

**SUPSI**



## RISULTATI DELLO SVILUPPO DI UN SISTEMA DI MONITORAGGIO BASATO SU COMPONENTI OPEN

Daniele Strigaro, Massimiliano Cannata,  
Milan Antonovic, Rangajeewa Ratnayake,  
BH Sudantha, Emeshi Warusavitharana



**SUPSI**



## Problem

missing hydro-met monitoring systems



[ COSTS ]

[ HARDWARE ]  
[ SOFTWARE ]



[ INACCESSIBILITY ]

[ LOCAL SUPPORT ]  
[ REPLACEMENTS ]  
[ SOURCE CODE ]



[ NO INTEROPERABILITY ]

[ CLOSED PROTOCOLS ]  
[ PROPRIETARY SOLUTIONS ]  
[ NO COORDINATION ]

## Solution

4 open & low-cost technologies

OPEN



Hardware

OPEN



Software

OPEN



Standard

OPEN



Data

STATE OF THE ART

State of play in many countries

Few data

Low quality control

No real time

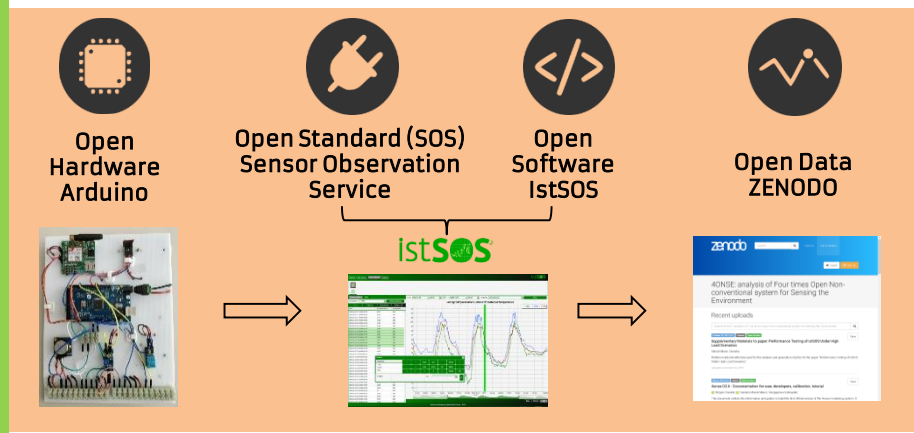
For purchase only

The motivation

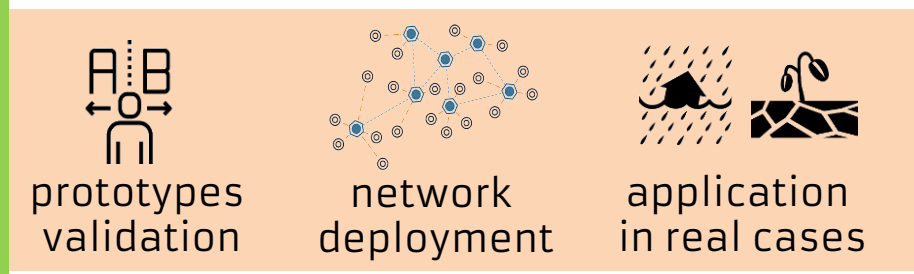
# Can we rely on these open technologies to fill the data gap and cope with climate change impacts?

Quality  
Durability  
Costs  
Sustainability

## Development Integrated open-monitoring-system



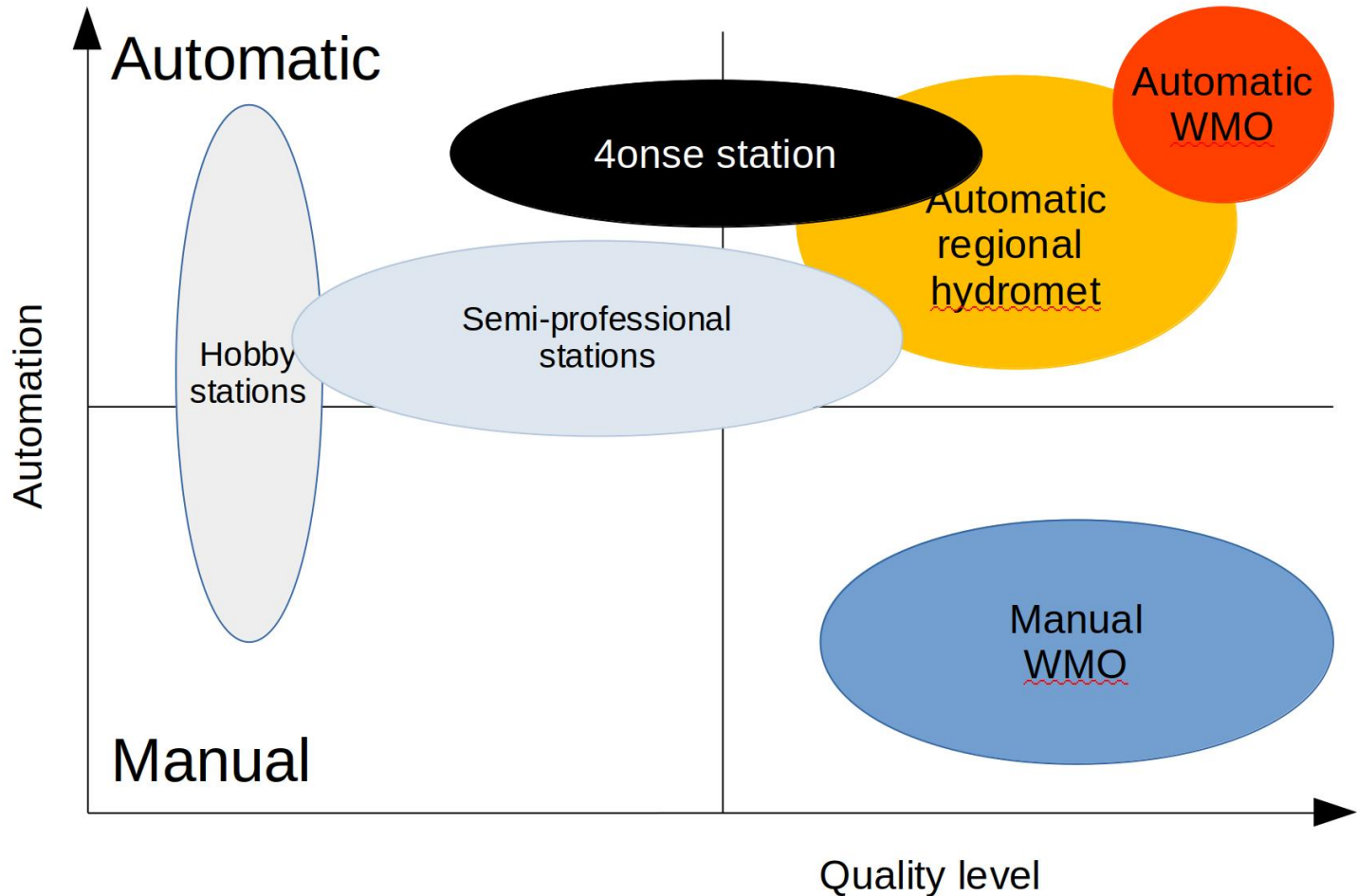
## Findings quality, applicability, sustainability



