



महाराष्ट्र MAHARASHTRA

2022

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उप क्षेत्रीय अधिकारी  
कल्याण

AGREEMENT

24 MAR 2023

This Agreement is made and entered into as of 20<sup>th</sup> April, 2023 by and between **Settlement Commissioner and Department of Land Records, Govt. of Maharashtra** having its registered office at Pune hereinafter referred to as 'Department' which expression, unless repugnant to the context shall mean and include its successors and assigns, of the FIRST PART,

AND

**Indian Institute of Technology Bombay** (through Prof. Milind Sohoni, Computer Science & Engineering Department), a research and educational institution in science, technology and engineering disciplines, established by a special act of Parliament of Republic of India and having its office at Powai, Mumbai-400 076, India hereinafter referred to as 'IITB', which expression, unless repugnant to the context shall mean and include its successors and assigns, of the SECOND PART



WVB





AND

WHEREAS, both the above mentioned hereinafter referred to as "PARTY" individually and "PARTIES" collectively.

AND

WHEREAS, both the PARTIES are desirous of undertaking a project on 'Modernization of Land Records' which is the purpose of entering into this agreement.

**Now, both the parties hereby expressly agree to the promises and covenants mentioned hereunder –**

**1. SCOPE OF PROJECT:** The scope of the project along with deliverables and payment terms will be as given in Annexure.

**2. DECLARATION:** All work undertaken by IIT Bombay as part of the project will be in good faith and based on material / data / other relevant information given by Department requesting for the work.

**3. CONFIDENTIALITY:**

IIT BOMBAY shall not use Confidential Information, the name or the logo of SC&DLR except for the purposes of execution of this Project.

IIT BOMBAY shall not, either during the term or after expiration of this Project disclose any proprietary or confidential information of SC&DLR relating to the project, source codes or the specifications of the product without the prior written consent of SC&DLR.

**4. REPORTS:** Any report given by IIT Bombay will be based on work performed according to available standards and / or open domain literature. In any event, this report may not be construed as a legal document, certificate or endorsement and may not be used for marketing of the products or processes, without prior consent from IIT Bombay. The institute reserves the right to retain one copy of the report and use the results of the project for its internal teaching and research purposes.

**5. WORK PERFORMANCE:** Every effort will be made to complete the specified work according to the planned time schedule. However, IIT Bombay will not be held responsible for delays caused beyond its reasonable control.

**6. CONFLICT OF INTEREST:** IIT Bombay may take up work for other organisations also in the same area, provided, to the best of the institute's knowledge, there is no conflict of interest in undertaking such projects.

**7. PAYMENT:** The payment of project charges to IIT Bombay are to be made as per the schedule in the Annexure through a demand draft drawn in favour of The Registrar, IIT Bombay. The charges will also include any applicable tax as prescribed by the Government of India from time to time.





**8. TERMINATION:** The project work may be terminated by either party by giving the other party a notice period of 30 days. However, both parties will meet any residual obligations in connection with the project.

**9. LIABILITY:** IIT Bombay shall not be held liable for any loss, damage, delay or failure of performance, resulting directly or indirectly from any cause, which is beyond its reasonable control (Force Majeure). The liability of IIT Bombay under all circumstances shall be limited to the funds received for the project.

**10. INTELLECTUAL PROPERTY RIGHTS:** All rights pertaining to any intellectual property generated / created / invented in the due course of the project, will be the joint property of IIT Bombay and Department.

SC&DLR shall have a non-exclusive right to use all software which has arisen out of or in connection with the course of implementation of this project, including but not limited to all processes, products, specifications, Source codes (programs/Applications developed), reports, drawings and other documents which have been developed by IIT Bombay during the performance of services under this Project.

Notwithstanding anything mentioned above, IIT Bombay shall not be liable for any damages arising due to the fault of SC&DLR during its usage of once product delivered.

**11. RESOLUTION OF DISPUTES:** Any disputes arising out of the project shall be amicably settled by both the organisations. Any unsettled disputes may be subject to resolution as per the Indian Arbitration and Conciliation Act 1996.

IN WITNESS WHEREOF, the Parties hereto have set and subscribed their respect; hands and seal on the day, month and year first herein above mentioned.

