Water Accounting Framework - Version 1
Database Formulation

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A Postgres database has been created as a pilot representation for implementation of water balance. This document describes the overall structural framework of the database along with functional requirements and queries. The schema and fields used for water balance computation are illustrated here and this document is referable as a guidance while actual implementation of water balance component in the MLP app.

The outcome of this exercise is -

1. Database compilation and sample schema design
2. Identifying data issues
3. Output Tables - Village water balance chart and zone level water balance actual state

1. Database Formulation

The overall process flow is as follows -

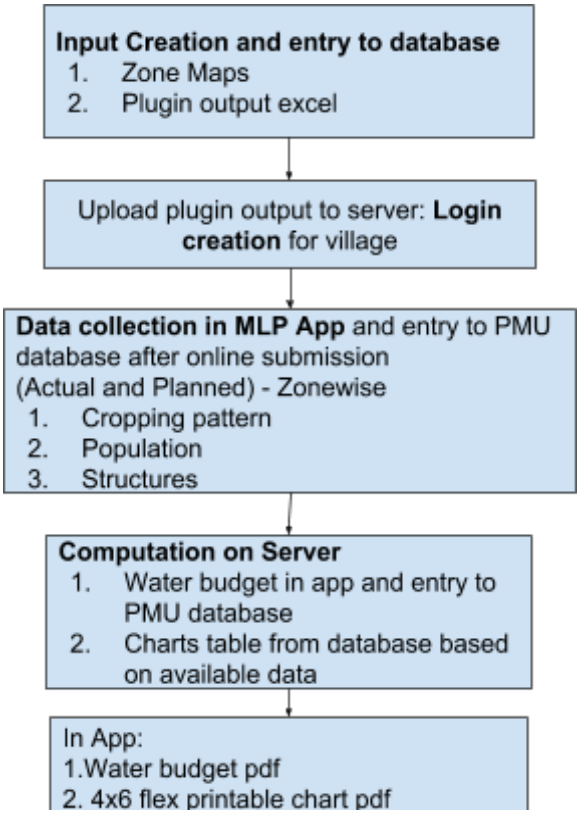


Fig 1: Process flow

The input database is created at PMU before beginning the microplanning process. This input database is uploaded on server to create login credentials for village and conveyed to field team. After this the field process starts on MLP app. The data from field is obtained from MLP app after submission to the server. Once the data is submitted water budget is generated on server and made available as a 'pdf' file on MLP app.

1.1 Pilot Implementation for Village Charts

Pilot implementation in Postgress was to be done for 106 phase I villages to generate village charts attribute table for year 2018. This was to be done on existing dataset already submitted by the field team. For this purpose the existing MLP dataset was downloaded from salesforce server and loaded into Postgress. Since, there were multiple issues in existing data, as a one time process following steps were taken and based on issues faced solutions are proposed for future implementation.

Steps for Pilot Implementation -

1. Run QGIS plugin for last 6 years (2013-2018) for all 106 villages and load into Postgress year-wise tables
2. Keep printable zone maps for 106 villages ready
3. Get MLP database from salesforce and load into Postgress
4. Finding data issues and Data Cleaning for one time (to be taken care of and automated in future)
5. Reporting issues in data to PMU for correction
6. Building queries for chart table generation - village-wise year-wise for last 6 years
7. Validation of queries

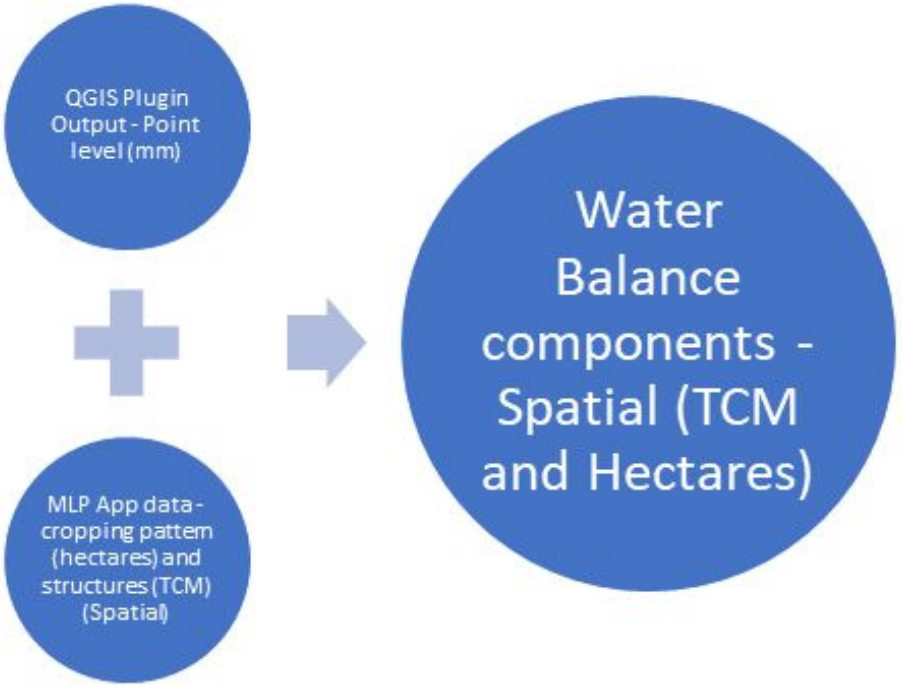


Fig 2: Data source and usage

The output of this exercise is queries to generate table for village charts, water balance-actual state for last 6 years and MLP data issues from plugin and MLP water balance data loaded into database. The tables in database their data source, generation timeline and their use as input or output is illustrated in Table 1.

Table 1: Database Tables

Sr. no	**Data Table**	**Data source**	**Generated/ Timeline**	**Input/output**
1	Zonal water balance (for last 6 years 2013 – 2018) for the villages in the project area	QGIS plugin output	Before microplanning	Input - in Postgres from plugin
2	Village zone map in pdf/jpeg format at 300 dpi resolution	PoCRA PMU	Before microplanning	Input - On cloud/drive from PMU
3	Current zone wise cropping pattern data	Water Budget data - MLP app	After water budget data submission in the MLP app during microplanning.	Input - required to be stored in Postgres from MLP app as per given schema
3	Proposed zone wise cropping pattern data			
4	Current zone wise soil and water conservation structures data			
5	Proposed zone wise soil and water conservation structures data			
6	Population data			
7	Zone level water balance	Query in Postgres	After Microplanning	Output - generated in Postgres on request (from input no. 1 and 2)
8	Village charts water balance data	Query in Postgres	After Microplanning	Output - generated in Postgres on

				request (from input no. 1 and 2)

Along with this, there are other supporting datasets (Master tables) included in the database. Table 2 lists all data tables in the database along with their data source, primary key attributes and fixed or variable data. The Master lists such as village list, crop list, structure list is fixed. The Data from Plugin is uploaded continuously from PMU side while the MLP database should also keep updating continuously depending on the microplanning schedule.

