WaterSENSE

Making SENSE of the water value chain in Australia

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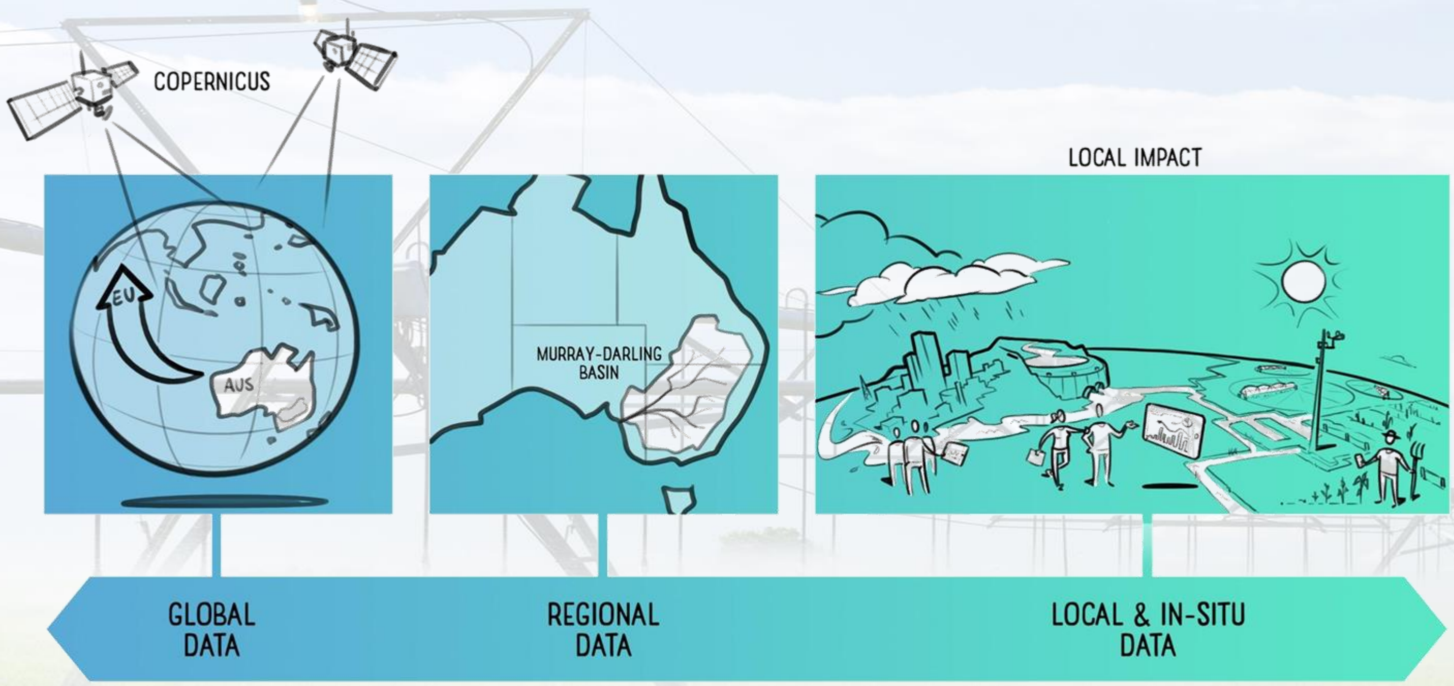
#MakingWaterSENSE