FOR AND ON BEHALF OF

Indian Institute of Technology Bombay

सह संकायाध्यक्ष, शोध एवं विकास  
Associate Dean, Research and Development  
कृते निदेशक, आय आय टी मुंबई  
For Director, IIT Bombay

Name: Prof. Upendra Bhandarkar  
Title: Associate Dean (R&D)  
Date: 20/04/2023

IN THE PRESENCE OF

WITNESS

Name: Milind Sohoni  
Date: 20/4/2023

FOR AND ON BEHALF OF

Settlement Commissioner and Department  
of Land Records, Govt. of Maharashtra



Name:  
Title:  
Date:

IN THE PRESENCE OF

WITNESS

Name: Kamalakar S. Horekar  
Date: 20/4/23



## Annexure

1. **Project title:** Technological interventions for modernization of land records maintained by SC & DLR, Government of Maharashtra
2. **Domain and sub-area:** Reconciliation of land records and situation on the ground using GIS, high resolution imagery and computer algorithms.
3. **Estimated cost:** Rs. 69,60,000 (Plus applicable GST & taxes)
4. **Principal Investigator:** Prof. Milind Sohoni
5. **Department:** Computer Science and Engineering
6. **Institution:** Indian Institution of Technology Bombay
7. **CoPIs name (with Dept):** --
8. **Partner Agencies** (for joint projects, if any, describe briefly): SC & DLR, Government of Maharashtra
9. **Project summary**

The Settlement Commissioner and Department of Land Records (SC & DLR), Government of Maharashtra are modernizing land records management, as per Digital India Land Records Modernization Program (DILRMP), Government of India [1]. Land records are organized village wise. Some forms of land records bear legal standing, e.g. tippans, bandobast, RoR whereas other forms are used to locate a specific land parcel on ground. Different forms of land records can be classified as follows:

A. Textual form with legal recognition, e.g. RoR record

B. Geometric form with legal recognition, e.g. Survey number maps, tippan, bandobast

C. Maps such as survey number map, MRSAC cadastres, etc.

During survey and settlement, survey number maps were created by triangulation on the ground. Tippans were derived from survey number maps. Survey number maps, therefore, have greater accuracy and legal importance. Though the textual Record of Rights (RoRs) have been computerized, the cadastral maps and survey number maps are still to be digitized completely and georeferenced. The legacy cadastral maps are of various kinds and are in the process of getting scanned and digitized. However, there is always a difference between the digitized map and the situation on the ground. The actual land occupancy / possession within a village is captured using satellite, known as high resolution satellite image (HRSI), or drone. Georeferenced vector maps identifying land occupancy as polygons are generated from these images. This is a manual step in the current workflow and the generated map is called possession boundaries. The possession boundary map forms an area partition of the village it



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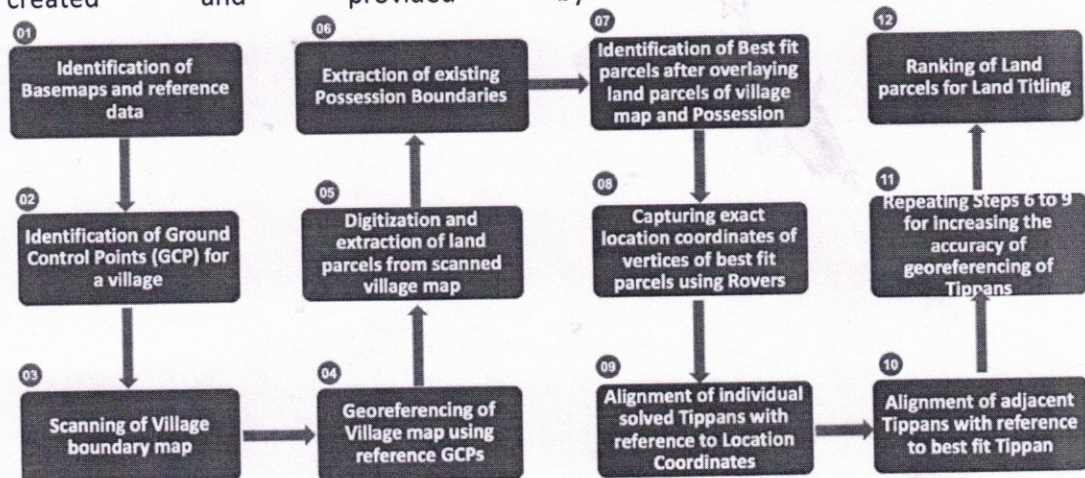
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represents. The modernization problem is to reconcile all the three forms of land records and the occupancy on ground so as to make them consistent. All the three forms as well as possession boundaries are considered adjustable in the process.

