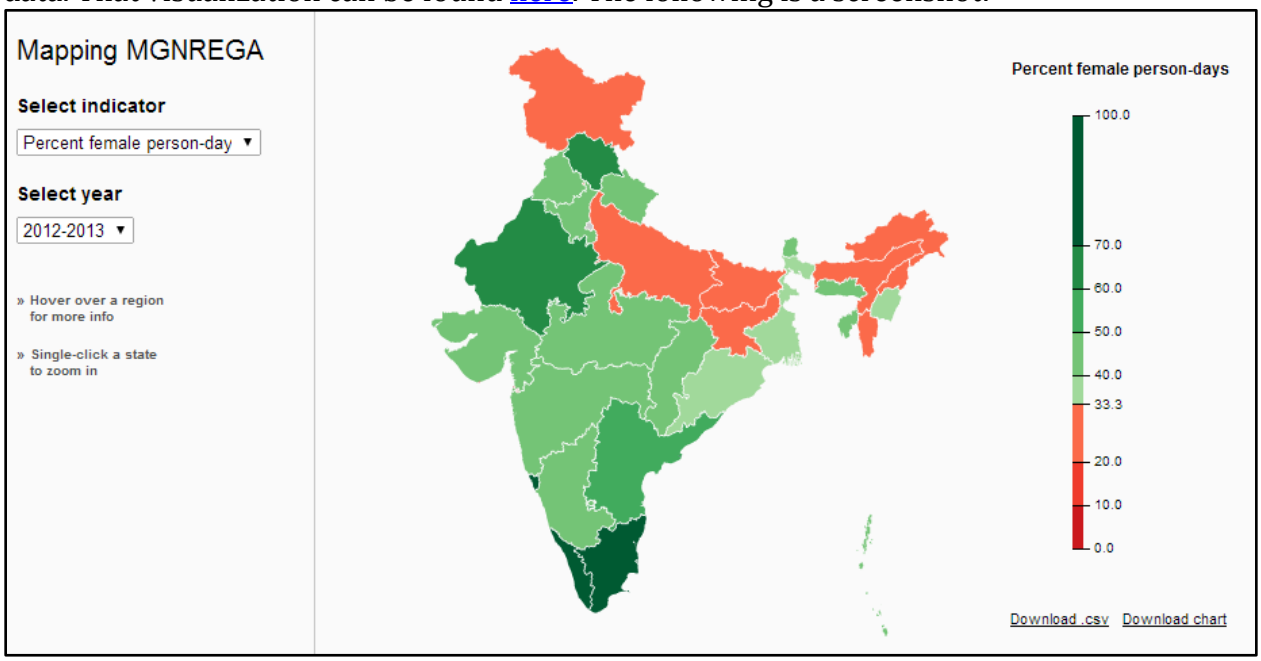
These indicators explain 37.9% of the variation in the performance score. The directions of most of the coefficients in the model are intuitive: for instance, performance scores are higher in villages that receive more benefits (person-days) or have higher average wages. Other coefficients are less intuitive: for instance, performance scores are lower in villages where more person-days are allotted to SC/ST (i.e. low caste) households, even though these households typically have higher need for program benefits.

The results of this model were applied to the 500 non-surveyed villages to obtain predicted performance scores for those villages.

Design Evolution:

Inspiration

My final project was inspired by a visualization created by Evidence for Policy Design (EPoD) at the Harvard Kennedy School, which involved mapping MGNREGS administrative data. That visualization can be found here. The following is a screenshot:

