JALTOL

A QGIS plugin for water balance estimation
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User Manual

November 2021
csei.org
About ATREE

Ashoka Trust for Research in Ecology and the Environment (ATREE) is a global non-profit organisation which generates interdisciplinary knowledge to inform policy and practice in the areas of conservation and sustainability.

ATREE envisions a society committed to environmental conservation, and sustainable and socially just development.

For over two decades, ATREE has worked on issues like biodiversity and conservation, climate change mitigation and development, land and water resources, forests and governance, and ecosystem services and human well-being. ATREE has consistently ranked in the top 20 Environment and Water Security think-tanks in the world.

About CSEI

ATREE’s Centre for Social and Environmental Innovation (CSEI) aims to translate research to enhance human well-being, while also conserving the natural environment. CSEI aims to co-create scalable solutions working with partners. We hope to build impact ecosystems to address the problems we work on.

Our solutions are rooted in scientific research. CSEI currently focuses on three problems: water & foods, invasive plant species, and climate resilient/green cities.

The Centre’s focus is on empowering the ‘first mile’- in their role as citizens, producers, or consumers. Our goal is to enable a transition to a more sustainable and fair system.
Firstly, we would like to thank the India Climate Collaborative and the partner organisations -- Edelgive Foundation -- who funded this study.

Secondly, we would like to thank all the institutions and individuals who participated in pilot workshops for Jaltol and offered feedback on the tool:

CSOs - Frank Water, SOPPECOM, PRADAN, ARGHYAM, WASSAN, Jal Smruti Foundation, Srijan India, Raah Foundation, Pragati Abhiyan, WOTR, Gram Vikas, Development Support Centre, Gram Gourav Pratishthan, MYRADA, Rotary Club, Pani Panchayat
Government institutions - Advanced Centre for Integrated Water Resource Management (Karnataka), Public Water Supply (Rajasthan), Centre for Water Resources Development and Management (Kerala)
Academic institutions - Indian Institute of Technology Delhi, Indo German Centre for Sustainability, Chennai
Start ups - Oceo Water, Nature Dots
Expert researchers - James Wescoat

Thirdly, we would like to thank Ujaval Gandhi (Spatial Thoughts) who inspired the creation of Jaltol with his advocacy for open source tools. Tejasvi Hora for his guidance on usage of groundwater data.
The team

Anjana Balakrishnan
Created content around Jaltol, planned the launch event and managed publicity

Anjali Neelankantan
Managed the project development, coordinated with CSOs for piloting the tool

Anu Sridharan
Strategic partnership and fundraising for the development of Jaltol plugin

Aparna Nambiar
Created the Jaltol logo and visualized all creatives for communication

Craig Dsouza
Led the technical development of Jaltol QGIS plugin

Ganesh Shinde
Developed the data layers used within Jaltol and conducted pilot workshops

Kaavya Kumar
Planned content around Jaltol, media outreach ahead of the launch

Lakshmi Pranuti
Validated data layers used within Jaltol

Shilpa Swaraj
Conducted comparative review of existing digital tools for water balance estimation

Surabhi Singh
Provided technical inputs for the development of Jaltol plugin

Veena Srinivasan
Conceptualised and guided the development of Jaltol tool

Our interns, Maithili Khapre and Gurleen Kaur improved the quality of village shapefiles for Maharashtra
1. Introduction

1.1 Understanding rural water security

Since the 1990s, soil and water conservation measures have been the lynchpin of rural development. These involve boosting recharge through rainwater harvesting structures such as small check dams or farm ponds. The problem is that, this approach by design increases total water use. However, in many watersheds, all available water is already being used. So increasing water for some farmers, only results in leaving less for others because water is drawn from the same common pool. This is referred to as a zero-sum game. Ultimately, the water management problem is that of allocating the water available each year among users — both people and the ecosystem. Without understanding how much water is available, how much is being used, and by whom, solving India’s water crisis is going to be a non-starter.

Water security planning is important to assess the water availability (water balance) and demand in a region and to design rural water interventions and allocate water among users accordingly. To prepare a robust water security plan (WSP), we must first estimate the water balance accurately. A water balance is an accounting of the available water resources. It is a critical component of a water security plan based on which rural water security interventions are designed.

