FLASH FLOODING MONITORING SYSTEM

WORLD METEOROLOGICAL ORGANIZATION

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Agenda

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2.-Case study location
3.- Deployed network
4.- Flash flooding monitoring system's components
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Flash Flooding Monitoring System
Introduction

- Engineering and Physical Sciences Research Council (EPSRC), 2017 – 2020.
- The Global Challenge Research Fund (GCRF).
- Loughborough University, Dynamic Flow Technology, Ltd. (United Kingdom).
- National Autonomous University of Mexico (UNAM), University of Colima (UdeC), SITELDI (Mexico).

Case study location

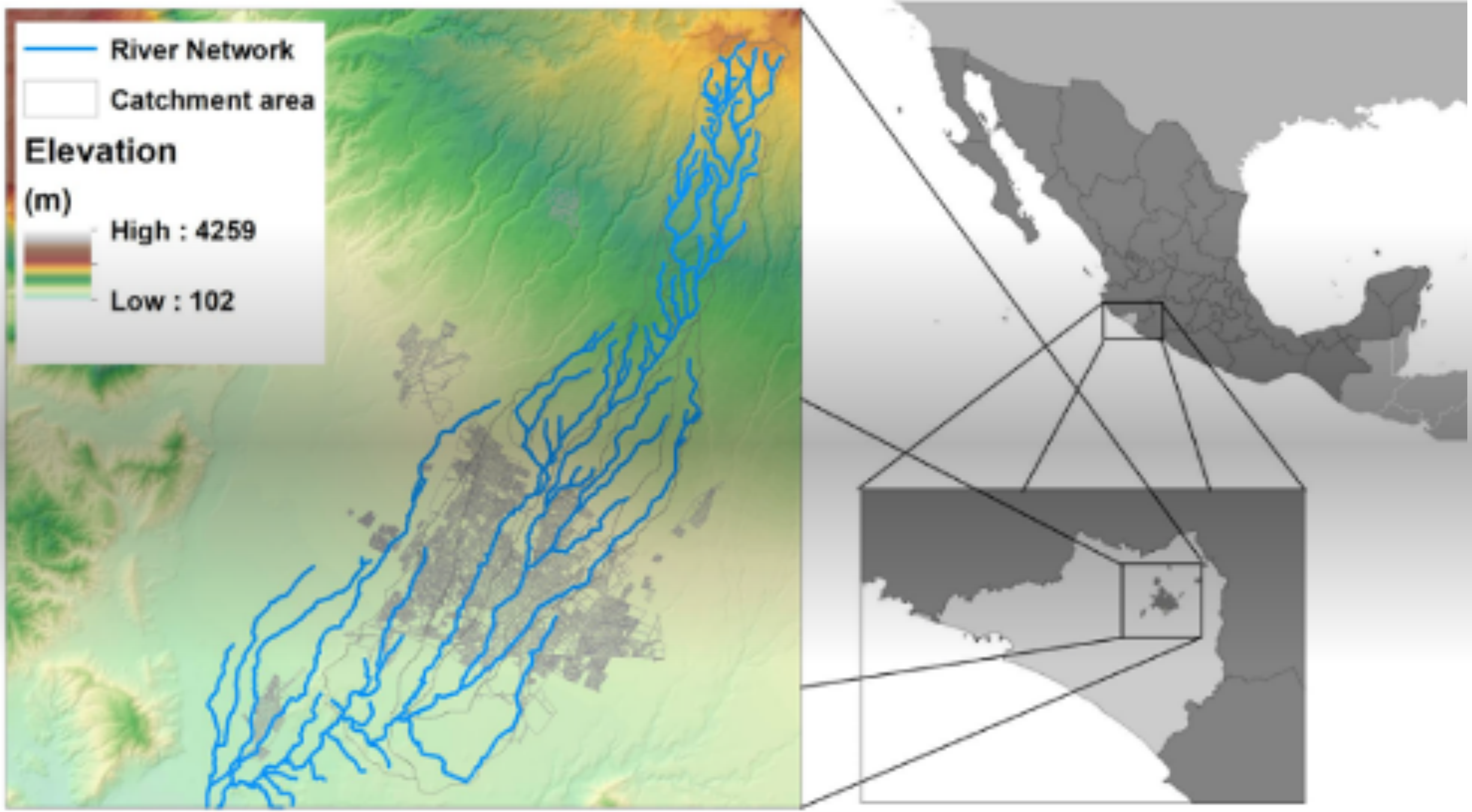


Figure 1. Oliver et al. (2021). Accepted for publication

Deployed network

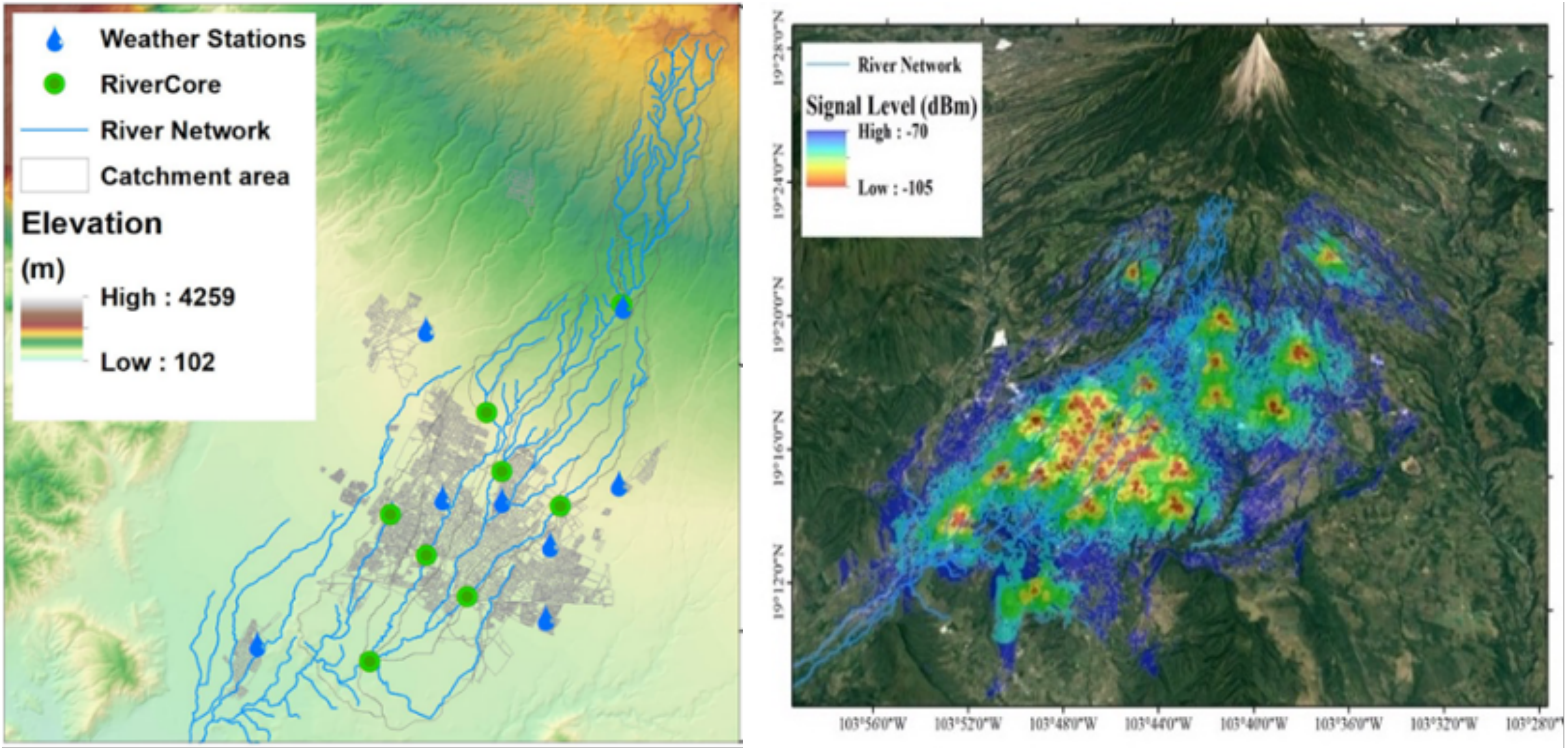


Figure 2. Oliver et al. (2021). Accepted for publication

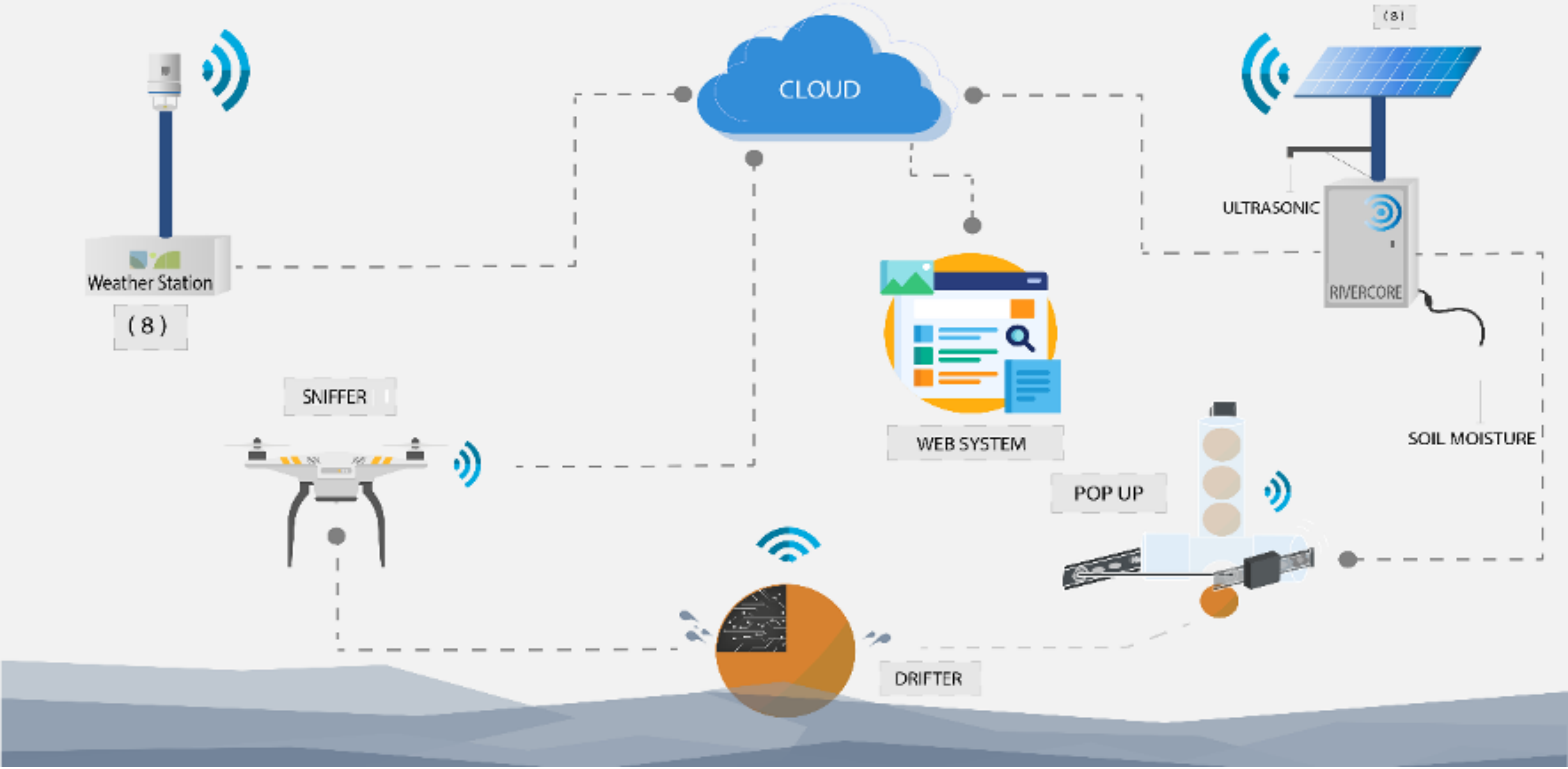


Figure 3. Flash flooding monitoring system's components. Ibarreche et al. (2020).