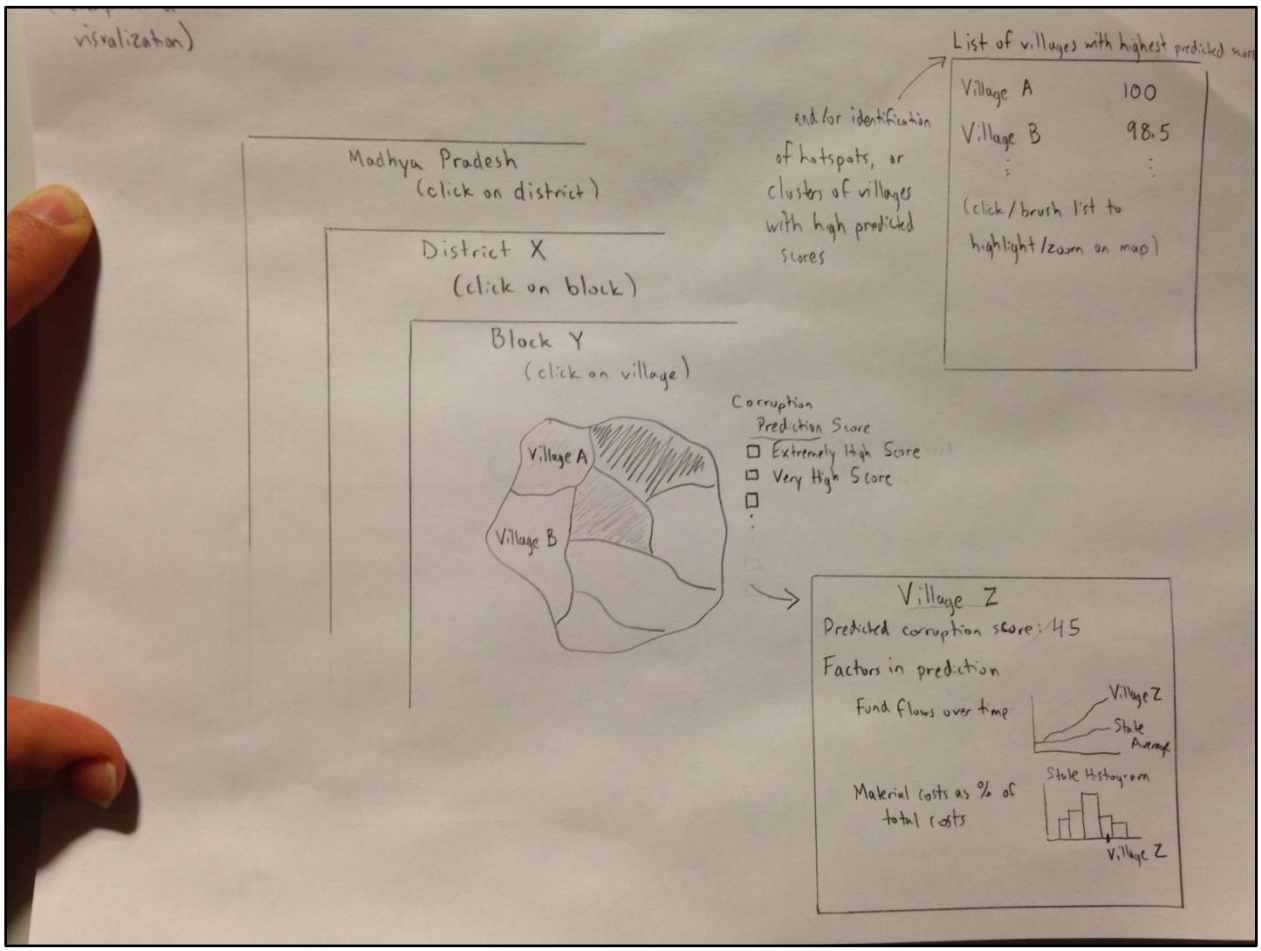


My project expands on EPoD's visualization in several ways, including the following:

1. I use a different dataset of survey responses from program beneficiaries to generate performance scores
2. I link these scores to administrative data, including the data used to create EPoD's visualization, to produce a predictive model that yields performance scores for non-surveyed villages.
3. I provide fine-grained visualizations down to the district-, block- and village-level (I created village boundaries using village geographic centroids and nearness polygons). The EPoD visualization only goes down to the district level.
4. I include village-level dashboards to provide details-on-demand of the prediction score and of key MGNREGS indicators.
5. I include a search feature if the user wants to view a specific village.

Initial proposal

My initial proposal was to visualize corruption hot-spots in MGNREGS, and called for a series of nested choropleths with a dashboard to provide details-on-demand. My sketch for this proposal was the following:



Revisions to proposal

My actual visualization was broadly similar to my initial proposal: I used data from the same program (MGNREGS) in a similar setting (another state northern India) with roughly the same objective (to create a tool for policymakers to help them identify where they should conduct social audits of the program). My actual visualization also involves a series of nested choropleths with a dashboard that provides details-on-demand.

However, I made several major revisions to my initial proposal, including:

1. Data: Initially, I intended to use data on "ghost workers" as a local estimate of corruption in the program. Ghost workers are people that exist in name only on the MGNREGS muster rolls, with their wages usually going to corrupt local officials. One study estimates that 75-80% of MGNREGS funds are lost due to over-reporting hours, and especially due to the presence of ghost workers on muster rolls (Sukhtankar 2012).