Table 2: Database and Primary key

Sr.no.	**Data Table Name**	**Data Source**	**Fixed/Variable data**	**Primary key attributes**	**Generation sequence**
1	master_village_list	PMU	Fixed	census_code	I
2	master_crop_list	IITB-PMU	Fixed	crop_id, crop_name_in_english	I
3	master_structure_list	IITB-PMU	Fixed	Structure_id, structure_name_english	I
4	rainfall_data_updated	IITB-PMU	Fixed-Variable (appended yearly)	district_name, taluka_name, circle_name_maharain, year	I
5	kharif_model_zonewise_budget_2013	Plugin	Variable (will get appended)	Census_code, zone_number, crops_in_english	II
6	kharif_model_zonewise_budget_2014	Plugin	Variable (will get appended)	Census_code, zone_number, crops_in_english	II
7	kharif_model_zonewise_budget_2015	Plugin	Variable (will get appended)	Census_code, zone_number, crops_in_english	II
8	kharif_model_zonewise_budget_2016	Plugin	Variable (will get	Census_code, zone_number,	II

			appended)	crops_in_english	
9	kharif_model_zonewise_budget_2017	Plugin	Variable (will get appended)	Census_code, zone_number, crops_in_english	II
10	kharif_model_zonewise_budget_2018	Plugin	Variable (will get appended)	Census_code, zone_number, crops_in_english	II
11	mlp_input_crop_data	MLP_App	Variable (will get appended)	census_code, zone_number,status, crop_id	III
12	mlp_input_population_data	MLP_App	Variable (will get appended)	census_code	III
13	mlp_structure_data	MLP_App	Variable (will get appended)	Census_code,zone_number,status,structure_id	III
14	water_balance_zone_level	Postgress query	Variable (will get appended)	census_code,water_balance_year,zone_number,date_created	IV
15	master_ouput_attributes_chart	Postgress query	Variable (will get appended)	census_code,chart_year,date_created	V

Appendix II provides the details of the schema for each table along with existing fields in current salesforce implementation and newly added or expected in future implementation.

The main outputs from this database are -

1. Water balance - zone level for actual state (for all years 2013 - 2018) table named ‘water_balance_zone_level’
2. Water Balance Charts attributes - Village level (for all years (2013 - 2018) table named ‘master_ouput_attributes_chart’
3. Issues in MLP data - Village level named ‘village_data_issues_all’ for 459 villages whose data was downloaded from server

Queries have been implemented for this and current level of functionalities and issues are given in next section.

2 Data Issues and Cleaning

The dataset was validated while implementing in Postgres and following summary table provides a glimpse of issues in the current database. The steps taken to resolve this and probable solution for MLP is also given in the Table 3.

Table 3 Database Issues

Sr. no	Issue	Number of villages	Step taken	Probable solution
1	Null census code	12	Deleted from 'master_village_table'	Will add later once data is available from PMU
2	Duplicate population data for village	3	Deleted the null entries	Single entry should be allowed (previous should be updated instead of new entry) in app on resubmission of data
3	Duplicate crop entries in MLP crop data	400	Considered each entry separately after validating that cropping pattern and non-ag land summed up to village area	Single entry per crop should be allowed to maintain 'unique entries'
4	Duplicate structures data	65	Eg - multiple CNB entry with same or different capacity. Considered each entry separately. Primary key was not set for this table.	Additional field or appropriate naming (like CNB1, CNB2) for structures will be required to set primary key for this field.

2.1 Database Issues and Cases

1)**Absence of census code in master village list obtained from PMU**

Identified through:-

```
select *
from master_village_list
where census_code is null;
```

Results:-

Table 4**:** Cases with null census code

	village_name character varying(100)	census_code integer	village_name_marathi character varying(100)	district_code numeric	district_name character varying(100)	taluka_name character varying(100)	cluster_code character varying(100)	chart_status integer
1	Khanapur		रीक्त	501	akola			1
2	Chandrapur		रीक्त	503	amravati			1
3	Aki		रीक्त	501	akola			1
4	Akot		रीक्त	501	akola			1
5	Dewarda		रीक्त	501	akola			1
6	Kaulkhed Gumase		रीक्त	501	akola			1
7	Isapur		रीक्त	500	Buldana			1
8	Paturda Bk		रीक्त	500	Buldana			1
9	Pimpri Wanerkhed		रीक्त	500	Buldana			1
10	Daryapur Banosa (MCI)		रीक्त	503	amravati			1
11	Jasapur		रीक्त	503	amravati			1
12	Kinholi		रीक्त	503	amravati			1

Remaining after updating census_code from village shapefile:-

Table 5: Null census code cases after data updation from village shape file

	village_name character varying(100)	census_code integer	village_name_marathi character varying(100)	district_code numeric	district_name character varying(100)	taluka_name character varying(100)	cluster_code character varying(100)	chart_status integer
1	Aki		रीक्त	501	akola			1
2	Akot		रीक्त	501	akola			1
3	Kaulkhed Gumase		रीक्त	501	akola			1
4	Paturda Bk		रीक्त	500	Buldana			1
5	Pimpri Wanerkhed		रीक्त	500	Buldana			1
6	Jasapur		रीक्त	503	amravati			1
7	Kinholi		रीक्त	503	amravati			1

Solution:-

Manually added to the database from village shapefile. Currently the null entries have been deleted to set primary key. These need to be made available while implementation of new MLP app.

2. Repeated Entries in Master Village List:-

Table 6: Repeated entries in village list

	village_name character varying(100)	census_code integer	village_name_marathi character varying(100)	district_code numeric	district_name character varying(100)	taluka_name character varying(100)	cluster_code character varying(100)	chart_status integer	census_code integer
1	Khanapur	530001	रीक्त	501	akola	Akola	501_pt-18_03	1	530001
2	Khanapur	530001	खानापुर	501	akola	AKOLA	501_pt-18_03	1	530001
3	Chandrapur	532963	रीक्त	503	amravati	Daryapur	503_ptcs-2_01	1	532963
4	Chandrapur	532963	चंद्रपूर	503	amravati	Daryapur	503_ptcs-2_01	1	532963
5	Daryapur Banosa (MCI)	532294	रीक्त	503	amravati	Morshi	503_wrc-1_02	1	532294
6	Daryapur	532294	दर्यापूर	503	amravati	Morshi	503_wrc-1_02	1	532294
7	Isapur	528476	रीक्त	500	Buldana	Nandura	500_ptg-1_02	1	528476
8	Isapur	528476	रीक्त	500	buldana	Nandura	500_ptg-1_02	1	528476
9	Dewarda	529845	रीक्त	501	akola	Akot	501_pt-5_03	1	529845
10	Dewarda	529845	देवर्डा	501	akola	AKOT	501_pt-5_03	1	529845

The repeated entries were removed.

2)The absence of zone_number in plugin output for some villages

Identified through:-

```
select distinct(census_code),village_name,split_part(zone_number,'-',3)
from kharif_model_zonewise_budget_2017
order by  split_part(zone_number,'-',3)
```

Results(Top 2):-

Table 7: Absence of zone number inj plugin output

	census_code numeric	village_name character varying(100)	split_part text
1	530967	Isafpur	
2	530986	Wai Pr.Karanja	
3	548125	Naigaon P. Sevli	1
4	560820	Tadmugli	1
5	530046	Akhatwada	1
6	530029	Kasali Bk	1
7	530035	Apoti Kh	1
8	548851	Zalta	1

Solution:-
Rerun the plugin by correcting zone shapefiles.