From our review of 25 water security plans and conversations with grassroots communities, we realised that there are many challenges with preparing a water balance. There is a capacity gap at the community level in preparing hydrologically sound water balances. Water balance requires a high level of expertise which communities often don’t have, which makes them rely on other institutions to fill this gap. Primary and secondary data required for estimating water balances is not easily accessible to grassroot communities. It is a resource intensive excercise Also, the water balances from different organisations are non-comparable as communities often mix up stock and flow, and blue and green water components. For coming up with demand-side interventions as part of water security planning requires solving a highly technical problem in every gram panchayat with very limited funds and access to technical capacity.

1.2 Need for open source digital tools for water balance estimation

While it may be challenging to quickly build technical capacity at scale, new digital tools can make tools and data available more easily. These could ease the burden of developing in-house expertise. These insights led us to brainstorm about how to bridge the capacity gap at the community level, and specifically how digital tools can help. To help communities easily access secondary data spread across multiple websites, portals and formats, we developed “a QGIS plugin” called “Jaltol”.

QGIS is a free and open-source Geographic Information System (GIS) software application that supports viewing, editing and analysis of geospatial data. The Jaltol plug-in is a simple piece of code (an “Add-on”) that gets installed in the toolbar in QGIS and allows the user to download relevant datasets and combine them to develop a water balance for their local watershed. This QGIS plugin will provide communities and decision making institutions with a complete view of the watershed for a particular geographical area, allowing them to make more informed decisions about water management.
2 Methodology

2.1 About Jaltol QGIS Plugin

Water balance estimates the inflow and outflow of water in a system. It helps to understand the current status of water availability in a given region – the output of a water balance is in terms of either a deficit or surplus of water which appears as changes in soil moisture, groundwater and surface storages. Data for both inflow and outflow are usually collected from primary or secondary sources by the implementing NGO of an RWSP. Alternatively another secondary source of data is remote sensing data, which is what this plugin uses to compute water balances. These are then used to assess whether a geographical region under study has a water deficit or a surplus as a first step towards intervention planning. This QGIS plugin will provide communities and decision making institutions with a complete view of the watershed for a particular geographical area, allowing them to make more informed decisions about water management. It calculates annual water balance for the chosen geographical area with the help of shape files. Inter watershed groundwater flows and surface water flows are assumed zero. The simplest form of water balance equation is as follows:

\[ R = Q + ET_a + \Delta S \]

where \( \Delta S = \Delta SM + \Delta GW + \Delta SW \)

Here, \( R \) is rainfall, \( Q \) is runoff, \( ET_a \) is actual evapotranspiration, \( \Delta S \) is the storage in the soil (\( \Delta SM \), aquifers (\( \Delta GW \)) and lakes, tanks or reservoirs (\( \Delta SW \)).
2.2 Data layers used in Jaltol Plugin

Table 1: Summary of Data layers used in the Jaltol Plugin

<table>
<thead>
<tr>
<th>S.N</th>
<th>Data Layer</th>
<th>Source</th>
<th>Data Availability</th>
<th>Unit</th>
<th>Spatial Resolution</th>
<th>Temporal Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rainfall (R)</td>
<td>IMD</td>
<td>2000 to 2020 via plugin (original data-set has 1901 to 2020)</td>
<td>mm</td>
<td>0.25 degree (~25 km)</td>
<td>Daily rainfall dataset aggregated to water year¹</td>
</tr>
<tr>
<td>2</td>
<td>Actual Evapotranspiration (ETa)</td>
<td>SSEBop Model</td>
<td>2003 to 2020</td>
<td>mm</td>
<td>1 km</td>
<td>Monthly ETa data used to compute ET for a water year (June-May)</td>
</tr>
<tr>
<td>3</td>
<td>Change in soil moisture storage (ΔSM)</td>
<td>NASA SMAP</td>
<td>2015 to 2020</td>
<td>mm</td>
<td>10 km</td>
<td>Daily soil moisture data used to compute yearly change in subsurface soil moisture</td>
</tr>
<tr>
<td>4</td>
<td>Change in surface water storage (ΔSW)</td>
<td>JRC Global Surface Water Explorer</td>
<td>2000 to 2020</td>
<td>mm</td>
<td>30 m</td>
<td>Monthly water history dataset used to compute change in surface water storage in a water year</td>
</tr>
<tr>
<td>5</td>
<td>Change in groundwater storage (ΔGW)</td>
<td>CGWB (Central Groundwater Board)</td>
<td>1996 to 2016</td>
<td>mm</td>
<td>Point Locations</td>
<td>Monthly groundwater level data is used to compute change in groundwater storage in a water year</td>
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<tr>
<td>6</td>
<td>Land Use Land Cover Mask</td>
<td>LANDSAT (7 &amp; 8) Imagery</td>
<td>2000, 2015 onwards</td>
<td>-</td>
<td>30 m (Cauvery River Basin)</td>
<td></td>
</tr>
</tbody>
</table>