   However, I decided instead to use survey responses of program beneficiaries to construct local measurements of the quality of program management. The reason for this shift was data reliability: there was not a clearly objective and simple way to

estimate ghost worker prevalence from the data that I had, and there was no guarantee that extensive data cleaning would yield interesting findings (i.e. there may have been no variation in the estimated number of ghost workers across villages). On the other hand, the data that I received from the same researchers on beneficiary responses included several indicators with obvious linkages to the quality of program management.

This shift also led to a switch in the study region, from Madhya Pradesh (where the ghost worker data came from) to Rajasthan (where the beneficiary survey data came from).

2. Major features added to the initial proposal include:
    - Search feature: Based on feedback from the Design Studio, I included dynamic dropdown menus that enable a user to navigate directly to a specific village's dashboard of indicators.
    - Details about fine-grained performance scores visually apparent from study region overview: Based on feedback from the Design Studio, I included partially transparent village polygons in the study region view. This makes it clear to the user that more detailed information is available, and gives a more accurate view of variation in local program management. Initially I was planning on aggregating scores to the district-level, but decided not to since this would mask actual distribution of performance scores within districts.

3. Major features planned in the initial proposal but not implemented include:
    - Differentiation between performance scores from survey responses versus predictions: Since 2/3 of villages were not included in the survey sample, I initially planned on making it very clear to the user whether a village's performance score came from actual survey responses or from the prediction model. Additionally, I planned on including error bounds on performance scores for non-sample villages. However, I decided to omit this differentiation since it detracted from the clarity of the visualization, and undermined the credibility of performance scores (since 2/3 of them are from predictions and not actual survey responses). Ideally, I would have liked to figure out a way to include this information without confusing the user, but all designs I could think of would have added considerable complexity to the visualization.
    - Hot-spots feature: I initially planned on including a feature that would enable the user to identify performance "hot-spots": i.e. statistically significant clusters of villages that consistently have high or low scores. However, I realized that defining a cutoff for significance would have been an arbitrary decision (including defining cluster bandwidths and other parameters), and would have omitted clusters that may be practically significant if not statistically significant. Instead, I decided to include village-level details in the overview (via partially transparent village polygons), so that the user can visually identify hot-spots and zoom in for more information.

- Ranking of best and worst villages: Once I decided to scale the performance score (1 to 10), I decided to omit this feature since many villages scored 10 and many scored 1, without clear differentiation of villages within scores. It would have been possible to create a performance score with a wider range (e.g. 1-100), and thus differentiate more between villages, but I decided not to do this in order to keep the visualization simple.

Key decisions for final design

Key decisions that went into the final design include:

- **Core design principles**
  I tried to adhere to Ben Shneiderman's mantra: Overview first, zoom and filter, then details on demand (Shneiderman 1996). Hence the Study Region view provides a broad overview of performance in the three districts, with the ability to zoom down to the district- and block-levels, and with village-level details available in a dashboard of indicators at the lowest level.

- **Nested choropleths**
  In order to differentiate between the quality of management in different villages, I used choropleth maps with village-level, block-level, and district-level administrative boundaries. I nested these inside each other in order to make navigation more intuitive (district-block-village is the predominant hierarchy of administrative units in the Indian bureaucracy), and simpler (since it may be difficult to select a single, tiny village in the overview).

- **Navigation and context**
  I tried to simplify navigation and retain context at all levels of the visualization. I considered this to be a priority since many target users would not have detailed knowledge about the geography of the study region.

  Map navigation employs left-clicks to zoom down and right-clicks to return to the previous view. I found this way of navigating intuitive, but I included clear instructions (in the modal overlay, at the top of the webpage, and in tooltips) in case it is less intuitive for certain users. I opted for left-clicks and right-clicks rather than the more common +/- (as in Google Maps) since I wanted the ability to select and display details of specific geographic units, rather than enable global zoom.

  I included clear navigation instructions in tooltips, which are activated on mouse-overs (and in the case of the dashboard view, when the user attempts to click). I also provide context while navigating by retaining surrounding polygons and dynamically changing titles at the top of the map.