3)Duplicates in mlp_input_crop_data

Identified Through:-
select census_code,zone_number,status,crop_id,count(*)
from mlp_input_crop_data
group by (census_code,zone_number,status,crop_id)
having count(*) > 1

Results (Partial):-
Total-443 rows
Distinct:-35 census_codes or villages

Table 8: Duplicate crop entries in MLP data and distinct census codes with duplicate entries

	census_code numeric	zone_number numeric	status character varying(100)	crop_id character varying(100)	count bigint
1	560887	4	Actual	C49	2
2	560889	3	Actual	C29	2
3	560887	3	Actual	C26	2
4	560887	3	Actual	C22	2
5	560889	2	Actual	C28	2
6	560889	4	Actual	C36	2
7	544877	4	Actual	C21	2
8	560887	2	Actual	C12	2
9	548850	2	Planned	C20	2
10	560887	2	Actual	C11	2
11	547038	1	Planned	C18	2
12	560887	1	Actual	C14	2
13	560887	1	Actual	C7	2
14	560889	1	Actual	C35	2
15	560889	3	Actual	C19	2
16	560887	3	Actual	C42	2
17	560889	4	Actual	C16	2
18	560889	4	Actual	C20	2
19	560889	1	Actual	C29	2
20	560889	2	Actual	C37	2
21	549115	2	Planned	C47	2
22	560887	1	Actual	C26	2
23	560887	1	Actual	C22	2

	census_code numeric
1	559626
2	544877
3	532134
4	528876
5	545176
6	528030
7	544873
8	544234
9	548852
10	542597
11	560887
12	528449
13	549115
14	560889
15	549160
16	531207
17	547038
18	547031
19	544788
20	547037
21	548850
22	547930
23	544785
24	532143
25	561206
26	561463
27	549119
28	5587477
29	528648
30	533819
31	547041
32	527882
33	532478
34	560919
35	561094

Solution:-
Sum up the duplicate rows crop area count and update the MLP actual cropping pattern database with unique entries - one per crop. It was verified that the sum of cropping pattern equals village area. Validation was done through below queries.

with xyz as
(select distinct(census_code)
from mlp_input_crop_data
group by census_code,zone_number,crop_name,status
having count(*) > 1)

select b.census_code,sum(b.crop_area_count),sum(distinct(b.zone_area))
from mlp_input_crop_data b , xyz x

where b.crop_season_and_landuse <> 'Rabi' and b.status='Actual' and x.census_code=b.census_code
group by (b.census_code)

Table 9: Validation to resolve duplicate crop entries issue

Actual:-

	census_code numeric	crop_area numeric	zone_area numeric
1	527882	499	498.58
2	528030	1478	1478.36
3	528449	2891.00	2890.48
4	528648	1279.00	1279.26
5	528876	1615	1614.56
6	531207	738	737.98
7	532134	600	600.32
8	532143	907.00	907.93
9	532478	530.000	529.69
10	533819	663.00	663.08
11	542597	634	634.08
12	544234	611	1049.07
13	544785	771	770.21
14	544788	198	197.86
15	544873	1174	1173.19
16	544877	808.00	806.34
17	545176	1130.00	1129.83
18	547031	879	879.44
19	547037	1318	1317.59
20	547038	216	215.68
21	547041	754	754.41
22	547930	2927	2926.54
23	548850	833.00	833.43
24	548852	1311.0	1311.89
25	549115	1054	1053.47
26	549119	900	900.92
27	549160	1160.00	1160.57
28	559626	1785.0	1786.37
29	560887	733.00	732.55
30	560889	1524	1523.43
31	560919	507	507.10
32	561094	315	315.84
33	561206	1402	1401.50
34	561463	614.0	614.45
35	5587477	1058.00	1058.07

Planned:-

	census_code numeric	crop_area numeric	village_area numeric
1	547038	216	215.68
2	560889	1524	1523.43
3	545176	1130.00	1129.83
4	532134	600	600.32
5	528648	1279	1279.26
6	549115	1054	1053.47
7	531207	738	737.98
8	544877	807	806.34
9	561206	1402	1401.50
10	544785	771	770.21
11	548852	1311.0	1311.89
12	544873	1174	1173.19
13	549119	900	900.92
14	544234	611	1049.07
15	527882	244	498.58
16	560919	507	507.10
17	547041	754	754.41
18	5587477	1058.00	1058.07
19	547930	2927	2926.54
20	528030	1478	1478.36
21	547037	1318	1317.59
22	532143	907.00	907.93
23	547031	879	879.44
24	561094	315	315.84
25	533819	663.00	663.08
26	528449	2891.0	2890.48
27	559626	1785.0	1786.37
28	542597	634	634.08
29	549160	1160.00	1160.57
30	548850	833.00	833.43
31	561463	614.0	614.45
32	528876	1399	1614.56
33	560887	733.00	732.55
34	544788	198	197.86

4)Same census code for two villages in population data

Identified Through:-

select census_code
from mlp_input_population_data
group by census_code
having count(*) > 1;

```
select * from mlp_input_population_data
where census_code in (548028,549590,528466)
order by census_code;
```

Results:-

Table 10: Duplicate census-code entries in MLP data for Population and distinct census code with duplicate entries

	census_code integer
1	549590
2	528466
3	548028

	village_name character varying(100)	census_code integer	poultry_farming numeric	small_animals numeric	people numeric	cattle numeric
1	Majalapur	528466				
2	Majalapur	528466				
3	Majalapur	528466		0	0	0
4	Majalapur	528466				
5	Majalapur	528466				
6	Majalapur	528466				
7	Majalapur	528466				
8	Majalapur	528466				
9	Majalapur	528466				
10	Majalapur	528466				
11	Majalapur	528466				
12	Majalapur	528466				
13	Majalapur	528466				
14	Majalapur	528466				
15	Majalapur	528466				
16	Majalapur	528466				
17	Majalapur	528466				
18	Majalapur	528466				
19	Majalapur	528466				
20	Majalapur	528466				
21	Majalapur	528466				
22	Amba	548028				
23	Amba	548028				
24	Agar nandur	549590	160	136	1794	125
25	Apegaon	549590				

Solution:-

The duplicate rows were removed and flag the mismatch of village_name for 549590 to the concerned authority for further clarification.

Note this constraint to allow only unique entries in each MLP input database. Set primary keys and database schema accordingly.

6)mlp_structure_data:-
Result: 65 distinct census codes with duplicate structure entries.

Table 11: Duplicate structure entries in MLP data

	census_code numeric	zone_number numeric	status character varying(100)	structure_id character varying(100)	count bigint
1	527105	2	Actual	S1	2
2	527105	2	Proposed	S1	2
3	527106	4	Proposed	S1	2
4	527562	1	Proposed	S1	2
5	527728	1	Proposed	S1	2
6	527881	1	Proposed	S1	3
7	527881	2	Proposed	S1	4
8	527944	2	Proposed	S1	2
9	527947	1	Proposed	S1	5
10	527947	4	Proposed	S1	2
11	528032	1	Proposed	S1	4
12	528032	2	Proposed	S1	5
13	528032	3	Proposed	S1	2
14	528032	4	Proposed	S1	7
15	528032	6	Proposed	S1	2
16	528135	2	Actual	S7	2
17	528135	2	Proposed	S19	2
18	528447	1	Proposed	S6	2
19	528466	1	Actual	S11	20
20	528466	1	Actual	S7	20
21	528643	1	Proposed	S1	2
22	530419	2	Actual	S17	2
23	531648	2	Proposed	S7	2
24	532368	1	Proposed	S1	5
25	532476	3	Proposed	S1	3
26	532862	7	Actual	S21	2
27	542596	2	Proposed	S13	2
28	542598	3	Proposed	S7	2
29	544910	1	Proposed	S7	2
30	545989	1	Actual	S20	2
31	545989	1	Actual	S21	2
32	545989	2	Actual	S20	2
33	545989	2	Actual	S21	2
34	545989	3	Actual	S20	2
35	545989	3	Actual	S21	2
36	547036	1	Proposed	S11	2
37	547037	7	Actual	S12	2
38	547840	2	Actual	S7	2
39	548371	2	Proposed	S20	2
40	558745	3	Proposed	S1	2
41	558747	4	Proposed	S1	2
42	559420	1	Proposed	S1	4
43	559421	4	Proposed	S1	2
44	559437	1	Proposed	S1	2
45	559437	2	Proposed	S1	5