RESEARCH

# The research question





support the implementation of  
management actions

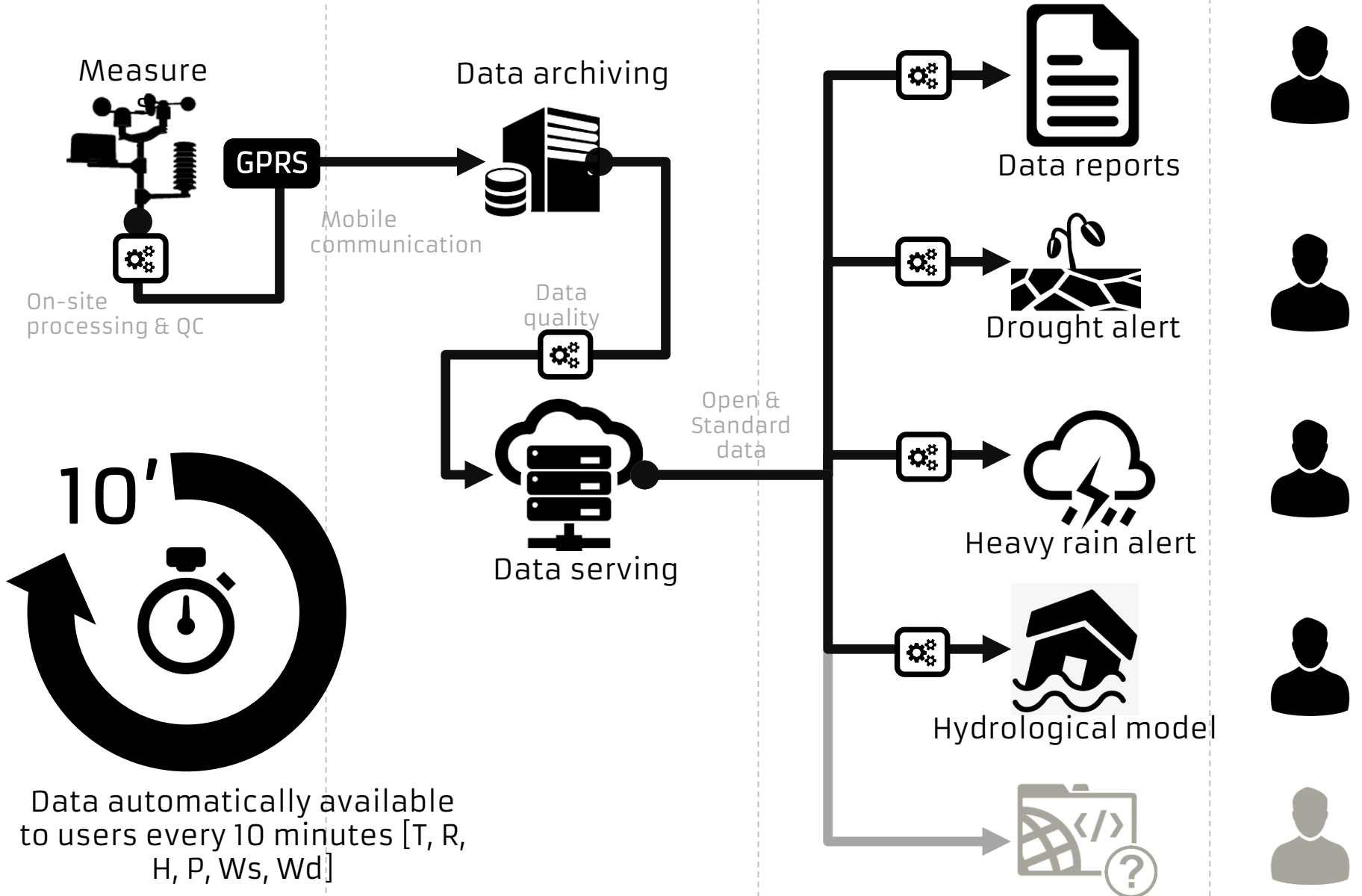
# System Design

FIELD

CLOUD

APPLICATIONS

USERS



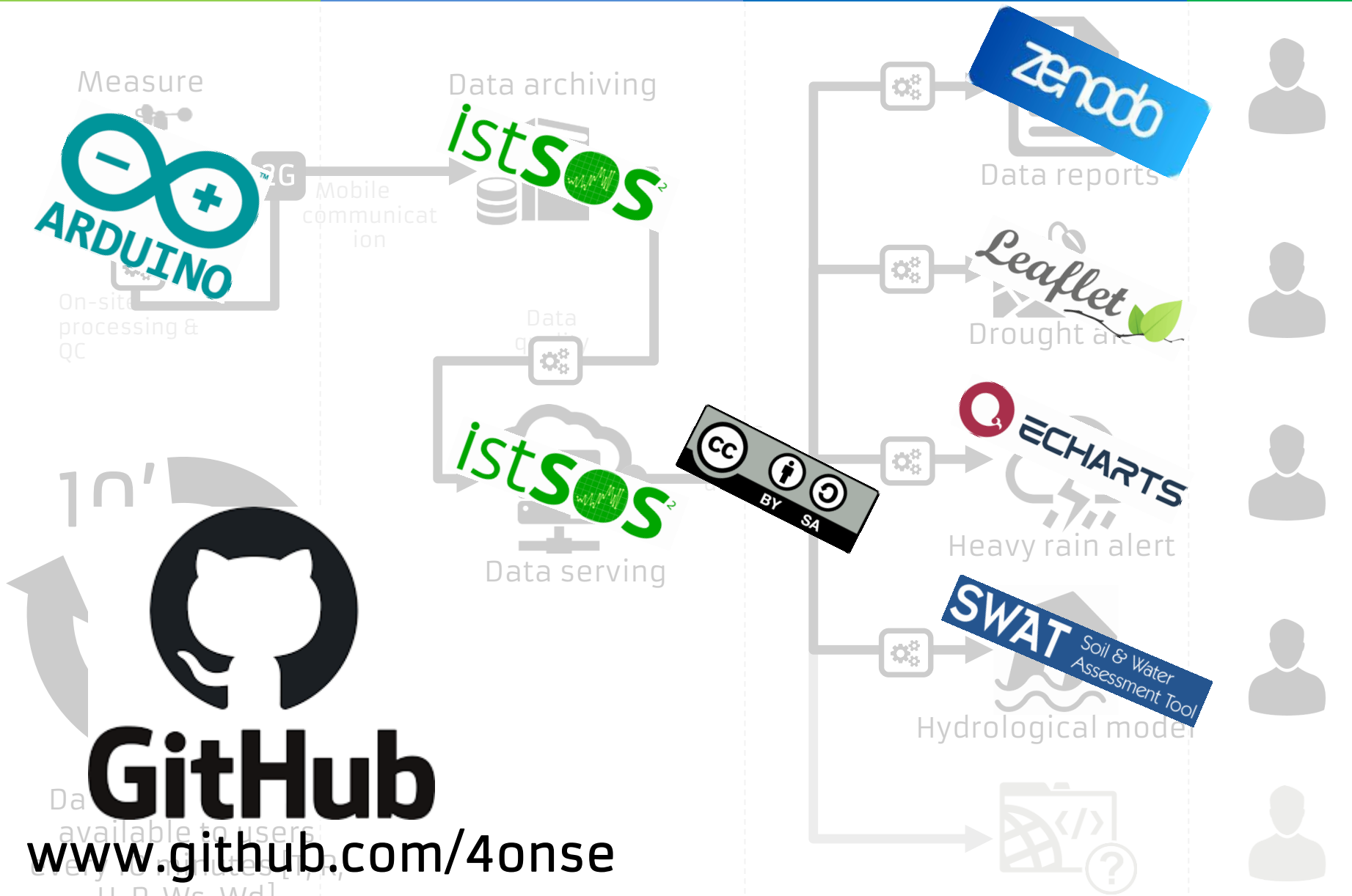
# Open technologies

FIELD

CLOUD

APPLICATIONS

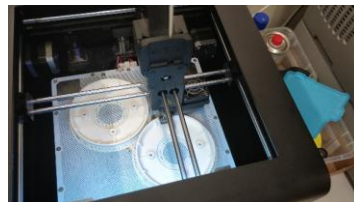
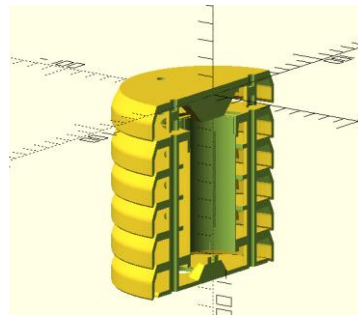
USERS



4onse-mod



4onse-pcb



# Data archiving and serving



istSOS: Welcome | geoservice.ist.supsi.ch/4nse/admin/ | Server Services - Data Management | istSOS

Data Editor | Data Viewer

Service: lkaqc | Offering: temporary | Procedure: KOKKAWILA\_MOD | Add

From: 2019-09-17 00:00 +01:00 To: 2019-09-25 00:00 | Property: air-rainfall | Line | air-temperature | Line | Plot