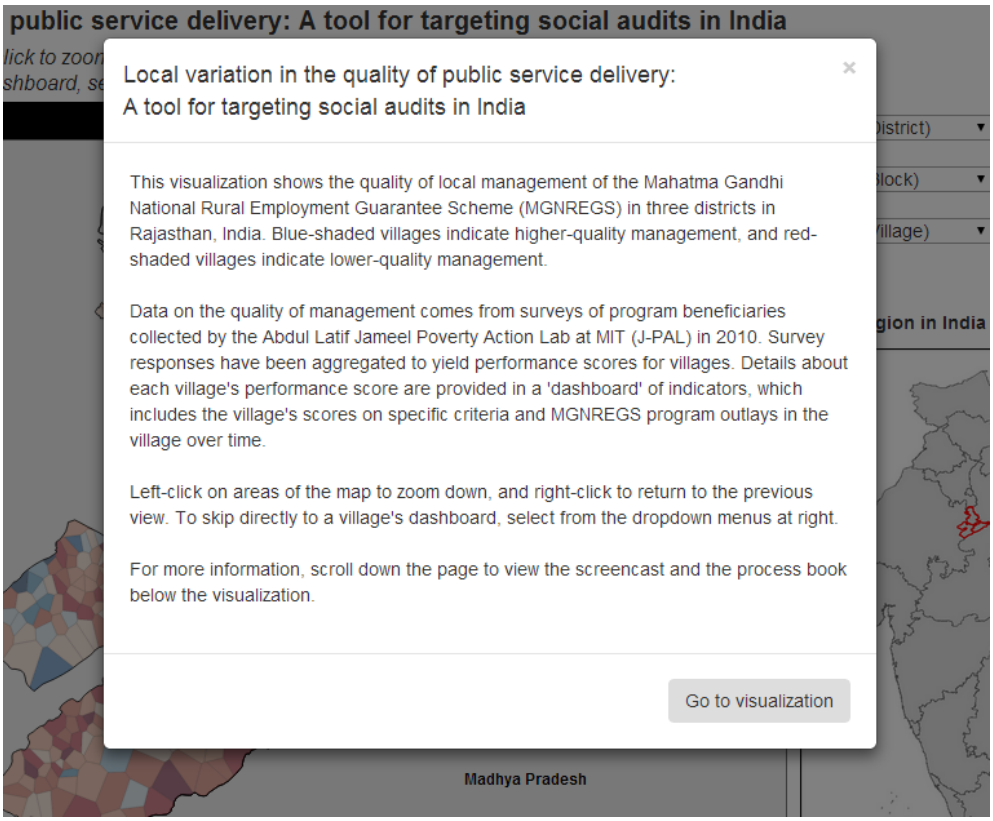
  Finally, I enable the user to bypass click-navigation by using the dynamic drop down menus at the right.

- **Color**
  I used ColorBrewer to obtain optimal colors to differentiate between performance scores in the choropleth maps. I opted for a diverging red-to-blue color range to implicitly identify villages as below-average (red) and above average (blue).

- **Graphics in the dashboard**
  I use several graphics in the village-level dashboard of indicators to visualize performance scores and key MGNREGS administrative indicators. I arranged these graphics in equally-sized quadrants with borders to improve readability. I selected appropriate chart types based on the data that I wanted to communicate: histograms for distributions, tables for lists of indicators, and line charts for time-series data. A consistent theme in all graphics is comparability between the selected village and the average village in the sample, which is a natural anchor to provide context to the selected village's performance.