The challenge is (i) to design metrics at land parcel as well as village level to quantify the mismatch between possession boundaries and legal land entitlement on record, and (ii) to prepare a geo-referenced digital village map wherein the mismatch is minimized. Quantification of mismatch needs to be followed up with a strategy to rectify either the possession on ground or the entitlement on record. An added complication is the lack of availability of records in digital form. For example, tippan shapefiles are typically available for only some of all land parcels within a village.

The modernization methodology adopted by DLR is founded on decades of experience with paper based land records and their implementation in villages. Several key artifacts such as village maps are generated manually by visual inspection or using tools such as AutoCAD. The process is summarized by the following diagram as created and provided by the DLR team.



The boxes labeled 05, 06, 07, 10 in the above diagram are performed manually, with visual inspection. In addition, the data sets maintained by DLR are scattered across different storage devices and computers. A data repository that provides a consistent view of the state of the art across Maharashtra to all stakeholders within DLR is therefore desirable. The present state of data storage offers no easy way to obtain data for specific villages within a district. The land parcels of village map referred to in Box 07 may undergo subdivisions. In fact, subdivisions and mergers can take place at any time.

Note from DLR: The box 02 requires a sufficient number of ground control points (GCP) to be collected. Geo-referencing of village maps is done using the GCPs that match trijunction, bi-junction, on field and on survey maps / FMBs and also naturally identifiable features on the ground. The department has formulated an SOP for collection of GCPs, it should be adhered to in step 1.b below.





IIT Bombay offers the expertise to build sound, consistent, flexible automation into DLR workflow. For example, Box 07 in the diagram can be automated using the "jitter fit" [2] algorithm that transforms tippans to best-fit a possession boundary. Box 05 can be automated with "cadastral simplification" [3] algorithm. Box 06 can be automated using segmented satellite images provided as "Google Anthrokrishi farm plots" and processing them with voronoi polygon construction [4] algorithm. Using modern open source tools such as PostgreSQL, PostGIS, the data sets presently scattered across storage devices can be organized into an IT stack with efficient and consistent access across DLR. Engagement with IIT Bombay may include not only software creation but also field work to formulate the problem and validate the solution.

Objectives of the proposed project can be summarized as:

1. Minimize manual work in the DLR modernization workflow so as to make it more consistent, flexible, provable and efficient. We expect to reduce manual intervention by 50%. E.g. automated fitting of tippans within a village should be satisfactorily done for at least 50% of the tippans.
2. Reform the workflow adopted by DLR into a solution that meets competing demands.

We propose to start the engagement in four phases, spanning 3 months each. The methodology adopted in each phase is outlined below. Collaboration from DLR is expected in the form of code reviews, feedback on user interface and output, data gathering and conversion into specific formats as needed by our software, and assistance with field validation of generated output. A set of 15 villages will be used as pilot villages to assess the software in initial phases. Subsequently, a strategy for broader application / scale up of the automated workflow will be developed. The DLR can exercise the automated workflow as per their scale-up and deployment strategy with support from IIT Bombay. The project methodology can be summarized as follows.

#### 1. Preparatory steps

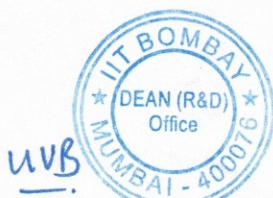
- a. Identify 15 pilot villages, identify a subset for field visits.
- b. Collection of GCP and required datasets from pilot villages to be done by DLR team.
- c. Create data repository containing existing datasets on pilot villages
- d. Pair with the DLR team to understand the existing workflow.
- e. Georeferencing of Village maps using satellite images and/or collected GCPs to be done by IIT team before using the village map data in the proposed algorithms.
- f. Georeferenced Village maps should be submitted by IIT team to Department for QC.
- g. QC of the Georeferenced village maps will be done by the Department officials at 1:1000 scale.