Newsletter 3 - August 2021



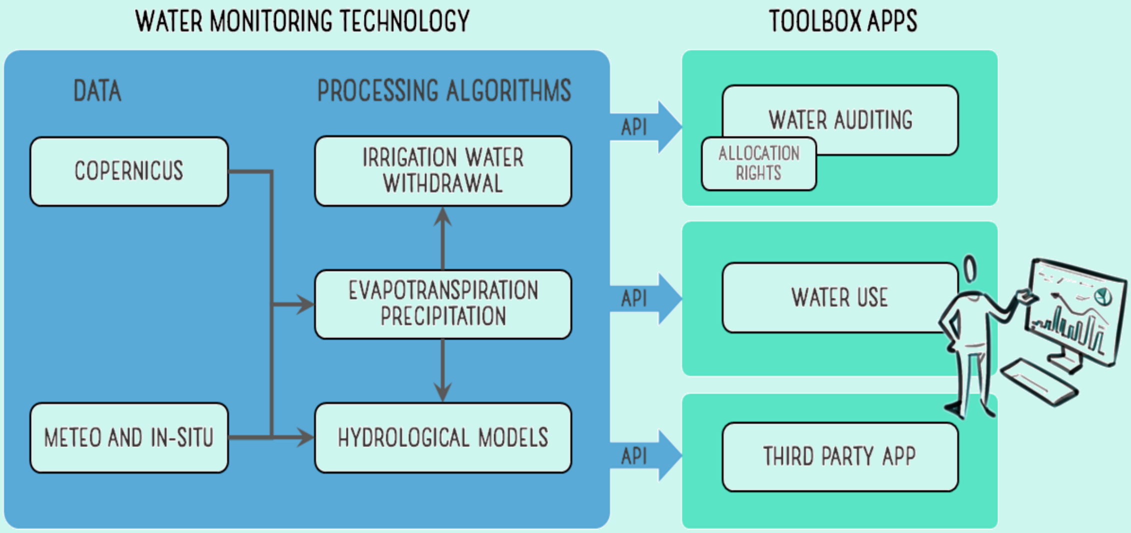
LinkedIn: Project WaterSENSE **Twitter:** @MakeWaterSENSE

This project has received funding from the Horizon 2020 research and innovation programme grant agreement No 870344

WaterSENSE

WaterSENSE Toolbox Concept

- Water Monitoring System: Modular, operational, water monitoring system: Integrates Copernicus EO data, ground radar, models, in-situ data, and novel research.
- Water Management Toolbox:
    - Makes data, algorithms and services available to users. Various Apps provide reliable, actionable Information.



Novel Research

Novel research in the project will develop scalable information services, based on advanced big-data processing algorithms, to determine variables such as evapotranspiration, irrigation water use, rainfall and soil moisture. Machine learning will be used where appropriate to allow automatic data processing and reduce uncertainty.

WaterSENSE consortium members

The WaterSENSE consortium consists of 7 partners: eLEAF BV (Netherlands), Hydrologic Research (Netherlands), Water Technology (Australia), Hidromod (Portugal), hydro & meteo (Germany), the University of Sydney (Australia) and HCP International (Netherlands).

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Partner Spotlight – University of Sydney

Associate Professor of Hydrology and Catchment Management, Dr. Willem Vervoort

A/Prof Willem Vervoort is the leading hydrologist at the University of Sydney and an expert in quantitative Hydrology and Catchment Management, having established and grown this discipline in the Faculty of Science over the last 20 years.

His specific discipline expertise is in developing and improving models to advance sustainable water management. This requires understanding interactions between human management, vegetation, water and climate in semi-arid landscapes, as well as understanding flow paths groundwater and surface water geochemistry. His technical expertise focusses on improving simulation modelling of catchments at different scales. This includes quantifying uncertainty in predictions, integrating big data and remote sensing in models and understanding how the real world is simplified in models.

He has strong industry collaborations in research and consultancy projects and international collaborations in Europe, Indonesia, Uruguay, and India. For this he translates technical expertise into management and policy outcomes.

He teaches in his expertise area in undergraduate and post graduate courses. Under his primary supervision, 18 PhD students have completed their program.

Apart from WaterSENSE, Willem is involved on projects on landscape rehydration in northern NSW, catchment management in Uruguay, and has just been appointed the Director of the IITC ARC centre DARE (Data Analytics for Resources and the Environment).

Dr Ignacio Fuentes

Dr Ignacio Fuentes completed his PhD from the University of Sydney focussing on remote sensing and hydrology at large scales in 2020. This builds on his undergraduate and masters' degree in Engineering and Agriculture from the University of Chile. His current work related to WaterSENSE focusses on the quantification of aspects of the water balance using remote sensing, specifically focussing on soil moisture and water levels in farm dams and Copernicus data. He is developing a data science approach based on deep learning neural networks to predict soil moisture across Australia using Copernicus and other remote sensing data. Recently, he published a paper outlining how we can observe water levels in farm dams using Sentinel satellite data, but also how the uncertainty related to this can be quantified (https://doi.org/10.1016/j.envsoft.2021.105095).

Both the soil moisture and farm dam product will be implemented in the Hydronet platform, working with the WaterSENSE partners.