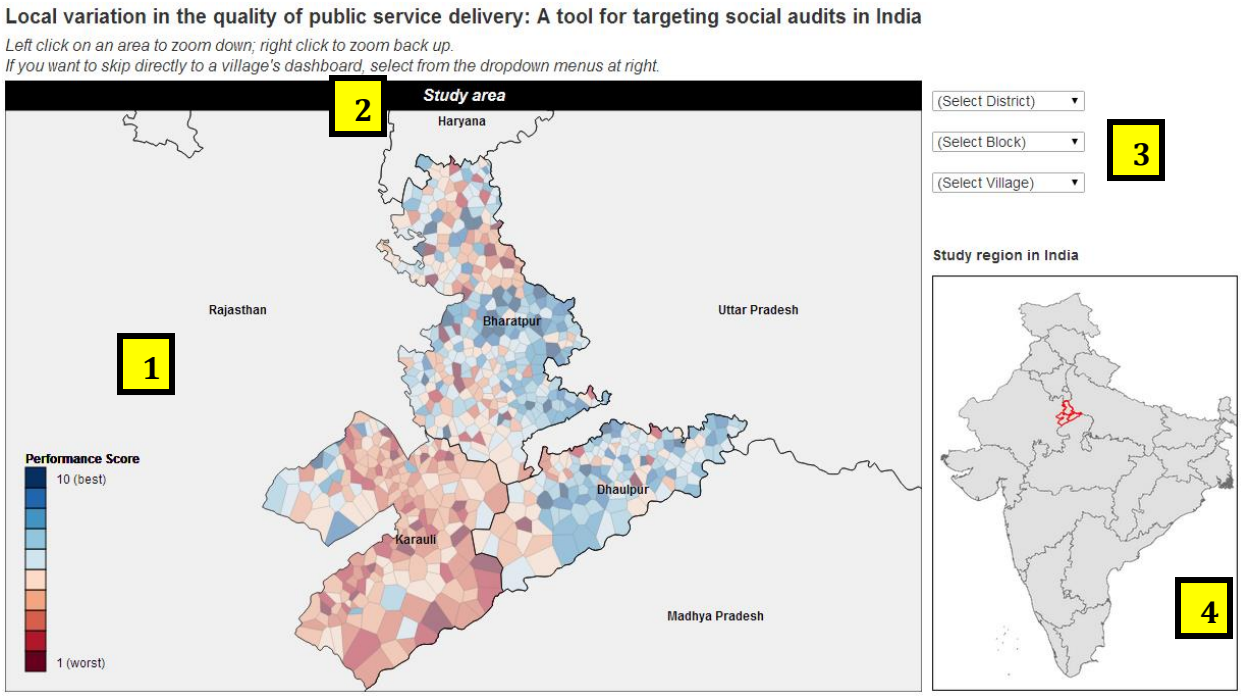
Implementation:
The visualization consists of the following main components:

Project explanation
The target user is a policymaker in the Ministry of Rural Development, who would already be familiar with the program (MGNREGS), the study region (Rajasthan), the indicators (survey questions and MGNREGS administrative data), and the objective of the visualization (to inform targeted audits). However, secondary users may be less familiar with the context, and so I provide a description of the context up-front as a modal overlay:



I also provide more information at the bottom of the page in links to the screencast and this process book.

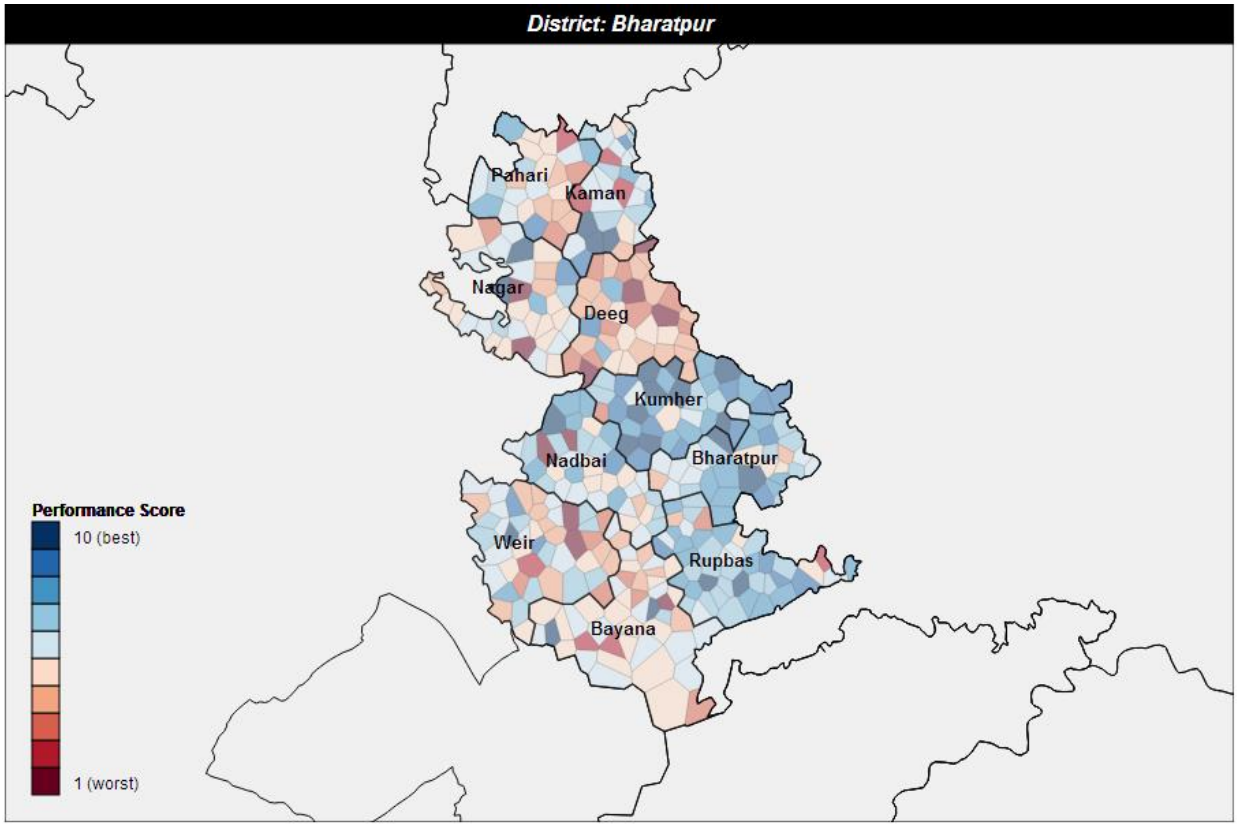
Primary view
The primary view is available after the user clicks out of the modal overlay.