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1. Phase 1:
  - a. Alpha release: automate key areas in current modernization workflow
    - I. Software to create georeferenced survey plots from paper based survey number maps/Gut maps.
    - II. The above process will be tried for georeferencing of Tippians with reference to village survey map using GCPs through automated mosaicing and creation of seamless tippians map.
    - III. Software to automatically generate possession boundaries from Google farm plots with MRSAC cadastres as reference.
    - IV. Software to compare legal land records with possession boundaries. The possession boundaries can either be manually generated by DLR or software generated from Google farm plots.
    - V. Software will also contain the automatic ranking of the polygons based on the parameters defined in the ranking.
    - VI. The software should allow correlation of land records based on some common identity eg. all subdivided parts of a survey polygon from a subdivision map should automatically correlate to the survey polygon from a larger map using survey number as alphanumeric attribute.
  - b. Involve the DLR software team early on, in reviewing the code, user interface and signing off the output.
  - c. Formulate metrics to capture mismatch with textual land records, i.e. RoR. E.g. total area of village as sum of RoR vs total area occupied by polygons in possession boundary map.
  - d. Visit pilot villages, at least 3, to:
    - I. validate the software output produced in item (a)
    - II. understand the process of land measurement, subdivision and identification of land parcels on ground
    - III. understand land measurement tools used and data sets maintained at village level
2. Phase 2:
  - a. Beta release:
    - i. Incorporate feedback from the field.
    - ii. Triage bugs and release beta versions of software created in phase 1.
    - iii. Field validation of output produced by the beta release.
  - b. During the 1st Phase, DLR officials and surveyors & IT-GIS cell of Department of Land Records will be involved in understanding, checking the intermediate results for 15 villages. Post 1st Phase, IIT will impart training to DLR officials who will take forward the project for roll out. These training sessions will be organized by office of SC&DLR.



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- c. Scale up strategy:
  - i. Performance evaluation of beta release using industry standard software profiling tools. The 15 pilot villages are sufficient for this exercise.
  - ii. Identify bottlenecks and assess the feasibility for scale up.
3. Phase 3:
  - a. Scale up to one taluka (version 1.0):
    - i. Release version 1.0 of the software by addressing performance issues identified so far.
    - ii. Software team from DLR to populate the database with village wise data from one taluka and run version 1.0 with the assistance of IITB. Farm segmentation data for scale up is to be procured by SC&DLR from Google or its vendors.
    - iii. Create scripts to automate the data loading process as needed.
  - b. Field validation: identify a few villages from the taluka and validate the output by visiting farm plots on the ground.
4. Phase 4:
  - a. Incorporate feedback from the field.
  - b. Scale up: all 6+ districts where digitization of land records is complete.
  - c. Field validation driven by DLR field team.
  - d. Support DLR software team with deployment: issues with data loading / running the software.

Parts of phases 3 and 4 which relate to the scale-up and deployment will be driven by DLR team, with support from IIT Bombay as and when needed.

**10. Keywords:** land records, survey maps, tippans, bandobast, parcels, RoR.

**11. Expected Research Impact**(in terms of publications, sustainability, policy inputs, and potential benefit to society): The work will require development of geometric algorithms which may be reported in research journals. The software produced will be available in public domain for use elsewhere in the country.

## **12. Outcomes and Deliverables:**

- a. Phase 1:
  - i. Report on existing modernization workflow at DLR. The workflow should be described in detail.





- ii. Alpha release of software items outlined previously in the form of a version tag in source repository.
  - iii. Comparison of land records (metrics) generated by alpha release for 15 pilot villages.
- b. Phase 2:
  - i. Beta release of software items outlined previously.
  - ii. Output of beta release for 15 pilot villages.
  - iii. Report on metrics of goodness, overall strategy. Key algorithms and the new workflows. Expected outcomes in terms of goodness.
- c. Phase 3:
  - i. Version 1.0 of software items outlined previously and hand-over to DLR IT team.
  - ii. Support to DLR to execute version 1.0 on a limited set of talukas or a district.
  - iii. Report on strategy to scale up the land records modernization workflow.
- d. Phase 4:
  - i. Comparison of land records from all villages in several districts.
  - ii. Bug fixes to software released previously.

**13. Collaborations and MoUs :** Google Research / partners, for farm plots.

**14. Academic Provisions:**

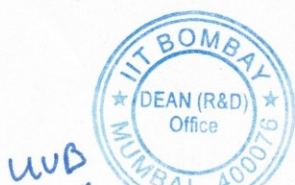
- a. **UG, PG and PhD students to be trained** (numbers to be mentioned): 2 UG / PG students
- b. **Student Dissertations, thesis:** If they arise.