46	559481	6	Proposed	S1	5
47	559661	1	Proposed	S1	2
48	559718	5	Actual	S4	2
49	559837	1	Proposed	S1	3
50	559853	1	Proposed	S1	2
51	559853	2	Proposed	S1	2
52	559853	3	Proposed	S1	2
53	559870	4	Proposed	S1	10
54	559870	4	Proposed	S9	2
55	559870	5	Proposed	S1	3
56	559917	2	Proposed	S1	3
57	559932	1	Proposed	S1	2
58	559932	3	Proposed	S1	2
59	559932	4	Proposed	S1	3
60	560011	1	Proposed	S1	4
61	561182	5	Proposed	S20	2
62	5587477	1	Actual	S7	2
63	5587477	5	Actual	S11	2
64	5587477	5	Actual	S7	2
65	5587477	5	Proposed	S1	3

Solution: Based on the information filled by field team each entry was considered separately. Multiple or duplicate entries need to be allowed in structures database considering that each structure on field may have different storage capacity. Instead some other attribute must be added to schema to enable unique identification. Hence primary key was not set for this.

2.2 MLP Data Issues

Following issues were identified in input data which result in incorrect water budget.

1. Null population data
2. Null cropping pattern (Actual or planned)
3. Null structures (Actual or planned)
4. Mismatch in cropping pattern and village area

Table 12 provides a summary for these issues.

Table 12: Summary of MLP data issues

Parameter for Data issues	Total	Phase I	Phase II
No. of villages in MLP	459	58	401
No population data	67	10	57
No current structures data	75	4	71
No planned structures data	25	4	21
No current cropping data	5	0	5
No proposed cropping data	44	9	35
Incorrect current cropping data	5	1	4
Incorrect planned cropping data	3	0	3

Similarly 48 villages from 106 phase I completed by Yashada are yet to fill water budget data into the app due to its deployment in later stage. Table below provides a compiled list of 144 villages from 459 villages with specified data issues.

Legend for Table -

0-proper data

1- no data filled

2-incorrect data filled(checked only for cropping pattern)

Table 13: Data issue cases

Sr. no.	census_co	village_name	population	current structu	proposed structures	current cropping	proposed crop
1	528415	KHATKHED	1	0	0	0	0
2	528441	YEULKHED	1	0	0	0	0
3	528447	ALASNA	1	0	0	0	0
4	530040	Lakhonda Bk	1	0	0	0	0
5	530042	Apoti Bk	1	0	0	0	0
6	530046	Akhatwada	1	0	0	0	0
7	530048	Nirmalkhed	1	0	0	0	0
8	528649	Bhadgani	0	1	0	0	0
9	542435	Ghodkhindi	0	1	0	0	0
10	542436	Pandhari	0	1	0	0	0
11	542432	Dhamani	1	1	0	0	0
12	528642	Gahukhed	0	0	1	0	0
13	528648	Umali	0	0	1	0	0
14	527026	Manegaon	0	0	0	0	1
15	527032	Salbardi	0	0	0	0	1
16	528422	KALKHED	0	0	0	0	1
17	560574	Halki	0	0	0	0	1
18	560819	Shelgi	0	0	0	2	1
19	528414	TARODA TARODI	1	0	0	0	1
20	528450	KHERDA	1	0	0	0	1
21	527027	Kothali	0	0	1	0	1
22	527034	Hartale	0	0	1	0	1
23	528032	Ranjani	0	0	0	2	2
24	544225	Darsangavi (sindkhe	0	0	0	2	2
25	545789	Goregaon	0	0	0	2	2
26	527914	Anturli Kh.Pr.Lohare	1	0	0	0	0
27	528466	Majalapur	1	0	0	0	0
28	529829	Lotkhed	1	0	0	0	0
29	530055	Warudi	1	0	0	0	0
30	530110	Bondarkhed	1	0	0	0	0
31	532146	Malkapur1	1	0	0	0	0
32	532359	Shekdari	1	0	0	0	0
33	532487	Wadhona1	1	0	0	0	0
34	533832	Malatpur	1	0	0	0	0
35	533834	Ambapur	1	0	0	0	0
36	533836	Dahyapur	1	0	0	0	0
37	544200	Hatola	1	0	0	0	0
38	545784	Surajkheda	1	0	0	0	0
39	545995	Pazar tanda	1	0	0	0	0
40	547042	Katkarwadi	1	0	0	0	0
41	547043	Tandulwadi1	1	0	0	0	0
42	547610	Kharati	1	0	0	0	0
43	549116	Dahegaon	1	0	0	0	0
44	549118	Lakhmapurwadi	1	0	0	0	0
45	549127	Chinchadgaon	1	0	0	0	0
46	549133	Hargovindpur	1	0	0	0	0
47	549160	Chorwaghalgaon	1	0	0	0	0
48	549308	Malunja Kh.	1	0	0	0	0
49	549340	Surewadi	1	0	0	0	0
50	549341	Balapur	1	0	0	0	0
51	549342	Maujudabad	1	0	0	0	0
52	560222	Khanapur	1	0	0	0	0
53	561134	Tambewadi	1	0	0	0	0
54	527722	Visapur	0	1	0	0	0
55	529907	Malwada	0	1	0	0	0
56	531642	Gangarkheda	0	1	0	0	0
57	531643	Kotmi	0	1	0	0	0
58	531644	Toranwadi	0	1	0	0	0
59	531645	Katkumbh	0	1	0	0	0
60	531646	Koylari	0	1	0	0	0
61	531648	Bhamadehi	0	1	0	0	0
62	531649	Bhagdari	0	1	0	0	0
63	531650	Doma	0	1	0	0	0
64	531767	Husenpur Khodgaon	0	1	0	0	0