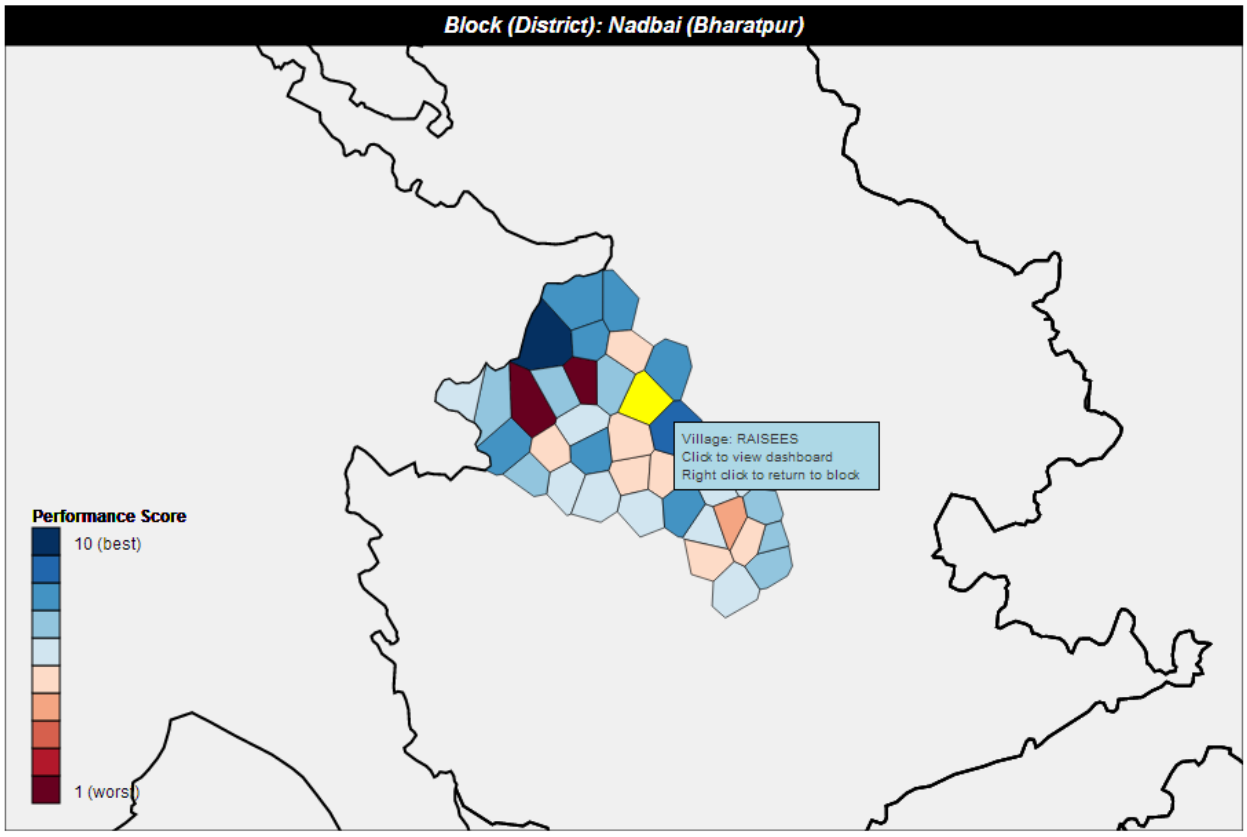
The primary view provides the overview of the study region (1), including boundaries for surrounding states to provide context. A title bar (2) features dynamically-changing titles based on the map view. The search feature enables a user to navigate to a specific village's dashboard, using dynamically-changing dropdown menus as the user selects different layers. Finally, a static image of the country with the study region outlined in red (4) is included in order to provide additional context. More information on the visualization is provided in the screencast and process book, which are available below this view.