### air-rainfall / air-temperature

um:ogc:def:parameter-x-istisos:1.0:meteo:air:rainfall | um:ogc:def:parameter-x-istisos:1.0:meteo:air:temperature

Day Week All

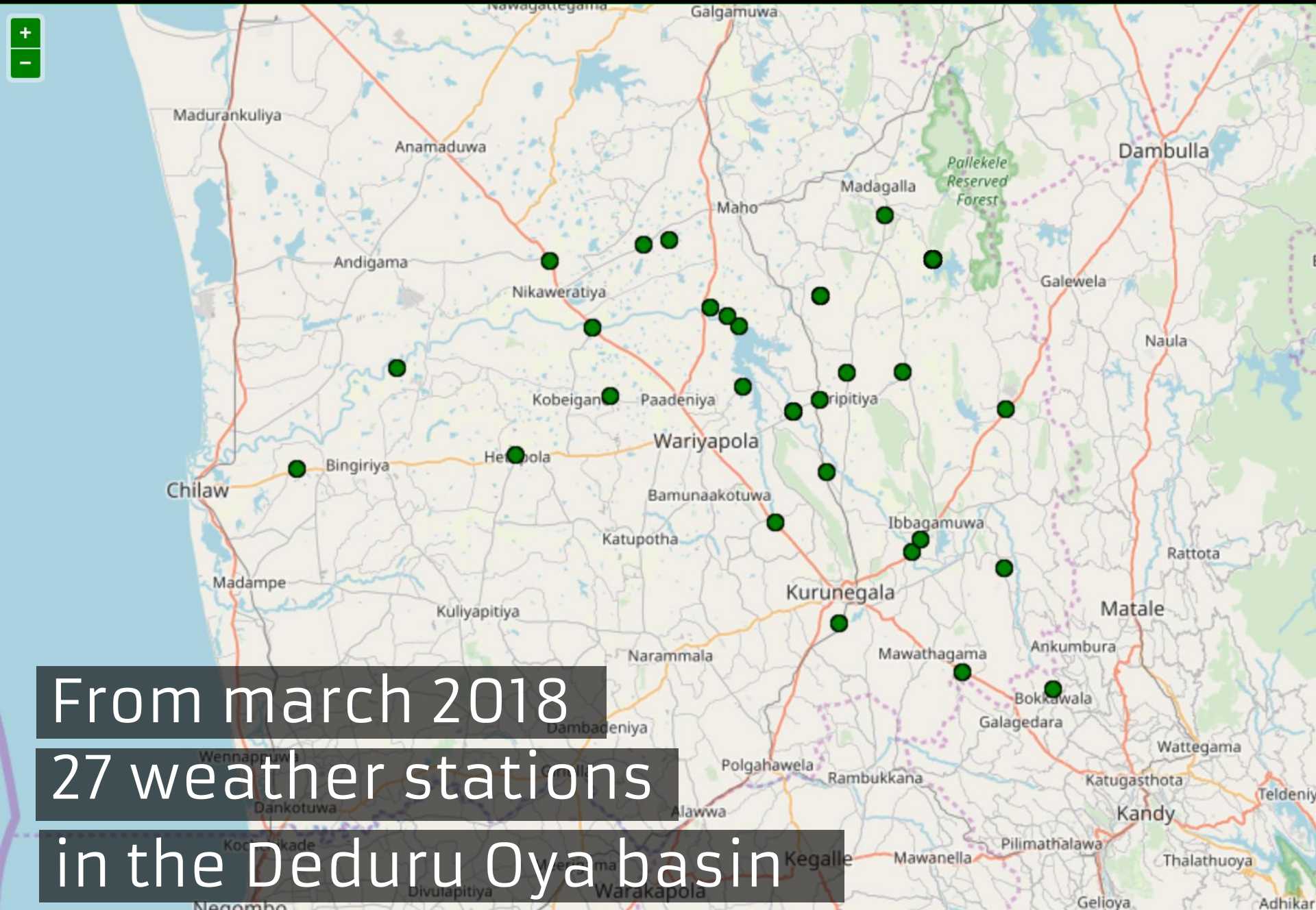
Show CSV

Date	\$_KOKKAWILA_M QI	KOKKAWILA_MOE QI
2019-09-18T07:25:01+01:00	29.98	710 0 700
2019-09-18T07:35:01+01:00	30.14	710 0 700
2019-09-18T07:45:00+01:00	29.94	710 0 700
2019-09-18T07:55:00+01:00	26.74	710 0.5 700
2019-09-18T08:05:01+01:00	27.15	710 0 700
2019-09-18T08:15:02+01:00	28.28	710 0 700
2019-09-18T08:25:01+01:00	28.25	710 0 700
2019-09-18T08:35:01+01:00	28.11	710 0 700
2019-09-18T08:45:00+01:00	28.83	710 0 700
2019-09-18T08:55:01+01:00	29.45	710 0 700
2019-09-18T09:05:00+01:00	30.07	710 0 700
2019-09-18T09:15:01+01:00	29.96	710 0 700
2019-09-18T09:25:00+01:00	29.82	710 0 700
2019-09-18T09:35:01+01:00	29.62	710 0 700
2019-09-18T09:45:01+01:00	29.43	710 0 700

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# Monitoring network



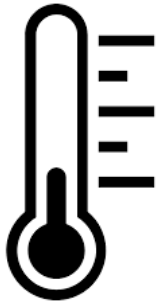
From march 2018  
27 weather stations  
in the Deduru Oya basin