Sr. no.	census_co	village_name	population	current structu	proposed structures	current cropping	proposed crop
65	532728	Afjalpur	0	1	0	0	0
66	532732	Rama	0	1	0	0	0
67	532746	Anchalwadi	0	1	0	0	0
68	532751	Himmatpur	0	1	0	0	0
69	532753	Makrampur	0	1	0	0	0
70	532876	Ghodchandi	0	1	0	0	0
71	532883	Adula	0	1	0	0	0
72	533817	Panjara Bothali	0	1	0	0	0
73	533821	Bodad	0	1	0	0	0
74	534263	Ganeshpur	0	1	0	0	0
75	534273	Kharda	0	1	0	0	0
76	542536	Jawala	0	1	0	0	0
77	542583	Taroda	0	1	0	0	0
78	542597	Khed	0	1	0	0	0
79	542601	Sindhi	0	1	0	0	0
80	543142	Thar Kh.	0	1	0	0	0
81	543178	Wadad	0	1	0	0	0
82	543186	Dagad Thar	0	1	0	0	0
83	544234	Mohada Tonda	0	1	0	0	0
84	544784	Wadi Muktapur	0	1	0	0	0
85	544785	Ijali	0	1	0	0	0
86	544789	Chikala	0	1	0	0	0
87	545783	Garkheda1	0	1	0	0	0
88	549557	Indegaon	0	1	0	0	0
89	549590	Agar nandur	0	1	0	0	0
90	559479	Karalwadi	0	1	0	0	0
91	559915	Selu	0	1	0	0	0
92	531754	Gavandgaon Bk	1	1	0	0	0
93	531830	Chincholi Bk.	1	1	0	0	0
94	532754	Malpur	1	1	0	0	0
95	533829	Nagapur	1	1	0	0	0
96	534249	Durgada	1	1	0	0	0
97	547034	Sirsam Shegaon	1	1	0	0	0
98	549366	Khairgawhan	1	1	0	0	0
99	533831	Sirpur	1	1	0	2	0
100	531791	Kalwada	0	0	1	0	0
101	532738	Jaitapur	0	0	1	0	0
102	532752	Marki	0	0	1	0	0
103	532759	Hatkheda	0	0	1	0	0
104	533828	Saikheda	0	0	1	0	0
105	532153	Govindpur	0	1	1	0	0
106	534266	Kolhapur	0	1	1	0	0
107	534304	Bopapur	0	1	1	0	0
108	527626	Soke	1	1	1	0	0
109	527732	Palasare	1	1	1	0	0
110	532154	Sultanpur	1	1	1	0	0
111	533830	Laxmipur	1	1	1	0	0
112	560228	Poharegaon Tanda	1	1	1	0	0
113	527909	Anturli Kh.Pr.Pachor	0	0	0	0	1
114	527910	Ozar	0	0	0	0	1
115	528029	Moyakhede Digar	0	0	0	0	1
116	528033	Gornale	0	0	0	0	1
117	530419	Kosgaon	0	0	0	0	1
118	544868	Jamdari	0	0	0	0	1
119	527582	Bodarde	1	0	0	0	1
120	527583	Vanjari Kh.	1	0	0	0	1
121	527912	Bambarud Kh. Pr.Pa	1	0	0	0	1
122	542599	Palashi	1	0	0	0	1
123	547969	Machindranath Chin	1	0	0	0	1
124	548154	Kinkheda1	1	0	0	0	1
125	529649	Warud Bk.	0	1	0	0	1
126	530743	Chakwa	0	1	0	0	1
127	531785	Hantoda	0	1	0	0	1
128	532743	Makrandabad	0	1	0	0	1

Sr. no.	census_code	village_name	population	current structure	proposed structur	current croppi	proposed croppi
129	542598	Lakhkhind	0	1	0	0	1
130	543477	Pimpari Road	0	1	0	0	1
131	527563	Hiwarkhede Kh.	1	1	0	0	1
132	527729	Chinchgavhan	1	1	0	0	1
133	527735	Tirpole	1	1	0	0	1
134	532478	Nagziri	1	1	0	0	1
135	542587	Haru	1	1	0	0	1
136	561204	Sukta	1	1	0	0	1
137	532477	Benoda	0	0	1	0	1
138	527915	Anturli Bk.Pr.Pachora	1	0	1	0	1
139	542600	Antargaon	1	0	1	0	1
140	534265	Husnapur	0	1	1	0	1
141	542535	Dolhari	0	1	1	0	1
142	542586	Takali Bk.	0	1	1	0	1
143	542581	Deulgaon	1	1	1	0	1
144	560230	Sangvi	1	1	1	0	1
Total issue villages in each category			67	75	25	5	44

Table 14 below provides example of incorrect cropping data

Table 14: sample cases with incorrect cropping data

	census_code numeric	crop_area numeric	village_area numeric
1	528032	1853.00	1649.07
2	533831	71.55	68.91
3	544225	813.00	672.23
4	545789	3819.0	3816.94
5	560819	1453	813.23

2.3 Other Issues and Corrections done

1. Handling null values in database: Null values in MLP data were replaced with zero to avoid computation error. Handling of null values in database must be decided and implemented during new development of MLP
2. Zone number format: Zone number from plugin is in format ‘zone-villagename-number’ whereas that in MLP app is in format ’number’. These formats must be decided and proper handling would be needed for post processing of MLP data
3. Required attributes from Master list: Crop list has now been given crop id’s but crop id’s are not there in plugin output. Matching fields must be incorporated in MLP database schema to be maintained at backend so as to allow easy post processing. Schema for pilot database must be referred for this and discussions must be conducted with IITB team and PMU for finalization.
4. Primary keys and duplicate data: Based on primary keys duplicate data entry in MLP app, where needed, must be handled by incorporating additional attributes in schema. Eg - structures data will need duplicate entry due to varying storage capacity. This can be handled by adding additional attributes in schema like CNB1, CNB2 or by post processing of data by summing up duplicate entries before entry into database.

5. Handling data issues at entry level: Data issues like null entries in population, current structures, proposed structures, current cropping pattern and proposed cropping pattern must preferably be handled at the entry level.
6. Backed reports and timeline:Viewable report formats must be pre-decided and implemented for monitoring purpose.

3 Validation of Postgress Queries

1.The chart attribute table query output is validated for 2018 data on below villages:-

1. Gunja, Washim
2. Kubhephal, Aurangabad
3. Pandaw Umra, Aurangabad
4. Paradgaon, Jalna

2.The zone level water balance output table (Actual state) has been validated on below villages -

1. Zalta - 548851
2. Gunja - 530632

3. Data issues table 'village_data_issues' was validated on below villages for presence of issues

1. Apoti Kh.-530035
2. Apoti Bk.-530042
3. Shelgi - 560819
4. Kasali Kh -530528
5. Warkhed -528653

4. The 'village_data_issues_all' table for 459 villages was validated on below villages for actual presence of issues -

1. Malpur -532754
2. Visapur - 527722
3. Hiwarkhede Kh -527563

4. Output Tables

Table 15: sample entries in chart attributes table

Data Output | Explain | Messages | History

	census_code integer	village_name character varying(100)	chart_year integer	village_area_hectare numeric	rainfall_crorelitres numeric	runoff_crorelitres numeric	kharif_area_hectare numeric	longkharif_area_hectare numeric	rabi_area_hectare numeric	annual_area_hectare numeric	agricultural_area_hectare numeric
1	542400	Kinhi	2014	1152.88	424.26	0	0	0	0	0	0
2	542400	Kinhi	2018	1152.88	508.54	0	0	0	0	0	0
3	542400	Kinhi	2016	1152.88	726.54	0	0	0	0	0	0
4	542400	Kinhi	2017	1152.88	425.41	0	0	0	0	0	0
5	542400	Kinhi	2013	1152.88	1047.39	0	0	0	0	0	0
6	542400	Kinhi	2015	1152.88	506.11	0	0	0	0	0	0