Please **refer to the section on research updates for more information on the current status** of the research.

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WaterSENSE Summer School

Aims

Our first WaterSENSE summer school event was successfully held from 23 – 25 February 2021. The aims of the summer school were for the students to:

- Work with an application platform that can be used for climate smart water management
  - a) Introduction into the Hydronet platform for data management;
  - b) Remote sensing information via different platforms, such as Digital Earth Australia, Google Earth Engine (GEE) and the Hydronet API;
  - c) scripting and associated tools for version control and collaboration.
- Develop scripting in python to access the different highlighted interfaces.
- Collaborate with fellow summer school participants to address real world challenges in three water management case studies in the Namoi basin.

How it went

17 participants attended the full workshop, with the majority being on-line. In fact, we only had one participant attend in person.

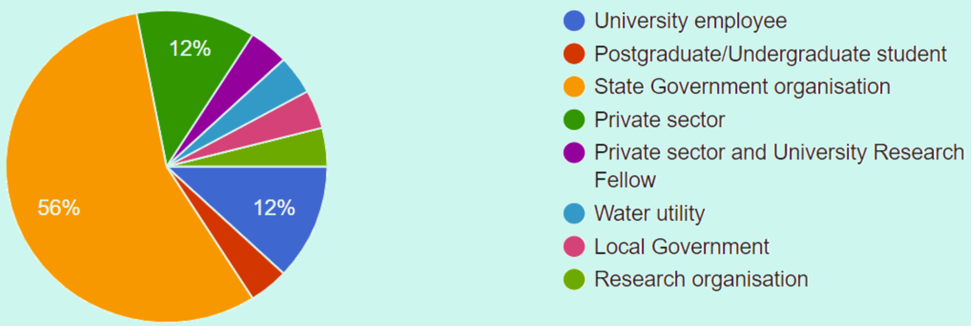

Figure 1: overview of the backgrounds of the summer school attendees

During the workshop, a combination of 'show and tell' and hands-on activities were presented by consortium members: Water Technology Pty Ltd, Hydrologic BV, eLeaf BV and the University of Sydney. In addition, Geoscience Australia presented some of their approaches and delivered a hands-on component.

A final component consisted of a short brain-storm session in which participants thought about possible applications of the applications they have been exposed to in the summer school.

Overall, the Summer School was a success. We received good feedback and participants were generally happy with the overall structure and delivery. The number of enrolments were greater than we expected. Verbal feedback was that all students liked the course and learned a lot. The variety of topics offered helped in moving the course along and gave nice hands-on experience.

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Research Update

Volume and uncertainty estimates of on-farm reservoirs using surface reflectance and LiDAR data

The WaterSENSE project has published its first paper, by consortim members Ignaciao Fuentes and Willem Vervoort from the University of Sydney. The paper has been published in the Journal of Environmental Modelling and Software, is titled "Volume and uncertainty estimates of on-farm reservoirs using surface reflectance and LiDAR data" and can be accessed here: https://doi.org/10.1016/j.envsoft.2021.105095

The methods in this paper will continue to be developed during the remainder of the WaterSENSE project and will be used to improve the link between the WaterSENSE irrigated water use at filed level from EO product and the authorised water use.

Abstract

Accurate estimates of water volumes are crucial for ater management. This study applies an automated methodology to detect small-scale on-farm dams and develops a novel application of Bayesian inference to jointly simulate volumes and uncertainties. A linear relationship was assumed between flooded pixel area images derived from LiDAR datasets and water index rasters derived from Sentinel 2 images. Using a Markov chain Monte Carlo (MCMC) method led to accurate estimates of water elevations and reservoir volumes, with a sys-tematic error of about 2.5% and 10% of the maximum capacity during the study period in Keepit dam and Pamamaroo lake, respectively. Additionally, the method quantifies uncertainties of volumes. The presence of woody vegetation growing at the reservoir walls leads to a deterioration of estimates. This methodology may be used as an auditing tool in water governance schemes or to gain knowledge on water losses at the field scale.

