Andhra Pradesh Water Resources Information and Management System(I) is truly impressive water information system, possibly not available in any other state or even at national level, at any time in India. The comprehensiveness of the water information system is striking, as it not only includes reservoir water storages of Major and Medium Projects, but also storages in minor projects, minor tanks, water conservation structures (check dams, percolation tanks) but also groundwater and most importantly, soil moisture. These are collected in real time from diverse information sources including on ground measurements, satellite based assessments and also sent via mobile apps from diverse sources. And the information is put out in real time, along with number of analysis. The data are collated and analysed using tools from Vassar Labs, like Machine learning, Artificial Intelligence and big data.

The APWRIMS of the Andhra Pradesh Water Resources Department (APWRD) works in collaboration with National Remote Sensing Centre (NRSC) for Indian Space Research Organisation (ISRO) and Vassar Labs(II). Vassar Labs is the technology partner for APWRIMS. Its headed by Dr Prasad, who is considered close to Andhra Pradesh Chief Minister Chandrababu Naidu. APWRIMS been functional now for about 18 months. The Andhra Pradesh Planning Department and Agriculture department has played a key role in conceptualizing this and ensuring its implementation, said A Ravindra of WASSAN, Andhra Pradesh.

THE PROCESS The process of putting together APWRIMS started in March 2017 with signing of three MOUs between APWRD and NRSC. The NRSC announcement of the collaboration[III]notes: ‘Memorandum of Understanding (MOU) was signed on 15 March, 2017 between Andhra Pradesh State Water Resources Department and NRSC, ISRO. The main objective of this agreement is to extend support for development a web-based geo-portal: ‘AP State Water Resources Information and Management System’ – APWRIMS by WRD-AP. The APWRIMS will host all the spatial and non-spatial data of water resources sector of the AP State. The system is expected to facilitate seamless data ingestion of real-time field data, facilitate water resources inventory through satellite observations & validated models, constitute decision support tools, water audit, etc. NRSC (ISRO) would provide requisite technical knowhow, training and guidance to WRD-AP:’ Vassar Labs was the chosen as technology partner to implement and scale the solutions.

ISRO provides further details about the three MOUs in Press Release dated March 15,2017[IV]. The agreement is valid for a period of two years till March 2019, extendable with mutual consent: Besides APWRIMS MOU mentioned above, an MOU for experimental meteorological services to the State was signed besides the third one about Disaster Management. Andhra Pradesh Varuna, an android mobile app was also released on this occasion. The App has been deployed as part of APWRIMS work by Vassar Labs. This app makes use of Automatic Weather Stations and Ground Water Piezometers, installed across the state, as well as weather forecast data from ISRO to provide required weather parameters:

- Current weather (Rainfall, Temperature, Humidity, Wind Speed and Direction, Ground Water Levels) from 1800 Automatic Weather Stations & 1200 Ground Water Piezometers
- Next 24-hrs forecast at six hourly intervals
- Next 7-days forecast

It’s likely that some or all of the funding for this may have come from the World Bank funded National Hydrology Project, see AP WRD presentation[V] on Aug 17-18, 2017. On Sept 6, 2017[V] the media reported, the www.apwrims.ap.gov.in has been updated.

The Dossier for the portal says: “Approx 1 million geo-tagged Water bodies, and 1.3 million geotagged bore wells, along with various layers like administrative, hydrological, soil, agriculture, satellite, aquifer, LULC, Rivers & Canal, Drainage network, DEM, Command Areas etc (are included)... Approximately 3 Lac point data comes every day from different sources like Automatic Weather Stations, Reservoir Level sensors, Ground Water Level sensors, River and Canal level sensors etc.” Information for different data points come from Satellites/ models/ IMD/ ISRO/ WRD, among other sources. Some ground trothing has been incorporated, but a lot more remains to be done, we gather from one of the co-founders of the project.

WEB PORTAL CONTENT

The web portal is divided into three main sections (each can be clicked from the top of the opening page): Water Resources Information, Water Resources Management and Geo Portal. More details are given below for each.