# Data Quality



# Accuracy: how data fit real values? 4onse

6 months data: official vs 4onse station (CH)



$\pm 0.2^{\circ}\text{C}$   
Air Temperature



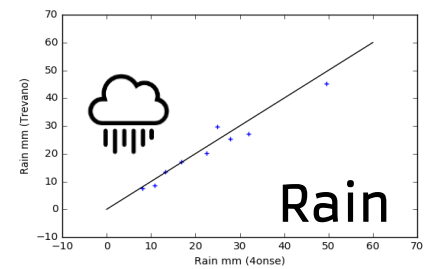
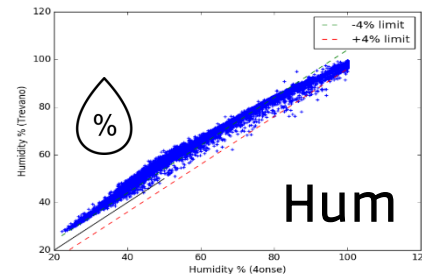
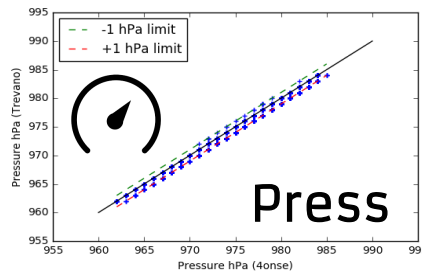
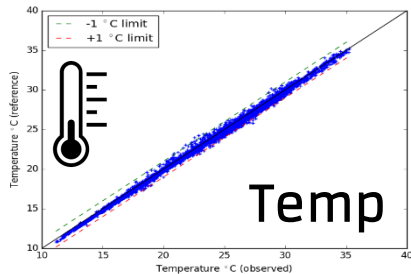
$\pm 3.8\%$   
Rel. Humidity



$\pm 0.5\text{ hPa}$   
Air Pressure



$\pm 9.8\%$   
Precipitation



# How frequent data gap?

## 60%

### Completeness with sporadic maintenance

	%	1H	6H	1D	1W
4ONSE_UOM_MOD	52	44	32	24	6
BAKMEEGAHAWATHITHA_PCB	56	262	47	26	3
BAMUNUGAMA_MOD	65	81	13	10	5
BATHALAGODA_MOD	56	134	32	14	7
DADURUOYA_RESERVOIR_DAM_PCB	83	47	16	13	1
GAJANAGGEGAMA_MOD	72	202	32	23	5
GUNAPALA_MALALASEKARA_MOD	51	89	12	9	8
HAKWATUNA_PCB	46	797	156	26	1
HETTIPOLA_PCB	70	115	50	23	3
HULOGEDARA_MOD	44	157	35	24	8
JOHN_KOTHALAWALA_MOD	52	88	18	11	5
KEDAPATHWEHERA_PCB	68	112	58	20	4
KIMBULANWAWA_PCB	49	520	42	19	6
KOKKAWILA_MOD	82	56	8	3	1
KUBUKGETE_MOD	60	347	37	29	10
LANKAPURA_PCB	56	48	6	7	3

## 80%


### Completeness with proper maintenance


	1W	1D	6H	1H	%
4ONSE_UOM_MOD	1	02	15	24	52
BAKMEEGAHAWATHITHA_PCB	1	4	34	45	60
BAMUNUGAMA_MOD	1	5	3	2	65
BATHALAGODA_MOD	5	2	18	23	56
DADURUOYA_RESERVOIR_DAM_PCB	0	5	3	24	83
GAJANAGGEGAMA_MOD	0	8	24	43	72
GUNAPALA_MALALASEKARA_MOD	0	0	0	1	51
HAKWATUNA_PCB	0	13	111	243	46
HETTIPOLA_PCB	5	11	24	88	70
HULOGEDARA_MOD	3	12	23	30	44
JOHN_KOTHALAWALA_MOD	5	3	3	4	52
KEDAPATHWEHERA_PCB	0	5	18	33	68
KIMBULANWAWA_PCB	5	8	55	60	49
KOKKAWILA_MOD	0	0	0	0	82
KUBUKGETE_MOD	4	14	13	18	60
LANKAPURA_PCB	0	5	3	28	56

# Timeliness: how late are data?

0.000 0 days  
00:00:12.421393  
0.100 0 days  
00:00:20.643247  
0.200 0 days  
00:00:23.942705  
0.300 0 days  
00:00:28.746212  
0.400 0 days  
00:00:31.121794  
0.500 0 days  
00:00:33.659747  
0.600 0 days  
00:00:35.450307  
0.700 0 days  
00:00:41.982987  
0.800 0 days