Table 16: Sample entries in water balance table

Data Output | Explain | Messages | History

	village_name character varying(100)	census_code integer	water_balance_year numeric	rainfall_mm numeric	zone_number numeric	monsoon_cropwater_requirement numeric	monsoon_crop_deficit numeric	monsoon_storage_available numeric	monsoon_groundwater_available numeric
1	Kinhi	542400	2018	441.1	1	0	0	0	0
2	Kinhi	542400	2017	369.0	4	0	0	0	0
3	Kinhi	542400	2016	630.2	3	0	0	0	0
4	Kinhi	542400	2014	368.0	3	0	0	0	0
5	Kinhi	542400	2013	908.5	4	0	0	0	0

Submission:

The following is submitted to PMU:-

1)Chart_MLP_Queries and results for 2013-2018 for first 106 villages
2)Constraints_Primary_Key Queries
3)Data_Issues_Queries_And_Results
4)Populating Plugin_Output_To_Database_Scripts
5)Status_Table_Queries
6)Water_Budget_Queries and results for 2013- 2018 for first 106 villages
7)MLP_Database Backup

Appendix I: Chart table to chart mapping - for Automation of display part from chart table

census_code	village_name	chart_year	village_area_hectare	rainfall_mm	rainfall_crorelitres	runoff_crorelitres	kharif_area_hectare	longkharif_area_hectare	rabi_area_hectare	annual_area_hectare	agricultural_area_hectare	non_agricultural_area_hectare	agricultural_pet_crorelitres
547930	Paradgaor	2018	2927	434.9	1273	453	894	1919	719	42	2855	72	2136
531207	PandavUn	2018	738	817.1	603	299	578	74	39	1	653	85	305
530632	Gunja	2016	586	884.0	518	261	359	53	34	2	414	173	194
Attribute name in chart													
		1	2g	1c	1a and 3a	1b	2a	2b	2c	2d	2e	2f	3b

drinking_water_crorelitres	kharif_pet_monsoonend_crorelitres	longkharif_pet_monsoonend_crorelitres	annual_pet_monsoonend_crorelitres	kharif_aet_monsoonend_crorelitres	longkharif_aet_monsoonend_crorelitres	annual_aet_monsoonend_crorelitres	kharif_deficit_monsoonend_crorelitres	longkharif_deficit_monsoonend_crorelitres	annual_deficit_monsoonend_crorelitres	rabi_pet_postmonsoon_crorelitres	longkharif_pet_postmonsoon_crorelitres	annual_pet_postmonsoon_crorelitres	rabi_aet_postmonsoon_crorelitres	longkharif_aet_postmonsoon_crorelitres
6	317	943	22	194	524	11	123	419	11	311	492	50	43	4
4	237	39	0.5	191	28	0	46	11	0	16	11	1	3	0.1
2	143	24	1	107	19	1	35	4	0	13	13	2	4	0.68
3c	4a	4d	4g	4b	4e	4h	4c	4f	4i	5a	5d	5g	5b	5e

annual_aet_postmonsoon_crorelitres	rabi_deficit_postmonsoon_crorelitres	longkharif_deficit_postmonsoon_crorelitres	annual_deficit_postmonsoon_crorelitres	monsoon_aet	ground_water_recharge	soil_moisture	runoff	available_runoff	currently_impounded_runoff	runoff_available_for_impounding	runoff_impounded_after_proposed_structures	pet_monsoon	pet_post_monsoon	aet_monsoon
0.5	268	488	50	750	12	67	456	228	85	143	124	1285	853	729
0.02	13	11	1	233	20	52	299	149	40	109	86	277	28	219
0	9	12	2	153	24.6	35	277	139	13	126	59	167	27	128
5h	5c	5f	5i	s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11

aet_post_monsoon	deficit_monsoon	deficit_post_monsoon	impounded_runoff_monsoon	impounded_runoff_post_monsoon	available_ground_water_monsoon	available_ground_water_post_monsoon	water_balance_current_state_monsoon	water_balance_current_state_post_monsoon	total_deficit_or_extra	water_cropping_and_proposed_structures	date_created
47	553	806	43	43	4	8	-506	-755	-1262	-1223	24-12-18
3	57	25	20	20	6.7	13.4	-30	9	-22	25	24-12-18
5	40	23	6	6	8.2	16.4	-25	0	-25	21.5	24-12-18
s12	s13	s14	s15	s16	s17	s18	s19	s20	s21	s22	