The web portal opens with an overview of water storage situation at a given point of time, starting with words: “Water Available Across State: 899.4. TMC” (as seen at 3 pm on Nov 12, 2018). The figure of water available across the state that the opening page at a given point of time (not clear how frequently this gets updated) is sum of water available in Reservoirs, in Geo tagged MI tanks and in Soil Moisture, but excludes water stored in water conservation structures or groundwater. No explanation is given for these inclusions and exclusions.

Below this we can see figures of water storage in 89 Reservoirs, 38413 MI (Minor Irrigation) Tanks and 969600 water conservation structure, with % of total capacity for respective type of storages. Below that, Total Rainfall (in TMC –Thousand Million Cubic Feet- since June 1), Available Soil Moisture (ASM) in TMC and Groundwater storage change (since June 1) in TMC is given. Below we give information for each section in detail to understand the breadth of information and also gaps or limitations, given in red lettered text through out this document.

Water Resources Information This section is divided into following six key areas:

- Reservoirs: This has Summary view and Release view. In Summary view there are two options: List View and Map View. List View Reservoir Type View: Major, Medium, Others River Basin View: Godavari, Krishna, Pennar, Others Water Available in Reservoirs of AP: for 89 reservoirs: Level (ft) and storage (TMC) at given date and time and storage as % of storage capacity, Inflow (Cusecs), Outflow (Cusecs), Basin where the reservoir is situated.
This is available in three ways: Summary, Details and SCADA view.

A question arises as to why only 89 reservoirs are included here, while as per National Register of Large Dams[7], Andhra Pradesh has 142 completed large dams and 25 under construction large dams, all of these should have been included in different modes.

- **Detail view includes levels and storage capacity at FRL, Dead storage, a year back on same date, on June 1.**

**SCADA view** is very useful in understanding the water flow patterns within and across basins.

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**APWRIMS: AP Reservoirs SCADA view Lowest part**

Water Storage in eight related reservoirs outside AP is also given at the end of Reservoir View page.

**Release View:** Here two options are available: Barrages and Reservoirs.

**Barrages:** Water Release information on a given date (cusecs) and Total water release since June 1 (in TMC) is given for three barrages: Prakasham Barrage, Sir Arthur Cotton Barrage and Gotta Barrage. From Prakasham Barrage, information is given about water releases into Guntur Channel, Krishna West Main Downstream, Krishna East Main Downstream and spill into river. From Sir Arthur Cotton Barrage, information is given about water releases into Eastern, Western, Central Delta and River Surplus. From Gotta Barrage information is given about water releases into Left & Right Main canal and River Surplus.

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**APWRIMS: Barrages Release view**

Reservoirs: Information about releases on given day (in cusecs, from spill way, power house, canals, others) and cumulative release since June 1 (in TMC) is given for Seven Reservoirs inside AP and 12 Reservoirs outside AP. Reservoirs within AP includes: AP Reservoirs: Srisailam, Nagarjun Sagar, Pulichintala in Krishna basin. Somasila, Velogodu Balancing reservoir, both in Pennar Basin Kandaleru Reservoir in Upputeru basin Yeleru Reservoir in Yeleru basin Outside AP Reservoirs: Krishna Basin: Almatti, Naryanpur, Jurala, Ujjani, Tungabhadra Godavari basin: Jaikwadi, Kadam, Lower Maniar, Nizam Sagar, Singur, Sri Ram Sagar, Sri Pada Yellampalli

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**APWRIMS: Reservoirs Release View of Reservoirs within AP**

- **Map View:** The map with district boundary gives location for each of the 89 reservoirs, size of the dot signifying the size of the storage capacity and colour code for Medium (yellow) and major (blue). On taking curser to the dot, the name of the project appears along with level and water storage figures for each day for last seven days. The Map could have easily also given river basin boundaries and names of the river basins.