Map views

The primary view shows the study region in the context of surrounding states. Once the user clicks on one of the three districts (which are highlighted on mouse-over), the map zooms to the selection and shows the blocks that are included in the district. The boundaries of surrounding districts and states are retained for context. For example, the following map is shown when the user clicks on Bharatpur district in the primary view:



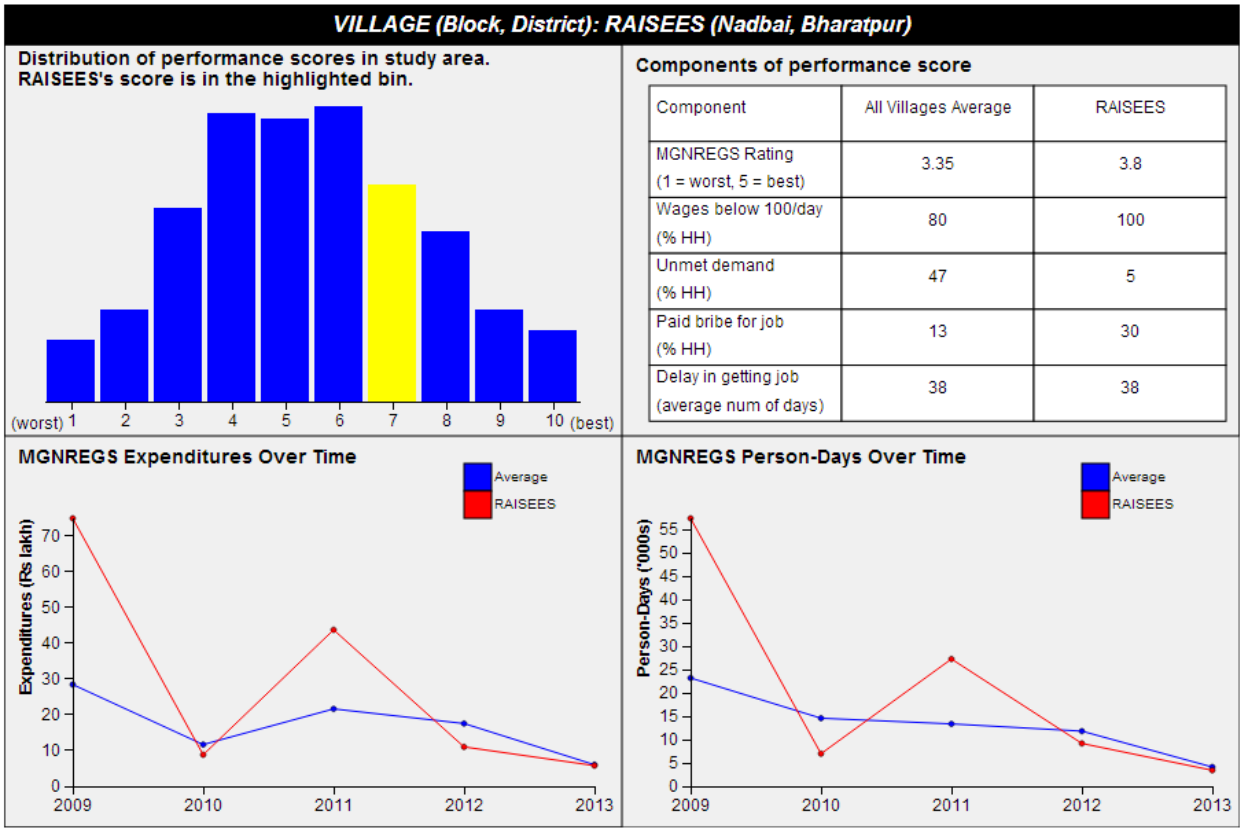
In order to highlight the selection, only village polygons within the selection remain visible. The title bar has changed to indicate that the user is now viewing Bharatpur district, and block boundaries with labels have been generated for this district. Once again, the user can click on a block (which is highlighted in yellow) to zoom in, and the boundaries of surround administrative units are retained for context. For example, the following map is shown when the user clicks on Nadbai block:



In order to highlight the selection, only village polygons within the selection remain visible. The title bar has changed to indicate that the user is now viewing Nadbai block in Bharatpur district. I opted not to show all village labels at this view in order to reduce clutter. Instead, village names are provided in tooltips when the user mouses-over a village polygon.