¹ Here “water year” implies the annual cycle associated with the natural progression of hydrologic seasons. We have defined the water year as a 12 month period starting from 1st June of any given year till 31st May of the following year.
2.3 Overview of Data Layers

2.3.1 Actual Evapotranspiration (ETa)

a. **Dataset** - Actual Evapotranspiration\(^2\) (ETa) is produced using the operational Simplified Surface Energy Balance (SSEBop) model for the period 2000 to present. The SSEBop setup is based on the Simplified Surface Energy Balance (SSEB) approach. It combines ET fractions generated from remotely sensed MODIS thermal imagery, acquired every 8 days, with reference ET using a thermal index approach.

b. **Methodology** - Monthly ETa dataset was downloaded from USGS FEWS NET website. Monthly ETa data for the water year, June to May, was combined to get the yearly ETa dataset. Using a shapefile of India the yearly ETa data was extracted for the whole country.

c. **Example**

![Figure 2: SSEBop actual annual evapotranspiration data layer for the water year 2015 overlaid on district boundary shapefile in Jaltol QGIS plugin.](image)

2.3.2 Rainfall (R)

a. **Dataset** - For rainfall, high spatial resolution (0.25 X 0.25 degree), daily gridded rainfall dataset, developed by India Meteorological Department (IMD) was used. The unit of rainfall is millimeters (mm). Data is available for 120 years, 1901 to 2020. It was prepared using the daily rainfall data from 6955 rain gauge stations, located across the country, available in the IMD archive. On an average, data from about 2600 stations per year were available for the preparation of daily grid point data.

b. **Methodology** - The daily gridded rainfall data was added to get an annual rainfall data layer for a particular water year.

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\(^2\) Evapotranspiration is the sum of evaporation from the land surface plus transpiration from plants. Actual evapotranspiration (ETa) is the amount of water that evaporates from the surface and is transpired by plants if the total amount of water is limited.
2.3.3 Change in soil moisture storage ($\Delta SM$)

a. Dataset - The NASA-USDA Enhanced SMAP Global soil moisture data provides soil moisture information across the globe at 10-km spatial resolution. This dataset includes surface and subsurface soil moisture (mm). The dataset is generated using satellite-derived Soil Moisture Active Passive (SMAP) Level 3 soil moisture observations.

b. Methodology - The change in soil moisture storage is calculated by finding the difference between the average subsurface soil moisture for the month of May (pre-monsoon period) in two subsequent years.

c. Example

Figure 4: Change in soil moisture storage data layer for the water year 2015 displayed in the Jaltol QGIS plugin (green indicates increase in soil moisture storage, red indicates decrease in soil moisture storage)
2.3.4 Change in surface water storage (ΔSW)

a. **Introduction** - The water detection history provides information on all the water detections at the monthly level from 1984 to 2020. This dataset was created by analysing 4 million Landsat satellite images of the entire planet to map the extent of and changes in global surface water over time, and visually verified forty thousand validation samples. The monthly water history dataset is available in Google Earth Engine as an image collection with 380 images.

b. **Methodology** - To calculate the change in surface water storage a pre-monsoon period (month of May) is defined. The Monthly Water History dataset is used to create raster images of surface water occurrence for the pre-monsoon period. The difference between pre-monsoon data layers for two subsequent years gives the change in total surface water area in a given water year. Using a power equation\(^3\) mentioned below, change in surface area is converted into change in surface volume (m\(^3\)). To arrive at ‘change in surface volume’ per village/watershed, the change in surface volume is divided by the area of the village/watershed.

\[
C = 0.0023 \times A^{1.5316}
\]

c. **Example**

![Image of Jaltol QGIS plugin with change in surface water storage data layer for the water year 2000 displayed](image.png)

Figure 5: Change in surface water storage data layer for the water year 2000 displayed in the Jaltol QGIS plugin (blue indicates new surface water storage after the end of the water year and red indicates loss of surface water storage).