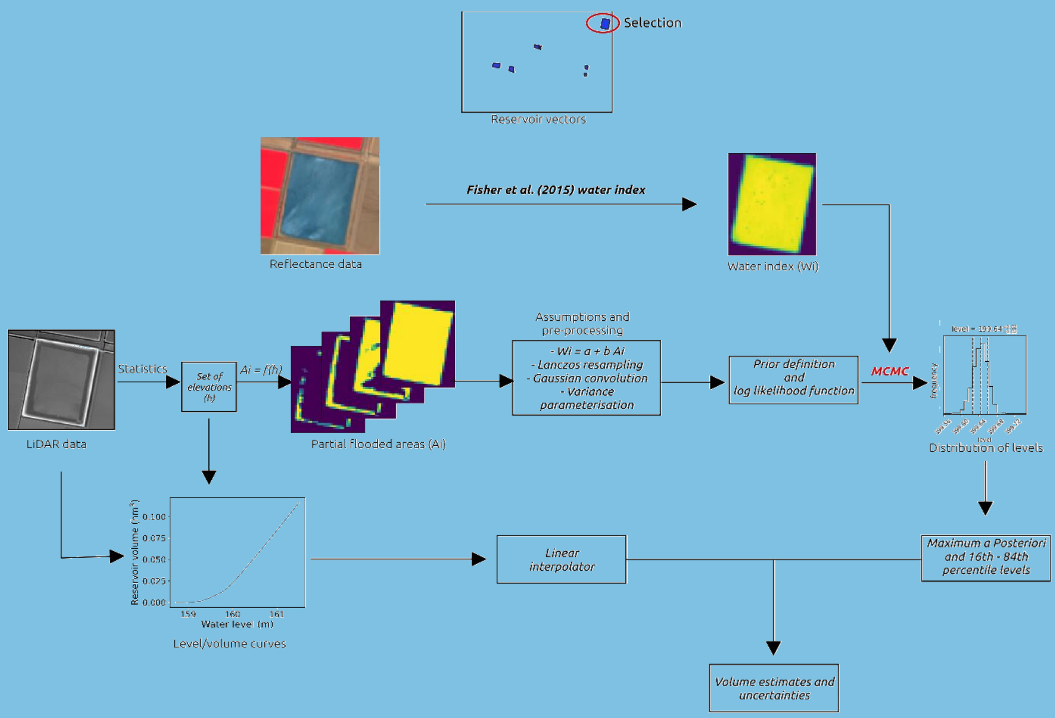

Figure 2: Flowchart for the reservoir volume modeling and the uncertainty calculation.

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Soil moisture

Soil water content is one of the cornerstones of the water balance and has many implications for the water and carbon cycle, the correct functioning of ecosystems, and agricultural management decisions. In agriculture, soil moisture monitoring allows farmers to optimise the water irrigation schedule, precluding stress conditions in crops that might lead to yield reductions.

The objective of our work is to downscale low-resolution (>10 km) soil moisture products (the NASA-USDA SMAP collection) to the field scale and across the root-zone soil depth fusing multiresolution datasets through deep learning models.

Our results show an improvement in performance using reference soil moisture networks across Australia compared against the NASA-USDA SMAP collection and the AWRA-L model. However, the performance of the models tends to degrade with the soil depth.

Additionally, the relationship between soil moisture and the input variables used and their order of importance was interpreted. Soil moisture and uncertainty maps were developed at the field scale and these seem to capture the correct spatiotemporal dynamic of dry/wet conditions. A discussion of further research based on our current results will still be carried out.