**93%**   
Within 10 minute

**5.3%**   
From 10m to 1h

**1.4%**   
From 1h to 1d

**0.3%**   
More than 1d

# Service Quality



# 99.246%

## Availability



# 3 days

## Downtime



# 811ms

## Response Time



# 98.827%

## Responsiveness





**16Mio**

Observations 

**6GB**

Size 

**19** 

Observed properties

**43** 

Procedures



**18M** 

Served requests

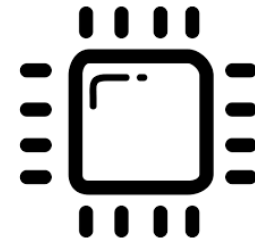
**0**




Failed requests

**140k** <sub>sec</sub>

Processing time



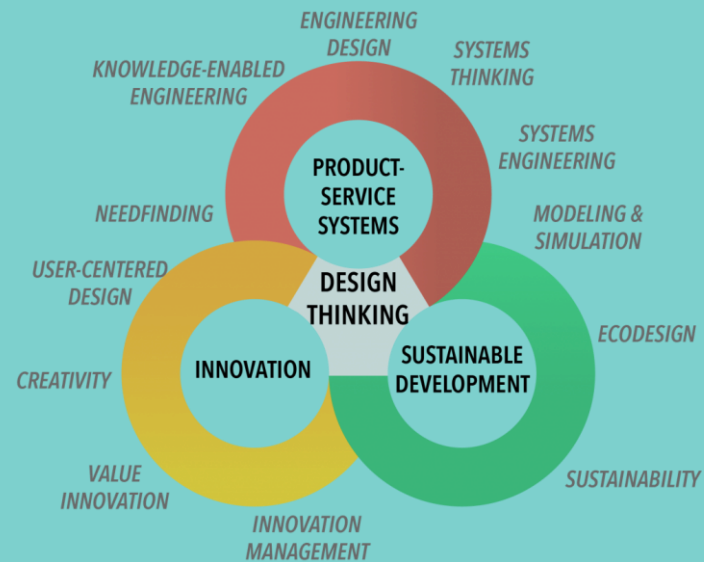
**150** 

Unique visitors

**35** <sub>GB</sub> 

Served data

# Sustainability



# 750 USD/station

## Total costs of deploy

(including taxers, batteries,  
installation & communication)

## Similar stations purchasing costs

Vantage Pro Plus Station 1,670USD

MetPak RG Weather Station 2,735USD

Rainwise PORTLOG 805-1018 5,036USD

# 54 USD/station

## Monthly maintenance cost

(including personnel 31USD and replacements 7USD)



## 9USD replacements

Station's replacements parts



## 14USD travels

From Kurunegala to stations



## 31USD personnel

2 people 100% for 30 stations

# Durability of components

>>1y

Solar panel

>>1y

Temperature  
(DS18B20)

>>1y

SD card

>>1y

Solar charger

3.3y

Board

1.3y

Battery

>>1y

RTC

6y

Wind (S,D)

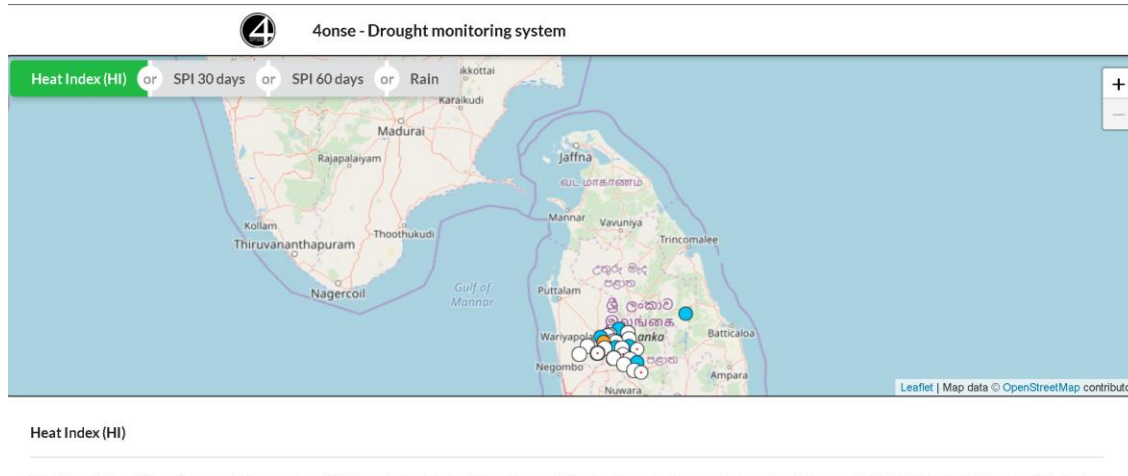
1.5y

BME (P, H)

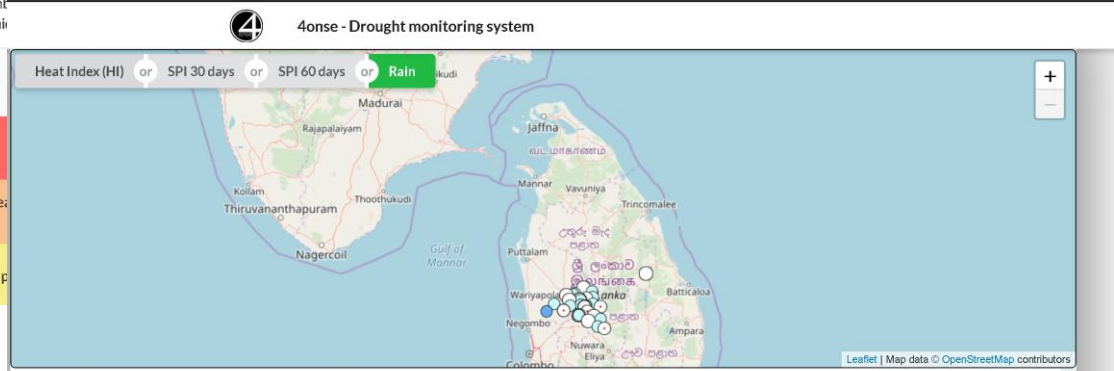
# Applicability



# Droughts and rain events



Intensity level	Heat Index	Dangers
Very high	Higher than 53°C	Heat stroke highly likely
High	40-53°C	Heat cramps or heat exhaustion likely, and heat stroke activity
Medium	32-40°C	Heat stroke, heat cramps or heat exhaustion possible