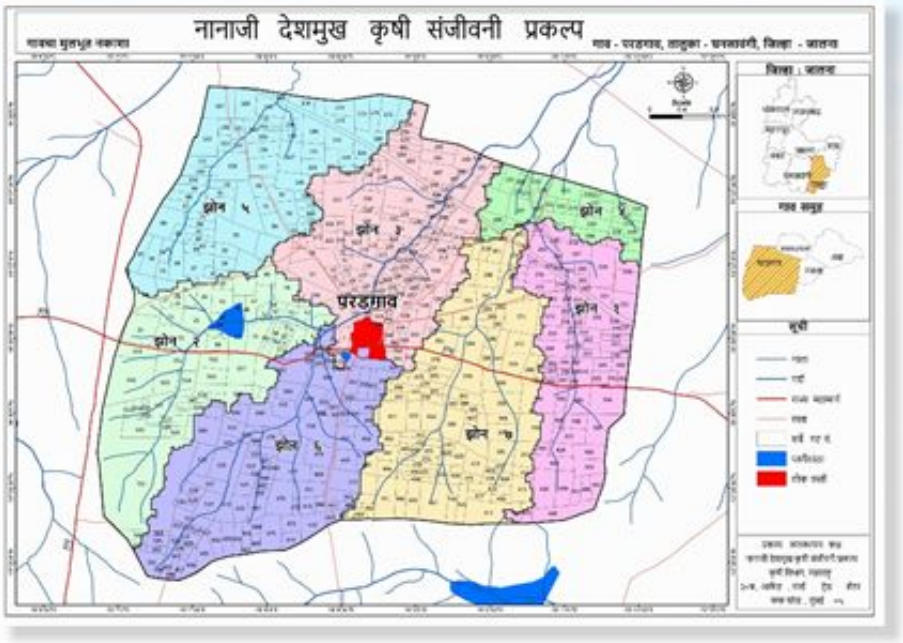
नानाजी देशमुख कृषि संजीवनी प्रकल्प

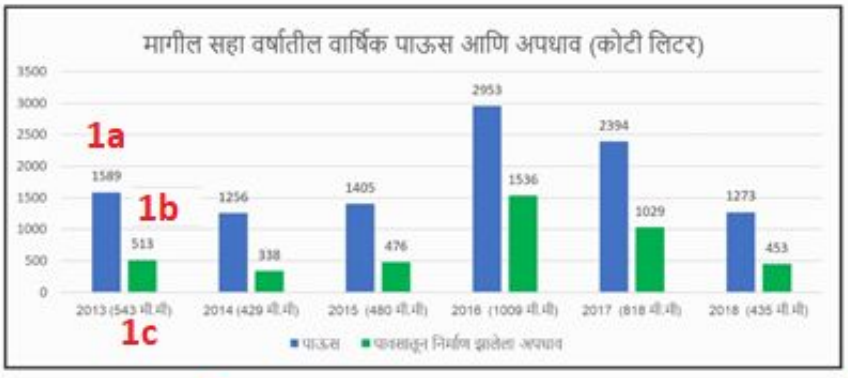
PoCRA

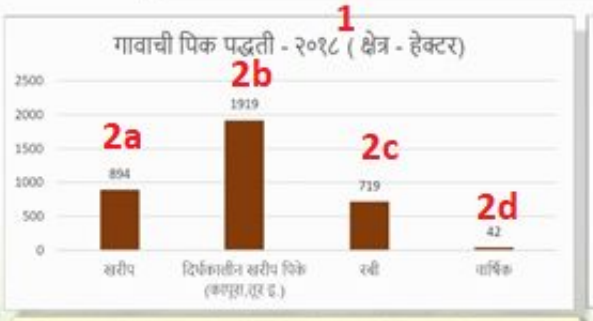
कृषि विभाग

गावशिवाराचा पाण्याचा ताळेबंद – वर्ष २०१८ 1

गाव: परडगाव, गाव समूह क्र. - ५१४_gp-३५_०३, तालुका: घनसावंगी, जिल्हा: जालना





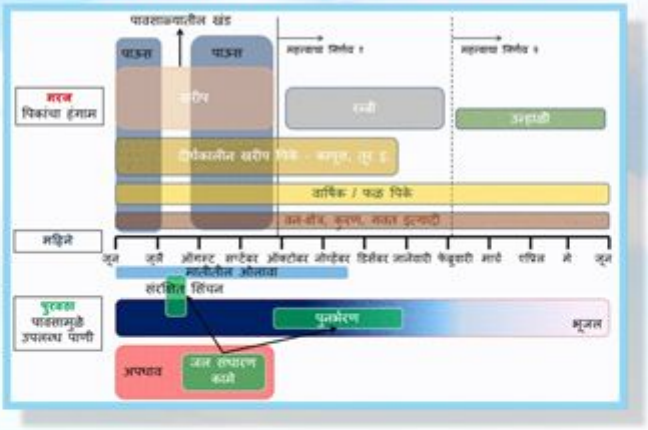


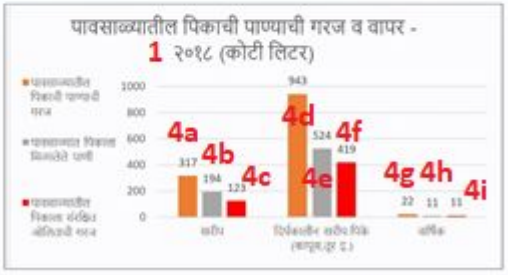
शेतीखालील क्षेत्र – २८५५ हे. बिगरशेती क्षेत्र - ७२ हे. एकूण क्षेत्र २९२७ हे.

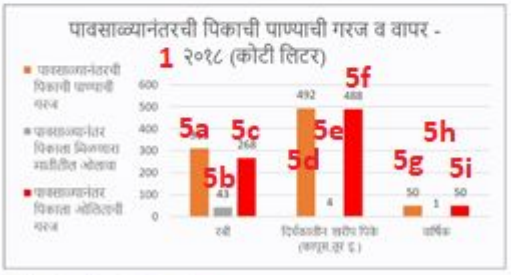
2e 2f 2g

भारतीय प्रौद्योगिकी संस्था (IIT), मुंबई यांचे तांत्रिक मार्गदर्शन व सहकार्याने

गावाच्या शेतीच्या पाण्याचे गणित







पाण्याचा ताळेबंद: सारांश (वर्ष - २०१८) 1

	पावसाच्या पाण्याचे गणित		
१	गावाचे एकूण क्षेत्र (हेक्टर)	२९२७	2g
२	पावसाचे पाणी (कोटी लिटर)	१२७३	3a
३	पावसाळ्यात पिकाने घेतलेले पाणी (कोटी लिटर)	७६०	s1
४	भूजल पुनर्भरण (कोटी लिटर)	१२	s2
५	मातीतील ओलावा (कोटी लिटर)	६७	s3
६	गाव शिवारातून निर्माण झालेला अपधाव (कोटी लिटर)	४५६	s4
७	गाव शिवारात अडविण्यासाठी उपलब्ध अपधाव (कोटी लिटर)	२२८	s5
८	गाव शिवारात आतापर्यंत अडवलेला अपधाव (कोटी लिटर)	८५	s6
९	अडविण्यासाठी शिल्लक अपधाव (कोटी लिटर)	१४३	s7
१०	प्रस्तावित कामांनंतर अडणारा एकूण अपधाव (कोटी लिटर)	१२४	s8
	पिकाची पाण्याची गरज आणि उपलब्धता	पावसाळ्यातील	पावसाळ्यानंतर
	पिकाची पाण्याची गरज (कोटी लिटर)	s9 १२८३	८५३ s10
१२	पिकाला मिळालेले पाणी (कोटी लिटर)	s11 ७२९	४७ s12
१३	पिकाला ओलितासाठी गरज (कोटी लिटर)	s13 ५४३	८०६ s14
१४	अडवलेला अपधाव (कोटी लिटर)	s15 ४३	४३ s16
१५	उपलब्ध भूजल (कोटी लिटर)	s17 ४.०	८.० s18
१६	सध्यस्थितीत पाण्याचा ताळेबंद	s19 -५०६	-७५१ s20
१७	एकूण तूट (कोटी लिटर)	१२६२	s21
	प्रस्तावित कामांनंतर पाण्याचा ताळेबंद		
१८	सध्याच्या पिकपद्धतीनुसार प्रस्तावित कामे केल्यानंतरची तूट (कोटी लिटर)	१२२३	s22

s7
१.शिल्लक अपधाव १४३ कोटी लिटर अडवण्यासाठी नवीन मृद व जल संधारण कामे घेण्यास वाव आहे.

२.शिल्लक अपधाव अडवल्यावर देखील पाण्याची तूट असल्याने पिक पद्धतीत बदल करणे आवश्यक आहे. २०१८ मध्ये पर्जन्यमान कमी झाल्याने खरीप पिकांच्या उत्पादकतेवर व रबी पिकांच्या पेरणीवर परिणाम झाला आहे.

३.सूक्ष्म सिंचनाचा वापर वाढवणे, कमी पाणी लागणारी आणि कमी कालावधीची पिके घेणे आवश्यक आहे. constant

भारतीय प्रौद्योगिकी संस्था (IIT), मुंबई यांचे तांत्रिक मार्गदर्शन व सहकार्याने

Appendix II : Database Schema

1.Master village list - schema

```
CREATE TABLE master_village_list
(
  village_name character varying(100),
  census_code integer NOT NULL,
  village_name_marathi character varying(100),
  district_code numeric,
  district_name character varying(100),
  taluka_name character varying(100),
  cluster_code character varying(100),
  chart_status integer,
  CONSTRAINT master_village_list_pkey PRIMARY KEY (census_code)
)
```

2.Master Crop List schema

```
CREATE TABLE master_crop_list
(
  crop_id character varying(100) NOT NULL,
  crop_name_in_english character varying(100) NOT NULL,
  crop_name_in_marathi character varying(100),
  crop_season_and_landuse character varying(100),
  CONSTRAINT master_crop_list_pkey PRIMARY KEY (crop_id, crop_name_in_english)
)
```

3. Master Structure list schema

```
CREATE TABLE master_structure_list
(
  structure_id character varying(100) NOT NULL,
  structure_name_english character varying(100) NOT NULL,
  structure_name_marathi character varying(100),
  storage_capacity_unit character varying(100),
  storage_capacity_per_unit numeric,
  evaporation_percent numeric,
  structure_type character varying(100),
        CONSTRAINT master_structure_list_pkey PRIMARY KEY (structure_id,
structure_name_english)
)
```