2.3.5 Change in Groundwater Storage (ΔGW)

a. **Dataset** - The station-wise historical groundwater level data was obtained from Central Groundwater Board (CGWB). The dataset contains over 28,000 groundwater well locations in India, with their historical water levels (BGL) in May, Aug, Nov, Jan. This dataset is available from 1996 to 2016.

b. **Methodology** - The point location data was converted into raster format for each month of available data. Specific yield was assumed to be 0.01 uniformly. Annual change in groundwater level was multiplied with the specific yield to get the groundwater storage in mm. The change in groundwater storage was calculated by finding the difference between groundwater storage for a particular date in the month of May for a given year and the same date in the month of May of the subsequent year.

\(^3\) Establishing Water Surface Area-Storage Capacity Relationship of Small Tanks Using SRTM and GPS - Venkatesan et al (2012)
2.3.6 Land Use/Land Cover (LULC)

a. Dataset - Land use/land cover classification was done using LANDSAT imagery. For the water year 2000-01, raw images from LANDSAT 7 was used while from the water year 2015 until 2020, LANDSAT 8 imagery was utilised. The spatial resolution of LANDSAT 7 and 8 imagery is 30 meters.

b. Methodology - A water year was classified into three seasons - kharif, rabi and dry season using four indices, namely, Normalised Difference Vegetation Index (NDVI), Enhanced Vegetation Index (EVI), Normalised Difference Built-up Index (NDBI) and Modified Normalised Difference Water Index (MNDWI). Five major classes were defined for land use/land cover classification—forest, urban, agricultural, water and others. Focussing only on agricultural land, we further classified the land class into irrigated crop or annual cropland, mixed double crop and mixed single crop. We intend to identify the crop types in the further analysis of this dataset.
c. **Example**

Figure 7: Land Use/Land Cover data layer for the year 2001 displayed in the Jaltol QGIS plugin.

d. **Metadata**

<table>
<thead>
<tr>
<th>Colour</th>
<th>LULC Class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Western Ghats, Elevated Forest, Plantation</td>
</tr>
<tr>
<td></td>
<td>Unirrigated Plantation</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
</tr>
<tr>
<td></td>
<td>Irrigated Horticulture, Plantation</td>
</tr>
<tr>
<td></td>
<td>Annually copped Paddy</td>
</tr>
<tr>
<td></td>
<td>Kharif-Rabi cropped Paddy</td>
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<tr>
<td></td>
<td>Rabi-Zaid cropped Paddy</td>
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<tr>
<td></td>
<td>Kharif-Zaid cropped Paddy</td>
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<tr>
<td></td>
<td>Kharif cropped Paddy</td>
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<tr>
<td></td>
<td>Rabi cropped Paddy</td>
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<tr>
<td></td>
<td>Zaid cropped Paddy</td>
</tr>
<tr>
<td></td>
<td>Kharif-Rabi Mix Crop</td>
</tr>
<tr>
<td></td>
<td>Rabi-Zaid Mix Crop</td>
</tr>
<tr>
<td></td>
<td>Kharif-Zaid Mix Crop</td>
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<tr>
<td></td>
<td>Kharif Mix Crop</td>
</tr>
<tr>
<td></td>
<td>Rabi Mix Crop</td>
</tr>
<tr>
<td></td>
<td>Zaid Mix Crop</td>
</tr>
<tr>
<td></td>
<td>Perennial Water Bodies</td>
</tr>
<tr>
<td></td>
<td>Seasonal Water Bodies</td>
</tr>
<tr>
<td></td>
<td>Annually Fallow, Open, Barren</td>
</tr>
<tr>
<td></td>
<td>Permanent Fallow land</td>
</tr>
</tbody>
</table>
3 Installation of Jaltol QGIS Plugin

3.1 Sign Up for Google Earth Engine

1. Sign up for Google Earth Engine Account, preferably using your Gmail account [here](#). You’ll find the sign up option in the top right corner of the page.
2. Check for acknowledgement of account. Once you fill up all the required details, you will receive the acknowledgement mail from Google Earth Engine in the inbox of your registered mail as shown here. (This should typically arrive in your inbox within 24 hours).

3.2 Install QGIS Software

1. Install QGIS from [here](#) for your respective operating systems. Please install the version 3.8 or higher, ideally 3.16 (the long term release).
Download for Windows

QGIS in OSGeo4W (recommended for regular users):

- OSGeo4W Network Installer

In the installer choose Express Install and select QGIS to install the latest release or QGIS LTR to install the long term release.

The express installs have several optional packages including non-free software. To avoid these you have to use the Advanced Install and choose qgis and/or qgis LETTER in the desktop section.

NOTES FOR EXISTING USERS: OSGeo4W v2 (previously known as testing) is now the regular repository. The latest QGIS release is only available there, as it already requires dependencies not available in the old repository. The long term release is additionally also available in the old repository using the same dependencies as before (see below). This also includes a 2.2.1 version, which OSGeo4W v2 does not support.