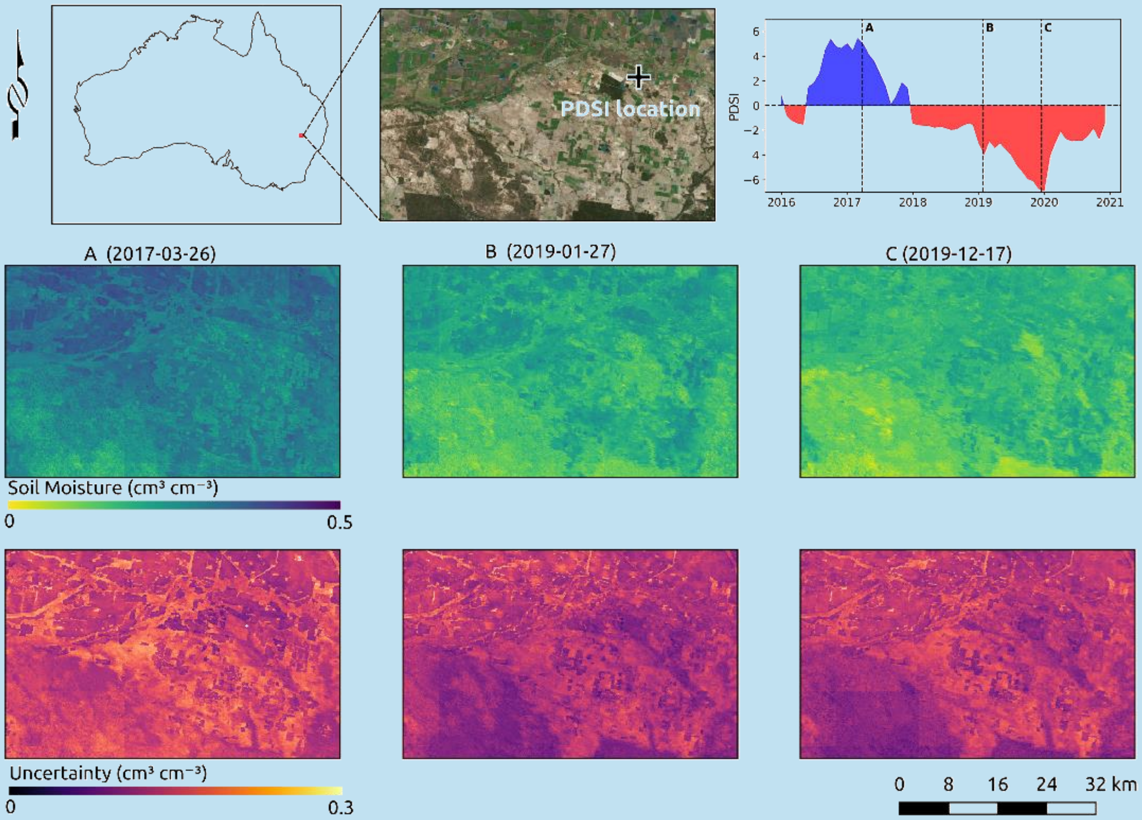

Figure 3: Surface soil moisture predictions in three selected dates for one area of interest (AOI). These dates were selected based on the Palmer Drought Severity Index (PDSI) series sampled within the AOI which can be observed in the right figure of the upper panel. The lower panels show the uncertainty calculated as the 90 % confidence interval of predictions for these three dates using 65 models (one per soil moisture station).

Working with colleagues in DARE and Water Technology, Willem and Ignacio are developing a proposal with the UK Turing institute to formally quantify uncertainty in the soil moisture model as an extension on the current work

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Automated Irrigated Area Detection

During the demonstration phase of WaterSense, among others, the Water Use Monitoring and Auditing Service (WUMAS) application will be demonstrated. This application calculates the difference in evapotranspiration for natural and irrigated pixels, which is used to estimate irrigation amounts on a monthly basis. Currently, the WUMAS application relies on third party land cover maps to distinguish between irrigated agriculture and natural vegetation.

However, these land cover maps are static and not updated every year or during the current season, resulting in areas being classified as irrigated agriculture that might not have been actively irrigated. Therefore, eLEAF is developing a high resolution (10 m) variable irrigated area map which reviews the irrigation likelihood of agricultural areas on a yearly basis.

This product is currently being developed and tested for a small part of the Namoi catchment, by combining statistics of various remote sensing based features, such as evapotranspiration, precipitation, NDVI, soil moisture, and albedo data.