4.Plugin output schema

```
CREATE TABLE kharif_model_zonewise_budget_2018
(
```

```
  village_name character varying(100),
  census_code numeric NOT NULL,
  date_of_creation character varying(100),
  rainfall_circle character varying(100),
  zone_number character varying(100) NOT NULL,
  zone_area_ha numeric,
  crops_in_english character varying(100) NOT NULL,
  crops_in_marathi character varying(100),
  crop_season_and_landuse character varying(100),
  rainfall_mm numeric,
  pet_monsoon_end numeric,
  aet_monsoon_end numeric,
  monsoon_deficit numeric,
  gw_recharge_in_monsoon numeric,
  runoff_in_monsoon numeric,
  soil_moisture_monsoon_end numeric,
  post_monsoon_pet numeric,
  infil_monsoon_mm numeric,
  soil_moisture_crop_end numeric,
  aet_crop_end numeric,
  pet_crop_end numeric,
  crop_deficit_duration numeric,
  post_monsson_ground_water numeric,
  post_monsoon_runoff numeric,
  rainfall_year numeric,
        CONSTRAINT kharif_model_zonewise_budget_2018_pkey PRIMARY KEY
(census_code, zone_number, crops_in_english)
)
```

5.MLP crop data schema

```
CREATE TABLE mlp_input_crop_data_updated
(
  village_name character varying(100),
  census_code numeric NOT NULL,
  crop_area_count numeric,
  crop_name character varying(100),
  zone_number numeric NOT NULL,
  zone_area numeric,
  status character varying(100) NOT NULL,
  date_of_creation character varying(100),
  crop_id character varying(100) NOT NULL,
  crop_season_and_landuse character varying(100),
     CONSTRAINT mlp_input_crop_data_updated_pkey PRIMARY KEY (census_code,
zone_number, status, crop_id)
)
```

6. MLP population data schema

```
CREATE TABLE mlp_input_population_data
(
  village_name character varying(100),
  census_code integer NOT NULL,
  poultry_farming numeric,
  small_animals numeric,
  people numeric,
  cattle numeric,
  CONSTRAINT mlp_input_population_data_pkey PRIMARY KEY (census_code)
)
```

7.MLP structure data schema

```
CREATE TABLE mlp_structure_data
(
  village_name character varying(100),
  census_code numeric,
  zone_number numeric,
  status character varying(100),
  total_capacity numeric,
  total_water numeric,
  structure_name character varying(100),
  strcuture_count numeric,
  structure_name_english character varying(100),
  structure_id character varying(100)
)
```

8.Rainfall_data schema

```
CREATE TABLE rainfall_data
(
  district_name character varying(100),
  taluka_name character varying(100),
  circle_name_maharain character varying(100),
  year integer,
  day_1 numeric,
  day_2 numeric,
  day_3 numeric,
  .
  .
  day_364 numeric,
  day_365 numeric
)
```

9.Data Issues schema

```
CREATE TABLE village_data_issues_all
(
```

```
  census_code numeric NOT NULL,
  village_name character varying(100),
  drinking_water_crorelitres_status numeric,
  currently_impounded_runoff_status numeric,
  runoff_impounded_after_proposed_structures_status numeric,
  agricultural_area_hectare_status numeric,
  agricultural_area_hectare_planned numeric,
  CONSTRAINT village_data_issues_all_pkey PRIMARY KEY (census_code)
)
```

10. Chart attributes schema

```
CREATE TABLE master_ouput_attributes_chart
(
  census_code integer NOT NULL,
  village_name character varying(100),
  chart_year integer NOT NULL,
  village_area_hectare numeric,
  rainfall_crorelitres numeric,
  runoff_crorelitres numeric,
  kharif_area_hectare numeric,
  longkharif_area_hectare numeric,
  rabi_area_hectare numeric,
  annual_area_hectare numeric,
  agricultural_area_hectare numeric,
  non_agricultural_area_hectare numeric,
  agricultural_pet_crorelitres numeric,
  drinking_water_crorelitres numeric,
  kharif_pet_monsoonend_crorelitres numeric,
  longkharif_pet_monsoonend_crorelitres numeric,
  annual_pet_monsoonend_crorelitres numeric,
  kharif_aet_monsoonend_crorelitres numeric,
  longkharif_aet_monsoonend_crorelitres numeric,
  annual_aet_monsoonend_crorelitres numeric,
  kharif_deficit_monsoonend_crorelitres numeric,
  longkharif_deficit_monsoonend_crorelitres numeric,
  annual_deficit_monsoonend_crorelitres numeric,
  rabi_pet_postmonsoon_crorelitres numeric,
  longkharif_pet_postmonsoon_crorelitres numeric,
  annual_pet_postmonsoon_crorelitres numeric,
  rabi_aet_postmonsoon_crorelitres numeric,
  longkharif_aet_postmonsoon_crorelitres numeric,
  annual_aet_postmonsoon_crorelitres numeric,
  rabi_deficit_postmonsoon_crorelitres numeric,
  longkharif_deficit_postmonsoon_crorelitres numeric,
  annual_deficit_postmonsoon_crorelitres numeric,
  monsoon_aet numeric,
```

```
ground_water_recharge numeric,
soil_moisture numeric,
runoff numeric,
available_runoff numeric,
currently_impounded_runoff numeric,
runoff_available_for_impounding numeric,
runoff_impounded_after_proposed_structures numeric,
pet_monsoon numeric,
pet_post_monsoon numeric,
aet_monsoon numeric,
aet_post_monsoon numeric,
deficit_monsoon numeric,
deficit_post_monsoon numeric,
impounded_runoff_monsoon numeric,
impounded_runoff_post_monsoon numeric,
available_ground_water_monsoon numeric,
available_ground_water_post_monsoon numeric,
water_balance_current_state_monsoon numeric,
water_balance_current_state_post_monsoon numeric,
total_deficit_or_extra numeric,
water_cropping_and_proposed_structures numeric,
date_created character varying(100),
rainfall_mm integer,
    CONSTRAINT master_ouput_attributes_chart_pkey PRIMARY KEY (census_code,
chart_year)
)
```

11. Water balance actual state - zone level schema

```
CREATE TABLE water_balance_zone_level
(
village_name character varying(100),
census_code integer NOT NULL,
water_balance_year numeric NOT NULL,
rainfall_mm numeric,
zone_number numeric NOT NULL,
monsoon_cropwater_requirement numeric,
monsoon_crop_deficit numeric,
monsoon_storage_available numeric,
monsoon_groundwater_available numeric,
monsoon_balance numeric,
monsoon_index numeric,
post_monsoon_crop_water_requirement numeric,
post_monsoon_drinking_water_requirement numeric,
post_monsoon_storage_available numeric,
post_monsoon_groundwater_available numeric,
post_monsoon_soil_moisture_available numeric,
```

```
  post_monsoon_balance numeric,
  post_monsoon_index numeric,
  runoff_generated numeric,
  runoff_available numeric,
  runoff_available_for_impounding numeric,
  zone_area numeric,
  kharif_area_hectare numeric,
  rabi_area_hectare numeric,
  soil_moisture_monsoon_end_kharif numeric,
  soil_moisture_monsoon_end_lk_a numeric,
      CONSTRAINT water_balance_zone_level_pkey PRIMARY KEY (census_code,
water_balance_year, zone_number)
)
```