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**APWRIMS: AP map with location of Reservoirs**

**MI Tanks:** Two views here: Summary Table and % fill report. In Summary table, district wise number of tanks, their storage capacity and storage on given day are given. The date and time of this information is not mentioned. In % fill report, number of tanks with 100%, 75%, 50%, 25% and 0% fill are given, in reality, this should be replaced by range, since that is the situation. On Nov 12, 2018, out of 38143 tanks in AP, 38101 tanks were already empty, only 42 tanks had some water. And strangely, 30.5% of the 202.56 TMC or, 61.78 TMC water was available! In no less than in eight districts, all the tanks had 0% water, but total water stored in MI Tanks in all these districts was significant, ranging from 0.37 TMC in Kadapa to 12.81 TMC in Krishna district!

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**APWRIMS: MI Tanks storage situation Fill Report in AP districts**

**Groundwater:** There are two filters here:

**Groundwater availability:** This can be seen in text view and Map view.

- **Text view:**

  - A table provides district wise details of average groundwater level among monitored wells on given date, the level a year back and on June 1 of the same water year. It also provides difference in levels and storage with respect to June 1 and same date previous year.

  - A graphic provides bar for each district, divided into % wells with water level below 3 m; 3-8 m; 8-20 m; above 20 m. Another graphic provides state wise % distribution of monitored wells for the same depth ranges.
A table gives % break up for the above class of depths for each district.

APWRIMS: Dynamic GW available table in AP districts

APWRIMS: GW wells distribution by depth class

Map View: This is most fascinating. The overview map gives the figure of number of wells in some 16 sections (not clear why 16, since AP has 13 districts), total coming to 1287, one assumes that is the number of monitored wells across AP. As one enlarges the map, these are further divided into sub sections and sub sub sections. In the fourth view (third enlarged view) we see a symbol for each of the monitored well at its location, in colour code: Blue (<3 m), Green (3-8 m), Yellow (8-20 m), Red (>20 m), White (no info). On clicking the symbol, a pop up window gives information about that well: Location (lat-long, name of village/ mandal/ district), time of observation and depth in m).

APWRIMS: Map snapshot showing GW wells location with colour code in AP

Power Saving: the graph on top titled “Power Saving due to Ground Water Recharge” depicts monthly average depth (in m) in blue line for current year, in green line for the last year and in black horizontal line for depth as on June 1. This graph implies that during Dec-June in past one year, the depths were 2 m less than the same previous year, this is claimed by Vasser Labs as impact of timely groundwater recharge and hence power saved. For November, the difference is less than 2 m. However, for the June-Oct period, the depths previous year were less than than those this year, the difference ranging from less than 2 m to up to 3.5 m. The table gives figures in Rs (Crores) saved for different comparisons, but it seems very unclear how this has been counted, an explanatory note is required. The graph should have also given month and year for each data point to avoid confusion.

 APWRIMS: GW cost saving Table

Soil Moisture: The table gives district wise figure of soil moisture stored upto 100 cm depth and its % with respect to total storage capacity of the same. This is apparently based on satellite images. The table should also give the specific date/ time for which this figure is valid.

APWRIMS: District wise Soil Moisture available

Rainfall: This is available in two options: summary and mandal level rainfall distribution. Summary is also available in table and in map view In Table view, district wise and state level actual rainfall for the current month till date, previous two months and total rainfall since June 1 is given along with normal rainfall. For the period from June 1, the % deviation of actual from normal rainfall and status (normal/ deficient/ scanty/ excess) is given. In Map view, it’s not clear what the number that appears as we enlarge the map, represents. Final view has many location specific symbols with colour code: Blank (no data), grey (no rain), Light green (upto 1 mm?), Bright Green (1-5 mm) and dark green (over 5 mm?). The pop up window for each symbol also gives name of the place/ mandal and district. In case of mandal wise rainfall distribution mode, the table gives figures of number of mandals with scanty, deficient, normal and excess rainfall in each district and state; the figures for state for Nov 13, 2018 were: 125, 405, 129 and 11 respectively, total number comes to 670, but it is not clear for what date or period is this relevant for.

APWRIMS: District wise Rainfall Table

APWRIMS – Rainfall distribution Mandalwise

Water Conservation Structures: This provides information in admin and basin filter. In admin mode, the table gives district wise and state level figures for number of structures, their total capacity and current storage (in MCFT), for farm ponds, Check Dams (E, not mentioned what E stands for), percolation tanks, others and Total. No date is given to clarify for which date this is the situation.