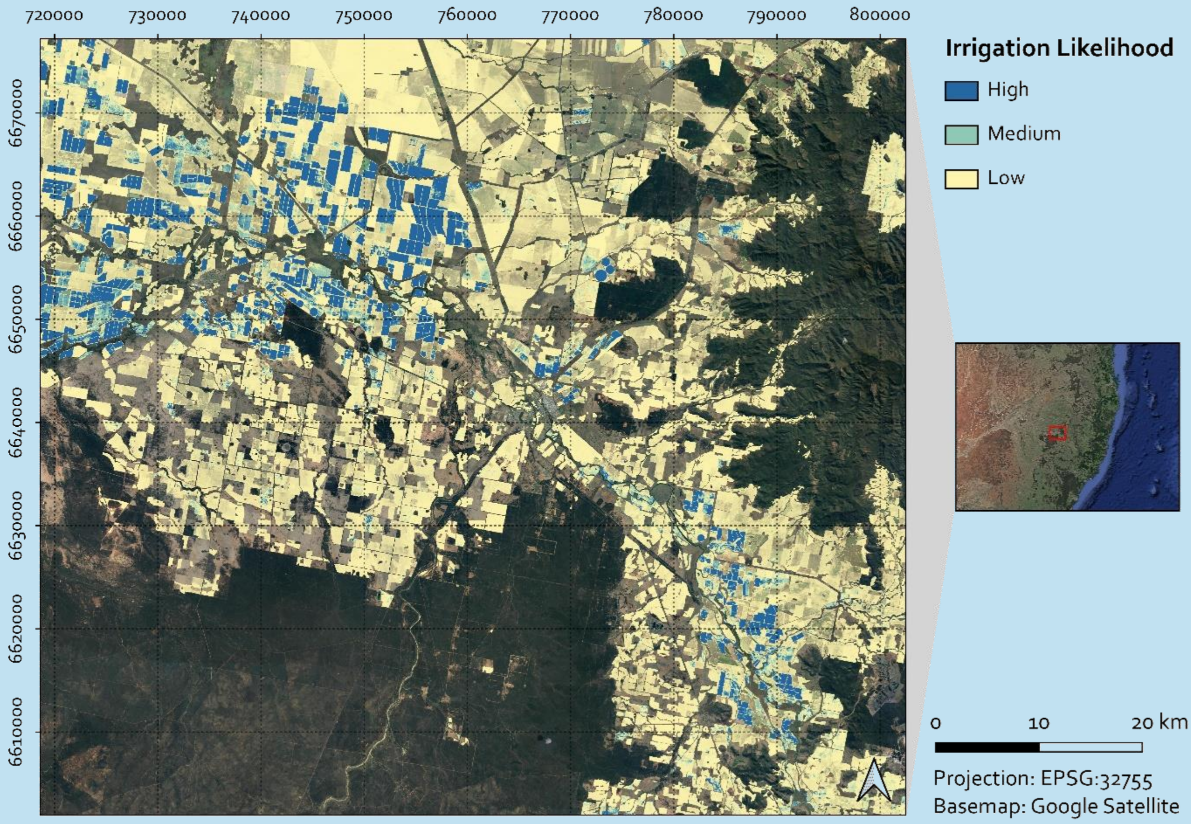

Figure 4: Preliminary results of the irrigated area map for a subregion surrounding the town of Narrabri in the Namoi Catchment.

Apps and Services Update

List of Services to be demonstrated

After the conclusion of the initial stakeholder engagement and user needs process we have prioritised our use cases to the following service options and features shown in the table over the page:

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Service	Features
Water Use Monitoring and Auditing Services (WUMAS)	Improved rainfall and weather information
	Irrigated water use determination and comparison with authorised and metered water use
	Automated irrigated land use detection
	Farm dam volume change indication and estimation
	Water Harvesting estimation and supplementary take planning and management support
Water Accounting (Sub Catchment / river reach scale modelling and data input into existing Water Resources Planning and Operations models)	Improved soil moisture observation and forecast across a basin
	Ungauged catchment flow modelling
	Improved estimation of river reach mass balance, losses and unaccounted for water
Regional Crop Water Use Decision Support	Crop Productivity and water use efficiency information across a region
Environmental Flow Management and Decision Support	Vegetation Condition
	Wetted area

WaterSENSE Data

In support of the above services, we have prepared a list of all the input and processed data that will be developed in the toolbox. These are currently:

Data Input products available in WaterSENSE
GFS weather Forecast (next day prediction) temp, pcp, RH, rad
BoM ADFD 1-hour
BoM ADFD 3-hour
BoM ADFD 24-hour
BoM Synoptic Weather Observation Network IDY3100
BoM Raingauge network 15-min data IDn65900
BoM Raingauge network Hourly data IDn65901
BoM Raingauge network 24 hour data IDn65902
BoM River gauge network data IDn65911
AWAP gridded meteorological data (Tmax, Tmin, Precipitation)
SILO gridded rainfall data
Evapotranspiration
Biomass
NDVI
Soil Moisture
WaterSENSE processed products