CAUTION: Upgrades of old setups using the new repository are not supported. You need to do a fresh install or use a different directory.

Download for macOS

Official All-in-one, signed installers

Mac Installer Packages for macOS High Sierra (10.13) and newer.

QGIS is not yet localized as required by macOS Catalina (10.15) security rules. On first launch, please right-click on the QGIS app icon, hold down the Option key, then choose Open.

Latest release (includes new features):

- QGIS macOS installer Version 3.22

Long term release (most stable):

- QGIS macOS installer Version 3.16

Alternative build

Mac Installer Packages for macOS High Sierra (10.13) and newer.

Installation instructions are in the ReadMe on the disk image. QDAI and Python (both included on the disk images) are installed separately and outside the QGIS app so they are usable on their own. These packages use the python.org Python 3 - other distributions are not supported.
3.3 Install Google Earth Engine Plugin

1. Go to the Plugins menu >> Manage and Install Plugins.

![Plugin Management](image1.png)

2. Click on All and search for “earth engine” in the search box.

![Plugin Search](image2.png)

3. Click on the Google Earth Engine plugin from the search results and click install option seen on the bottom right of the dialog box.

![Plugin Installation](image3.png)
4. Once the plugin is installed, click the checkbox on the left to activate the plugin.

It will show up in the Plugins menu as shown below if installed successfully.
3.4 Install the Jaltol QGIS Plugin

1. Install the plugin.
   - Go to the Plugins menu >> Manage and install plugins >> All
   - Click on Install Plugin

   ![Plugins Installation](image)

   - This will redirect you to the Earth Engine page and ask you to login with your registered email address.

   ![Google Earth Engine Authentication](image)
• Upon logging in, you will be shown a key which has to be copied and pasted in the QGIS dialog box.

• The plugin will install once the key is accepted

2. Jaltol plugin will now be available under the Installed plugins tab. If the checkbox on the left of the Jaltol plugin does not have a tick mark, then activate the Jaltol plugin by clicking it.
3. Check to see that the Jaltol plugin works!

4. Upon clicking the Jaltol option, a dialog box will appear on the right side of the QGIS window as shown here.
4 Sample Exercise

4.1 Selecting Area of Interest

Download the Village Shapefile\(^4\) using the dropbox link to your downloads folder. Watershed shapefile\(^5\) is also available via the same link.

Import the village shapefile using the Area of Interest tab on the Jaltol plugin. The dropdown lists in the Select Village panel will get populated and the village shapefile will be loaded. Select the village of your choice by selecting the state, district, block and then the village from the drop down list.

\(^4\) We have collected village shapefile layers from different sources. For the State of Karnataka we downloaded the shapefile directly from kgis.ksrsac.in portal which provides all available administrative boundaries. For other states there is no state government authorized portal so we had to rely on open source databases like Datameet - github spatial data portals to get the shapefiles. After downloading shapefiles we had done corrections based on "District Census Hand Book -2011 Census Of India" files where you can access tehsil wise village maps for reference.

\(^5\) Source: HydroSHEDS - HydroBASINS version 1.0
You can also select the village using the tool - select features by area or single click - on the selection toolbar.

Add satellite imagery to verify the boundaries of the selected village.
You can also add land use land cover base layer to understand the cropping and land use pattern of the village. Currently, this layer is only available for the Cauvery river basin.

4.2 Calculating Water Balance

Select the year for which water budget is needed and click ‘Save to desktop.’
The calculated water balance for Arepalya village, in the water year 2015-16, that is, June 2015 to May 2016 is displayed above. Out of 716 mm that fell as rainfall, 791 mm was returned to the atmosphere as evapotranspiration and the remaining translated into changes in storages.

In this water year the soil moisture storage went down by 42 mm whereas the groundwater storage went down by 12 mm and the surface water storage remained unchanged. Since we are losing more water to the atmosphere through evapotranspiration than we are receiving as rainfall, this is a water deficit village. If this continues year after year we will see a sustained decrease in groundwater levels.
4.3 Browsing water balance layers

Add water balance layers (Rainfall, Evapotranspiration, Change in surface water, groundwater or soil moisture) to the map by selecting the desired year and clicking ‘Add’.