Dashboard

Once in the block-level view, the user can click on a specific village to view that village's dashboard of indicators. The dashboard is also available if the user navigates to a village's name using the dynamic dropdown menus at right. For example, when the user selects clicks on Raisees village in the previous image, the following visualization appears in the map window:



The dashboard of indicators provides details on the selected village's performance score (in this case, 7), as well as administrative information on MGNREGS outlays in this village. The dashboard includes the following components:

- In the top-left quadrant, I show the village's performance score in the overall distribution of performance scores using a histogram. This provides a salient way for the user to compare this village with all other villages. In the example, Raisees village has a performance score of 7; the shape of the histogram indicates that this score is substantially better than the mean score, and that far fewer villages received this score than a 6.
- In the top-right quadrant, I show a breakdown of the five components parts of the performance score: the average of the 1-5 rating given by respondents to MGNREGS program management in their village, the percent of respondents that reported being paid less than Rs 100 per day (the state-mandated minimum), the percent of households stating that they wanted to work but could not, the percent of households reporting having to pay a bribe in order to get a job, and the average delay households had to wait in order to get work. I provide the sample average for comparison. In the example, Raisees village received a higher-than-average rating and far fewer households reporting unmet demand; hence it received a better-than-average performance score of 7, in spite of the fact that more households reported receiving low wages and having to pay bribes than in the average village.

- In the bottom-left quadrant, I show MGNREGS expenditures (one of the main administrative indicators of program activity) in this village as compared with the average over time. In the example, Raisees village moved with average village expenditures, but in 2009 and 2011 had much higher-than-average spending.
- In the bottom-right quadrant, I show MGNREGS person-days (i.e. the number of days of work completed in this village under the program, and the other main administrative indicator) in this village as compared with the average over time. In the example, Raisees village moved with average village expenditures, had much higher person-days in 2009 and 2011 than the average village.

Evaluation:

Insights from the visualization

The primary insight that I got from visualizing MGNREGS performance data is that variation in the quality of management is spatially clustered. Whereas villages in Karauli district generally have low performance scores, villages in Dhaulpur generally have higher scores. Clustering in part seems to adhere block boundaries. For instance, zooming into Bharatpur district reveals that villages in Deeg block generally have low performance scores, whereas villages in Kumher block generally have high performance scores. Block-level clustering is not uniform, however; blocks such as Kaman and Weir have considerable performance heterogeneity.

Spatial clustering of performance scores suggests that audits should perhaps target regions rather than randomly-selected villages. Targeting regions would be a cost-effective way to audit many low-performing villages, and may be more likely to lead to discovery of underlying regional trends in poor management, such as low capacity at the block level or collusion among neighboring village governments.

Suggested improvements

I think that the following additions would have led to a more powerful visualization:

- Input from actual policymakers about how they view MGNREGS performance, what drives auditing decisions, and what ideal features they would want in a visualization. My measure of performance is based on my subjective valuation of what policymakers and beneficiaries care about: fund leakages, delays, etc. My visualization would have ultimately been more useful to policymakers if I started with their value function and built up from there.
- Identification of performance "hot-spots." While policymakers can visually identify clusters of high-performing and low-performing villages, I would have liked to include a statistical model with objective criteria for what determines a cluster. I think that this feature would have ensured that policymakers did not overlook certain clusters or incorrectly perceive clusters in spatial randomness.
- Wider geographic coverage of my model. I only had data on three districts in Rajasthan, but as MGNREGS is national, I would have liked to extend the model to the whole country.
- Administrative boundaries of villages. The village-boundaries in my model are artificially constructed using nearness polygons and village centroids. In order to improve the ground-truthiness of the model, I would have preferred to use actual administrative boundaries (though I'm not sure this data exists publicly).
- Even more details-on-demand. The village dashboard shows the breakdown of the performance scores and two of the main MGNREGS administrative indicators (expenditures per village and person-days per village). Given the rich availability of data on other indicators on the MGNREGS website, I would have liked to create additional dashboards that provided details on other indicators.