APWRIMS – District wise water conservation structures

• In Basin mode, above mentioned figures are given for each of the 40 sub basins. If they could give the figures for WC structure sub basin wise, it’s not clear why they could not give break up of other figures (reservoirs, MI Tanks, Groundwater, Soil Moisture, Rainfall) too, sub-basin wise. The date for which these figures are relevant is also not given.

APWRIMS – Sub basin wise break up of Water Conservation structures – 1

APWRIMS – Sub basin wise water conservation structures -2

Lift Irrigation Schemes

Information here is available in list and map mode.
basins, but there is no forecasting information here! Large parts of AP, about 38 of the 40 sub basins are thus out of the Basin Inflow Forecasts.

In case of Godavari basin. Also most of the spaces for forecast are blank in the table, including all the outflow ones.

Praksham Barrage: This is the third (Optimal) mode, but that does not seem functional. The Map mode is also indicated, but does not seem to be functional.

The figures of water conserved as given here is lower than capacity of the water conservation structures in most districts except East & West Godavari, Srikakulam, Visakhapatnam and Guntur districts. Not explained why. In Anantpur, Chittoor and Kadapa, water conserved is very close to the Runoff quantum. But it is not mentioned as to what dependability these runoff figures are for. For each of these crops, one can view district wise figures of Area sown, area in critical stage, Area under pest and disease stress, additional water required (MCFT) and water available (in MI Tank, Groundwater, Farm Pond, Check dams, percolation tanks). It’s not clear why the water available in reservoirs is not included here. Strangely, Groundwater is shown as available only in Srikakulam district. This information is available in summary and detail mode. There is supposed to be a third (Optimal) mode, but that does not seem functional. The Map mode is also indicated, but does not seem to be functional.

Village Level Water Budget Some graphic and tabular figures are given, but would require explanatory notes to understand what this is about and how it is to be used. Water Conservation Management The figures of water conserved as given here is lower than capacity of the water conservation structures in most districts except East & West Godavari, Srikakulam, Visakhapatnam and Guntur districts. Not explained why. In Anantpur, Chittoor and Kadapa, water conserved is very close to the Runoff quantum. But it is not mentioned as to what dependability these runoff figures are for. For each of these crops, one can view district wise figures of Area sown, area in critical stage, Area under pest and disease stress, additional water required (MCFT) and water available (in MI Tank, Groundwater, Farm Pond, Check dams, percolation tanks). It’s not clear why the water available in reservoirs is not included here. Strangely, Groundwater is shown as available only in Srikakulam district. This information is available in summary and detail mode. There is supposed to be a third (Optimal) mode, but that does not seem functional. The Map mode is also indicated, but does not seem to be functional.

In addition to above Audit, the same page is also available with filters: Admin view/ basin view; Audit Period (it’s not clear dates within which period can be selected, since data is not likely to be available for all dates); any of the 13 districts or groups there of can be selected as admin locations; any of the 40 sub basins or groups thereof.

Crop Stress Management The crop water stress figure can be viewed here for a number of crops: Groundnut, Cotton, Castor, Sugarcane, Greene gram, Redgram, Blackgram, Jowar, Raagi, Bajra and Maize (Paddy, Pulses and Chillies are listed but seems inactive, as no information is available for them). In addition to above Audit, the same page is also available with filters: Admin view/ basin view; Audit Period (it’s not clear dates within which period can be selected, since data is not likely to be available for all dates); any of the 13 districts or groups there of can be selected as admin locations; any of the 40 sub basins or groups thereof.