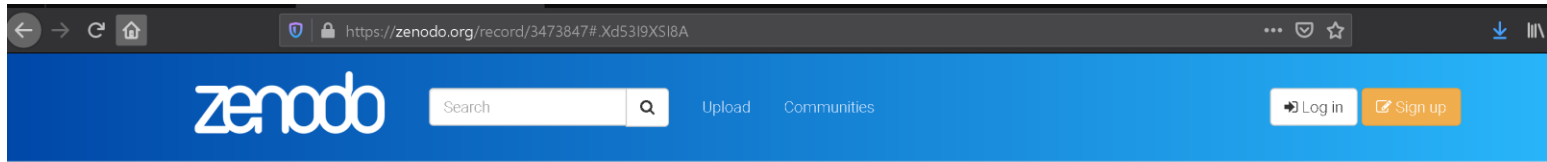


### Rain daily data

The daily sum of the rain amount daily rain data, is a simple statistical analysis that is useful to highlight particular heavy rain events. The map shows the rain data marked in different colours based on the amount of the rain collected by the 4nse weather stations. The last data collected is shown and by clicking on the points the last seven days data are plotted. In Table 1, the rainfall classification based on daily rainfall of a station is proposed.

Classification of rainfall event	Rainfall (R) in a day (mm)
Very heavy rain event	$R > 120.0$
Heavy rain event	$60.0 < R \leq 120.0$
Rather heavy rain event	$35.0 < R \leq 60.0$
Moderate rain event	$10.0 < R \leq 35.0$

# Monthly statistical report



November 25, 2019

## 4nse stations monthly

Strigaro, Daniele

This dataset contains monthly climatological reports (NOAA S in Sri Lanka.

Name
<a href="#">4ONSE_UOM_MOD_August_2019.txt</a> md5:52dcc31c95d0a45e4a699d83e467e476
<a href="#">4ONSE_UOM_MOD_July_2019.txt</a> md5:564a4784d046566ff8dd626a42259e4a
<a href="#">4ONSE_UOM_MOD_September_2019.txt</a> md5:125f6b1e05d81e8595d1bcf683410536
<a href="#">BAKMEEGAHAWATHTHA_PCB_August_2019.txt</a> md5:d4affe920c0aa22f7d4fa6c9e5623e2
<a href="#">BAKMEEGAHAWATHTHA_PCB_July_2019.txt</a> md5:f7bbeda4bdd535f11252930efd135ccdc
<a href="#">BAKMEEGAHAWATHTHA_PCB_October_2019.txt</a> md5:907d5422573666e396933417af86060c
<a href="#">BAKMEEGAHAWATHTHA_PCB_September_2019.txt</a> 3.2 kB <a href="#">Download</a>

4ONSE\_UOM\_MOD\_August\_2019 - Blocco note

File Modifica Formato Visualizza ?

MONTHLY CLIMATOLOGICAL SUMMARY for August 2019

NAME: 4ONSE\_UOM\_MOD CITY: Katubedda STATE: Sri Lanka  
ELEV: 37 m LAT: 6.7969 N LONG: 79.9018 E

TEMPERATURE (°C), RAIN (mm), PRESSURE (hPa), HUMIDITY (%), WIND SPEED (m/s)

Day	Mean Temp	Max	Time	Min	Time	Rain	Mean Press	Mean Hum	Avg Wind SPEED	Max	Time	DOM Dir
01	28.2	31.2	12:10	25.8	10:30	2.8	1007.4	87.4	0.0	0.0	00:00	90.0
02	28.3	30.5	12:45	27.0	04:45	0.0	1007.2	90.7	0.0	0.0	00:05	90.0
03	28.4	31.1	15:05	26.0	23:55	0.0	1007.0	88.6	0.0	0.0	00:05	90.0
04	27.7	30.9	11:25	24.5	06:35	0.4	1006.8	86.0	0.0	0.0	18:35	90.0
05	28.9	31.6	11:15	27.6	05:25	0.0	1005.9	84.1	0.0	0.0	18:35	90.0
06	28.8	31.2	13:50	27.6	04:00	0.0	1005.6	84.1	0.0	0.0	00:00	90.0
07	28.4	30.6	11:10	27.1	08:40	0.8	1005.1	84.3	0.0	0.0	00:00	90.0
08	26.6	29.7	15:15	22.2	03:15	25.4	1005.9	85.7	0.0	0.0	00:05	90.0
09	25.1	27.9	15:55	22.6	06:05	11.8	1006.1	95.1	0.0	0.0	00:05	90.0
10	25.3	28.9	09:05	22.3	11:05	25.8	1006.0	98.0	0.0	0.0	00:05	90.0
11	27.3	30.5	12:15	25.0	23:55	0.0	1005.2	83.7	0.0	0.0	00:05	90.0
12	27.1	29.8	15:25	24.4	06:15	3.8	1004.6	84.5	0.0	0.0	00:05	90.0
13	26.5	29.1	10:45	24.2	14:05	5.0	1005.6	97.3	0.0	0.0	18:35	90.0
14	27.2	30.1	13:15	25.5	16:15	0.2	1007.0	90.6	0.0	0.0	00:05	90.0
15	27.9	30.6	14:05	26.2	05:35	0.0	1007.1	84.4	0.0	0.0	18:35	90.0
16	27.8	30.8	11:30	26.9	06:20	0.0	1005.8	87.4	0.0	0.0	00:00	90.0
17	27.3	28.9	12:30	25.5	23:50	0.0	1005.1	89.7	0.0	0.0	00:00	90.0
18	27.7	31.5	13:50	25.0	01:00	1.0	1006.1	87.7	0.0	0.0	00:00	90.0
19	27.2	31.3	12:20	24.3	05:50	0.8	1006.9	88.6	0.0	0.0	00:00	90.0