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ET Deficit
Crop Factors
Irrigated area detection
Incremental ET
Irrigation volume at field and cluster level
Annual active on-farm dams
Water volumes and uncertainties
Soil moisture surface (beta)
Soil moisture subsurface (beta)
Crop detection cotton, cereal and canola (TBC)*
Kc maps and AET
SCOUT Radar data precipitation
SCOUT Radar data precipitation Q3
ETr (next day prediction)
Etc calculation with kc (next day prediction)
AET with Etc (next day prediction)
Soil moisture multi-depth (next day prediction)
Flow (next day prediction)
Prediction of water extent in wetlands using flow release
Crop detection

Conferences and Presentations

15th International Conference on Urban Drainage (ICUD)

WaterSENSE has submitted an abstract to the ICUD 2021 conference to be held in Melbourne between 24 and 29 October 2021 which has been approved as oral presentation.

The abstract is called **"Precipitation Data in Real-Time for Multiple Scale Applications in Australia"**

Highlights

- Precipitation data covering all Australia.
- Integration of satellite, radar and rain gauges, with forecast through SCOUT software.
- Web-based access to data through the award winning HydroNET portal.

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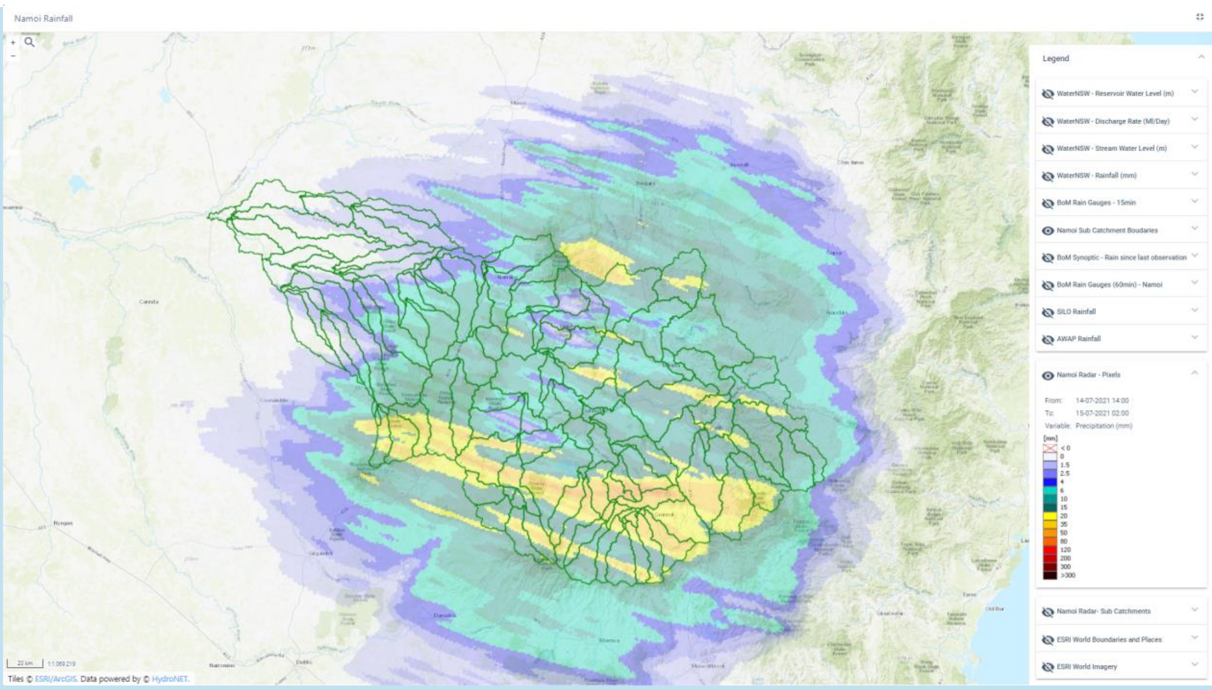

Figure 4: Example of a radar sum from the Namoi radar within the HydroNET portal, processed by SCOUT software.

Connect with us!

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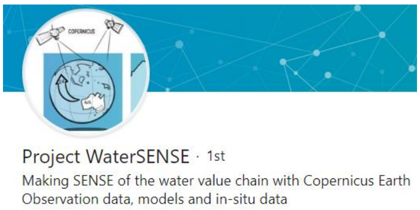

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