Run Off forecast This is available in tabular and map formats. In Tabular format, District wise forecast of runoff (in mm) for the current day and next five days is given. In another table, mandali distribution for the total of 667 mandals is given for no runoff (0-0.1, assuming the unit here is mm, though none is mentioned), very light (0.1-5), light (5-15), moderate (15-80), heavy (80-150) and very heavy (>150) runoff is given for current and next five days. No information seems available in the map view here.
inter-basin transfers) and demand (agriculture, Residential (strangely mentioned as ZERO), Evapo-transpiration and Inter-Basin outflow. Strangely, Industrial demand or requirement for environment flows does not even get mention). Map view does not depict any new information, except it provides colour code on the map for deficit basins (red) and surplus basins (blue). The results given here seem a bit counter intuitive here. All the sub basins of drought prone Rayalseema, including Krishna are shown surplus basins, while the relatively high rainfall sub basins North/ North East of Godavari, generally considered surplus basins are almost all in red!

**Deficit water indent** There are supposed to be two options: Productive and Optimal, with figures for ten crops, but almost everything is blank.

Geo-Portal Does not seem provide anything additional beyond what is already available under above heads.

**THE POSITIVES** There is no doubt that the breadth of water sector information that is available on APWRIMS portal, that too on real time basis is unprecedented. It’s almost dream come true for any one interested in water sector. Such information is not or has never been available for any state, or even at Union of India level. The portal helps[viii] in identifying the potential of water conservation at district, sub-district and sub basin levels, and find quick ways to achieve it locally, as one of the Vassar Labs Co Founders told SANDRP. He said the CM uses the portal during meetings each Monday to review the status of water storage, demand and supply and give targets for water conservation for each district/ Mandal/ Sub Basin. It can also help in identifying water stress area, close by water sources to ameliorate such stress and plan such actions in time to avoid the damage to crop. This can also be hugely helpful in avoiding or reducing the damage during flood disaster of the kind Kerala faced in 2018 monsoon or Krishna basin in Andhra Pradesh faced for example in Oct 2009.

The water storage information available itself is so amazing and unprecedented. Compare with CWC’s Weekly reservoir bulletins, its only system to measure and make public water storage situation in India, that too is not working on so many days. This is the only source media quotes in terms of water storage situation, which is seriously problematic as SANDRP wrote

[ix] recently.

The CWC’s reservoir level information comes with a lag of at least a day, not updated in real time. Its available only on weekly basis, unlikely the APWRIMS that updates several times in a day. And the reservoir storage capacity reported by CWC is not even updated for ages, even though high siltation rates plague almost all reservoirs. The bulletins do not even mention the river basins for each of the dams! The information on APWRIMS is a refreshing contrast to the information available on website of India’s premier technical body on water resources! [Its another matter that CWC’s bulletins are not even accessible for many days.]

**LIMITATIONS** In the detailed given above, we have already highlighted (in red letters) the limitations of the information available on the APWRIMS portal. Some other limitations:

No provision of E flows. No acknowledgement that water is integral part of environment and no mention of environment issues related to water. This is a very serious flaw of the portal, reflecting the mindset of APWRD. No Archives: No archives are maintained on the website for the precious information available, nor is most of the information downloadable. The least the portal managers can do is to download some key information on daily basis and others on weekly basis. The portal uses various units at different places. For example, for storage it uses TMC at some places and MCFT at others. May be MCM and BCM should be used at all places. Similarly, it uses mm and ft at different places. It should possibly use mm, cm and m at all places. Not all data is linked with specific date. The date for which the information is relevant must be mentioned everywhere. We have also heard that due to financial disputes with APWRD, certain informations/ aspects have been blocked or dropped. Reportedly, the system to gather make public water storage situation in India, that too is not working on so many days. This is the only source media quotes in terms of water storage situation, which is seriously problematic as SANDRP wrote

Suppose to be two options: Productive and Optimal, with figures for ten crops, but almost everything is blank.

A big question is, will APWRIMS continue beyond two-year term of MOU between APWRD and NRSC-ISRO? Considering the current situation, there are question marks, though one hopes that APWRIMS does continue the exemplary work it is doing and improve for long time to come. The Technology partners, Vassar Labs, are, we understand, in the process of discussing expansion of this system to other states and even Union of India. The one in North East India is already functioning, we hope to write about that soon.

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END NOTES:

[iii] https://nrsc.gov.in/APWRIMS
[viii] https://www.newsland.in/2017/10/16/plan-conservation-of-water-more-carefully/