Unix (LF) Linea 1, colonna 1 100%

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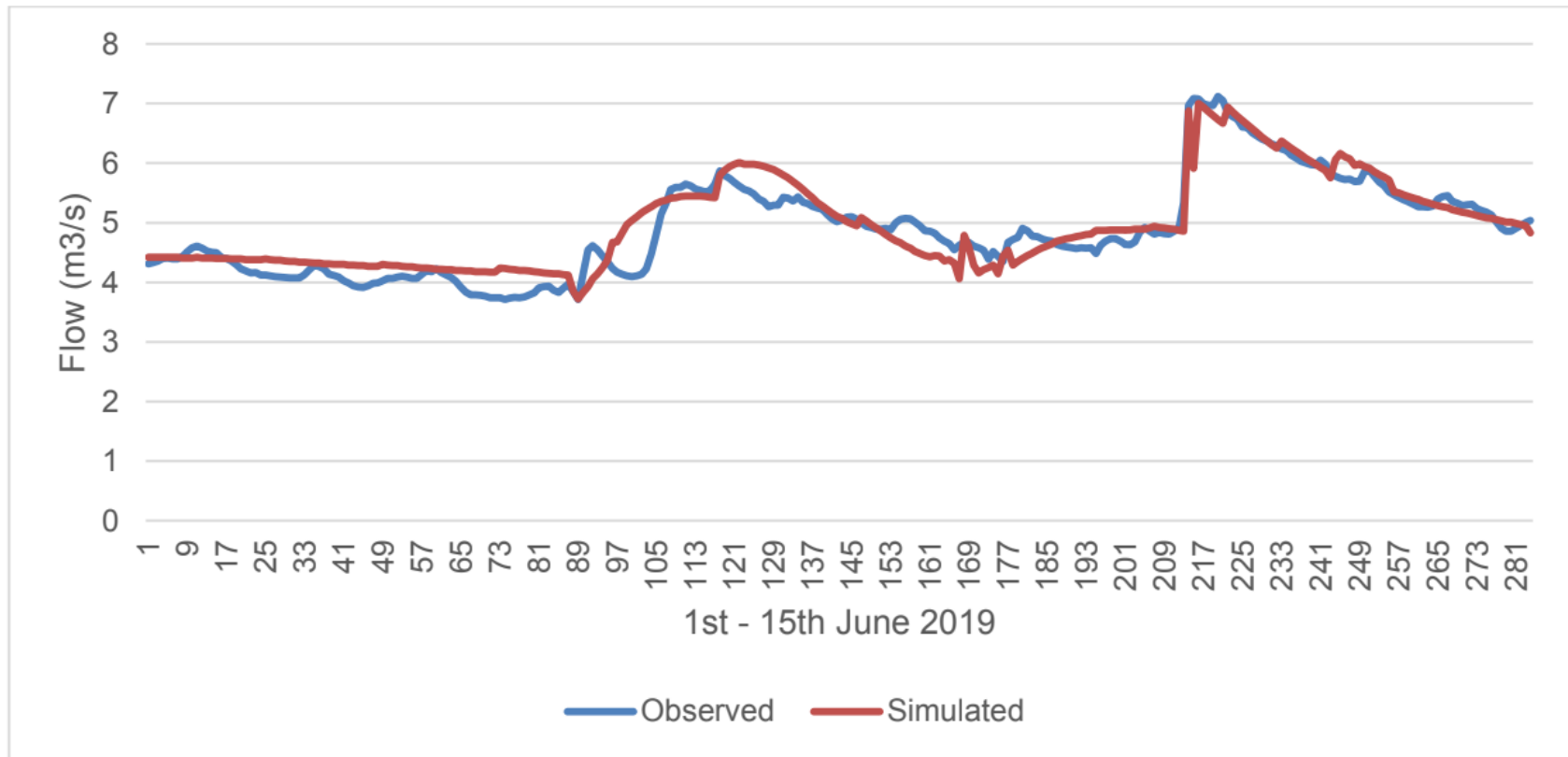


Figure 24: Observed and Simulated hourly flow for Deduru Oya sub-catchment during the period of 1<sup>st</sup> to 15<sup>th</sup> June 2019 – applied data of 4 stations



# Summary





- Good data quality of data
  - Good for modelling, alert, etc.
  - Failures in power -> data gaps



- Good data service
  - Stability
  - Availability
  - Performance -> max 500 concurrent users



- Good sustainability
  - Independence
  - Durability
  - Costs



- Good applicability
  - Data tested in 4 applications



@SNSF\_4onse



4onse

www.4onse.ch

# Thank you



## Swiss Programme for Research on Global Issues for Development

In light of global challenges, the Swiss Agency for Development and Cooperation (SDC) and the Swiss National Science Foundation (SNSF) launched in 2012 the joint «Swiss Programme for Research on Global Issues for Development» (r4d programme). The main goal of the r4d programme is the generation of new knowledge and the application of research results that contribute to solving global problems and securing public goods in low- and middle-income countries within the framework of global sustainable development. The r4d programme consists of six modules, five with thematic priorities and one for thematically open calls.

[www.r4d.ch](http://www.r4d.ch)



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