**15. Work plan** (See Item (12)):

**16. Project Risks:**

a. Land records department is having all types of maps to be undertaken under this project, however the conversion of paper maps to digital form is in progress. The village maps may have to be re-georeferenced and will have to be done as a parallel activity. Few maps that are very fragile – torn and not suitable for scanning will have to be reproduced or alternative maps are to be used. Timely availability of georeferenced maps is a challenge and poses a significant risk that could delay project execution.

b. Google has provided farm plots for some villages along with written consent. The terms of use are added in Appendix. Obtaining additional farm plots for more villages needs an MoU between GoM and Google Research. Until an MoU comes into being,



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we will continue with the existing arrangement of requesting farm plots data for specific villages to Google Research as needed.

c. The algorithms used to create the software proposed here rely on accuracy of Google farm plots. If they are not found accurate enough, e.g. due to hilly terrain of forest cover, the algorithms need to be adapted.

d. The project depends on data being procured and collated by SC&DLR from its divisional offices and validated and put into a common format. Student resources form an integral component of the project and help bring costs down. Both these have a bearing on the schedule.

## **17. Data and Security**

### **17.1 Information security**

- IIT BOMBAY shall comply with "Computer Security Guidelines-2006" formulated by Government of India, Intelligence Bureau to be followed by all Government organizations.
- During the application development, e-governance standards and security practices (<http://egovstandards.gov.in/>) must be followed.
- IIT Mumbai shall not carry any written / printed document, layout diagrams, floppy diskettes, hard disk, storage tapes, other storage devices or any other goods / material proprietary to SC&DLR into / out of any offices of SC&DLR premises without written permission from SC&DLR.
- IIT BOMBAY acknowledges that SC&DLR's data and other SC&DLR proprietary information or materials, whether developed by SC&DLR or being used by SC&DLR to a license agreement with a third party (the foregoing collectively referred to herein as "proprietary information", marked or identified as Confidential Information/ Proprietary Information) are confidential and proprietary to SC&DLR; and the IIT BOMBAY agrees to use reasonable care to safeguard the proprietary information and to prevent the unauthorized use or disclosure thereof, which care shall not be less than that used by IIT BOMBAY to protect its own proprietary information and good industry practice. IIT BOMBAY recognizes that the goodwill of SC&DLR depends, among other things, upon IIT BOMBAY keeping such proprietary information confidential and that unauthorized disclosure of the same by IIT BOMBAY could damage the goodwill of SC&DLR, and that by reason of IIT BOMBAY duties hereunder. IIT BOMBAY may come into possession of such proprietary information, even though IIT BOMBAY does not take any direct part of or furnish the services performed for the creation of said proprietary information and shall limit access thereof to employees with a need to such access to perform the services required by this





agreement. IIT BOMBAY shall use such information only for the purpose of performing the said services.

### 17.2 Ownership and Retention of Documents

Forth with upon expiry or earlier termination of this project, on demand by SC&DLR, IIT BOMBAY shall deliver to SC&DLR all Documents provided by or originating from SC&DLR and all Documents produced by or from or for IIT BOMBAY in the course of performing the Services, unless otherwise directed in writing by the SC&DLR at no additional cost. IIT BOMBAY shall not, without the prior written consent of SC&DLR store, copy, distribute or retain any such Documents. IIT Mumbai can use the documents for research or academic purposes.

### 17.3 Data

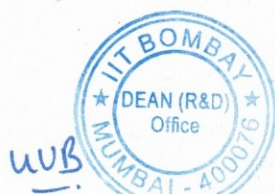
- By virtue of this Project, IIT BOMBAY may have access to personal information of SC&DLR and/or the citizen of the state. SC&DLR has the sole ownership of and the right to use, all such data in perpetuity including any data or other information pertaining to the residents that may be in the possession of IIT BOMBAY or IIT BOMBAY' Team in the course or performing the Services under this Agreement.
- IIT Mumbai has to submit an undertaking that the data used during the project will not be shared with anyone and used for any purposes other than research or academic purposes and that the agency will delete all the files received from the department during the execution of the project.