You can query the values of any data layer by using the tool - Identify Features - on Attributes Toolbar. Values for the selected region will be displayed on a panel located on the upper right side of the QGIS window.
5 Frequently Asked Questions

What does Jaltol do?
It allows users to compute ‘water balances’ for any area of their interest, be it a village, watershed or administrative area.

Do I need to be familiar with QGIS to use Jaltol?
Basic knowledge of QGIS is helpful, but not necessary, you can explore all of Jaltol’s functionalities using the Sample Exercises in this document.

Are there any other prerequisites to use Jaltol?
The main mandatory prerequisite for Jaltol is a Google Earth Engine account, which allows you to access the datasets that are used to compute the water balance. If you do not have one already, you can sign up for one at https://signup.earthengine.google.com/. Refer to section 3 for more information.

What inputs/data do I need to provide for the water balance computation?
If you wish to compute the water balance for a custom area of interest all you need to provide is a shapefile for that area. Alternatively you may use one of the shapefiles that come provided with the plugin.

Can this plugin compute the water balance for an area using data I have collected?
At present no, the water balance is computed using secondary data only. In the future we plan on developing features that allow users to compute the water balance using their own data as well. We are working on Jaltol version 2 that will incorporate this feature. To stay updated on the next version, join our mailing list.

Where does the data for the water balance come from?
All of the data used in this plugin comes from secondary data sources, most of these are remote sensing datasets, except for groundwater which is data derived from groundwater monitoring stations of the Central Groundwater Board (CGWB)

Is this water balance accurate?
The water balances developed with Jaltol currently are meant to provide a quick and approximate snapshot of an area. Thus since convenience, not accuracy, was the first point of focus, the initial datasets used within Jaltol may not always be accurate. We plan on providing alternate data layers and accuracy estimates for each layer in future iterations of this plugin.

How can I reach out to the Jaltol team for resolving queries or errors?
Please reach out to us at jaltol@atree.org
6 Way Forward

Jaltol Version 2

Over 8 weeks starting in July 2021, we held 16 training sessions which were attended by 51 participants from civil society organizations, startups, state government institutions and researchers.

<table>
<thead>
<tr>
<th>Types of Early Users</th>
<th>16 Training Sessions</th>
<th>51 Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civil Society Organizations (16)</td>
<td></td>
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<tr>
<td>• Frank Water</td>
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<td>• SOPPECOM</td>
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<td>• Development Support Centre</td>
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<td>• Rotary Club</td>
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<td>• Pani Panchayat</td>
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<td>• Nature Dots</td>
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Based on the feedback we received, we will work on developing the Jaltol version 2 to improve the accuracy of existing data layers and add some of the features that the CSOs have requested for.

In the coming months we would like to do the following:

1. Actively engage with 30 CSOs in 7 states to use the Jaltol to prepare water balances in 500+ villages.
2. Develop the tool to include the following features:

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The tool will focus on states where the Atal Bhujal Yojana is being implemented, since these states have a pressing groundwater management problem. The states that are a part of this programme include, Karnataka, Maharashtra, Madhya Pradesh, Gujarat, Rajasthan, Uttar Pradesh and Haryana. We will also include Tamil Nadu, since we have prior experience working with CSOs in the state.
<table>
<thead>
<tr>
<th>S.N</th>
<th>Categories</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Include primary data</td>
<td>• Incorporate ground data for accurate water balance estimation</td>
</tr>
</tbody>
</table>
| 2   | Improve data quality               | • Develop data quality standards for shape files  
• Offer alternate data layers for more accurate water balances  
• Follow 2016 GEC norms for groundwater change estimation |
| 3   | Optimise UI/UX                     | • Host vector boundaries in GEE/Geoserver  
• Add output in regional languages (focus on kannada)  
• Search for village name by text (after selecting district/block) |
| 4   | Provide other analyses (water balance related) | Provide the following analyses:  
• Annual trend analysis of water balance  
• Monthly/seasonal water balance  
• Wet/dry year comparison |
| 5   | Incorporate typologies             | • Incorporate typologies into the plugin                                                                                                                                 |
| 6   | Incorporate alternate official maps | • Incorporate Bhuvan LULC map                                                                                                                                 |
| 7   | Offer training                     | • Develop training material for allowing CSOs to be able to use the tool easily with little assistance |
| 8   | Offer customer Support             | • Set up a customer support contact with resources so CSOs can reach out to us for troubleshooting. |
| 9   | Develop and incorporate metrics for assessing usefulness of Jaltol | • Develop acquisition, activation, and retention metrics to monitor usage of the tool -- include metrics capturing features as a part of the tool. |