### 17.4 Representations and Warranties

- That IIT BOMBAY shall ensure that all assets/components including but not limited to equipment, software, licenses, processes, documents, etc. installed, developed, procured, deployed and created during the term of this Agreement are duly maintained and suitably updated, upgraded, replaced with regard to contemporary requirements.
- That IIT BOMBAY shall procure all the necessary permissions and adequate approvals and licenses for use of various software and any copyrighted process/product.

### 18. Project Timeline:

	Milestones/ Activities	Q1	Q2	Q3	Q4
1	Report on current workflow	X			
2	Field work	X	X		



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3	Alpha release	X			
4	Beta release		X		
5	Version 1.0			X	
6	Feedback from field validation	X	X	X	X
7	Incorporate textual records in validation	X			
8	Taluka level scale up			X	
9	District level scale up				X
10	Define new deliverables (if needed)	X	X		
11	Support for deployment			X	X

**19. Budget estimates:**

S.no.	Item	Amount (Rs.)
	2 students @50k per month X 12	12,00,000
	2 junior research fellows @100k per month X 12	24,00,000
	1 senior software consultant @200k per month X 4 (33%)	8,00,000
	1 faculty @50k per month X 12	6,00,000
	Consumables	1,50,000
	Travel	3,00,000
	Contingencies (Maximum 10% of the sum of above items)	3,00,000
	Overheads (20% of non-faculty fees + 30% of faculty-fees)	10,30,000 + 1,80,000
	<b>Total project cost</b>	<b>69,60,000*</b>

\* Plus applicable GST and taxes

The budget estimates above are indicative. The actual expenditure, and its heads, and schedule of expenses may change time to time as per project requirements subject to the overall limit of total project cost of Rs. 69,60,000/- (Plus applicable GST and taxes)

**20. Schedule of Delivery and Payments:**

The payments will be made against deliverables organized in phases. The schedule is indicative. The deliverables in phases 3 and 4 may change based on feedback from phases 1 and 2.





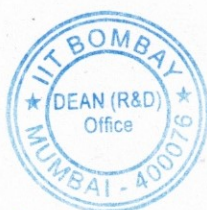
	Deliverables	After Project Start	Amount
Phase 0	Project start.	0 months	Rs. 21,60,000/-
Phase 1	<ul style="list-style-type: none"> <li>Report on current workflow</li> <li>Alpha release as a tag in GitLab repository</li> <li>Output for 15 pilot villages and way ahead</li> </ul>	3 months	Rs. 12 lakhs
Phase 2	<ul style="list-style-type: none"> <li>Beta release as a tag in GitLab repository</li> <li>Revised output for 15 pilot villages</li> <li>Report on scale up strategy</li> </ul>	6 months	Rs. 12 lakhs
Phase 3	<ul style="list-style-type: none"> <li>Release version 1.0</li> <li>Support DLR to generate output for 1 taluka</li> </ul>	9 months	Rs. 12 lakhs
Phase 4	<ul style="list-style-type: none"> <li>Continuous support for scale up to a district or more</li> <li>Release version 1.1</li> </ul>	12 months	Rs. 12 lakhs

[1] Land record modernization programme, Government of India

[2] Automatic fitting of tippans for Barhanpur village

[3] Georeference out of scale village survey number map and fit it to MRSAC cadastres

[4] Possession boundaries generation using voronoi polygons and fitting them with MRSAC cadastres using topological transformation

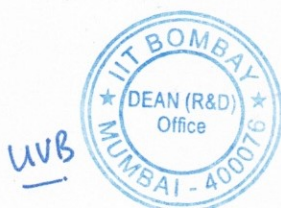




## ■ Appendix

Terms of use of farm plots data obtained from Google Research, as per the email from Dinesh Tiwari dated 16 Feb 2023:

- a) IP rights that are part of the MSRA govern the data shared.
- b) You can use the output of Google's model in a one time study for the purpose of exploring the efficacy of the model in downstream use cases of delineating the farm boundaries and compare it with other existing options.
- c) This study can be presented to an audience composed of the members for Govt of Maharashtra.
- d) While presenting the study, please do ensure:
  - 1. that prior approval is sought from Google on the same
  - 2. Proper attribution is given to Google on the models on which we have proprietary rights
- e) No commercial exploitation of study of output model should be done nor should it be combined with study of another company
- f) the study/ presentation should no way exploit the output model i.e intent should be only to take feedback on the output models.



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