Data collection

Weather station	Hydrological station
Solar radiation	Water level
Precipitation	Soil moisture
Vapor pressure	
Relative humidity	
Air temperature	
Humidity sensor temperature	
Barometric pressure	
Horizontal wind speed	
Wind gust	
Wind direction	
Tilt	
Lightning strike count	
Lightning average distance	

Weather station

Hydrological station

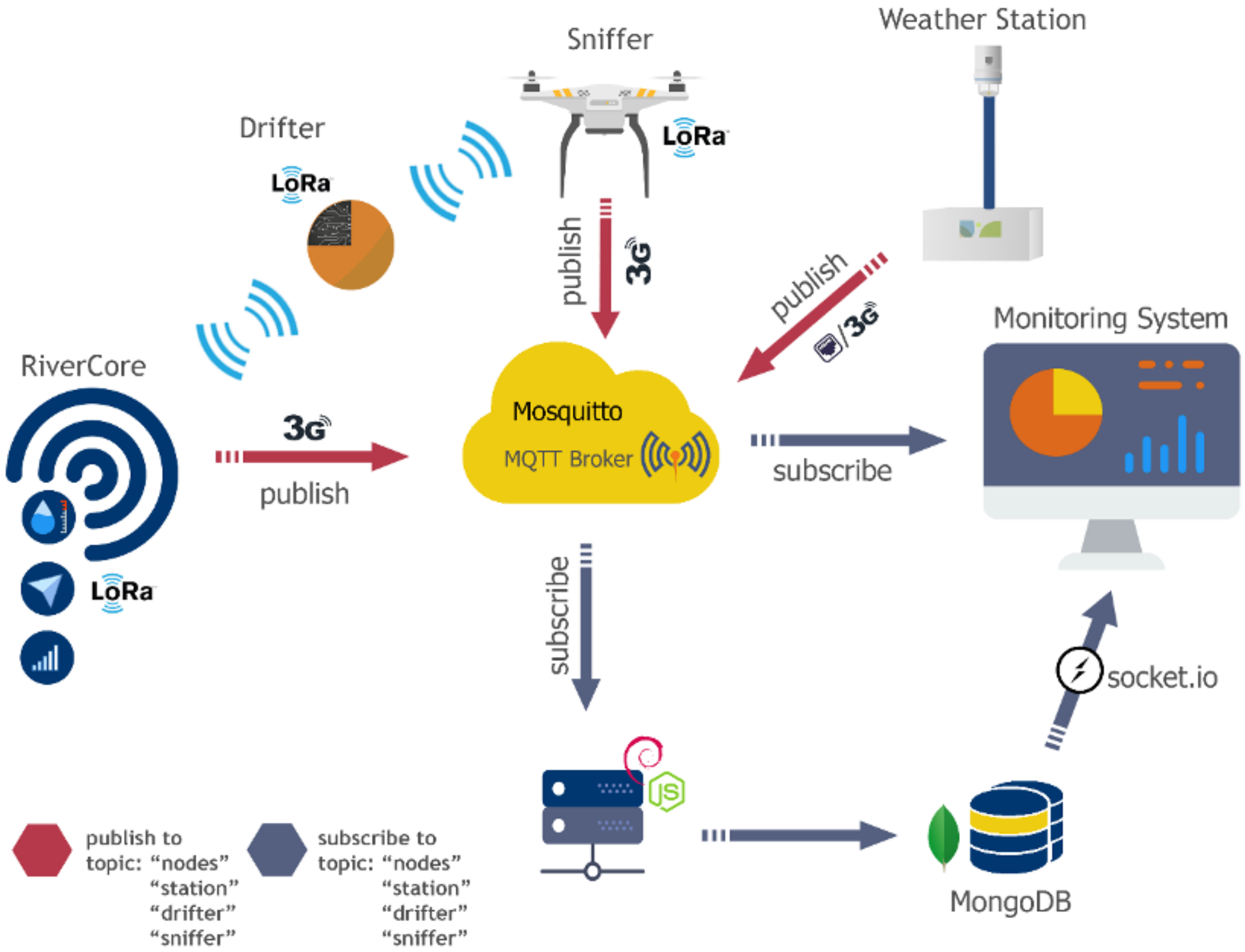
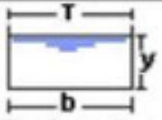
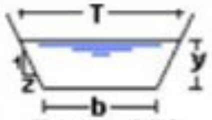
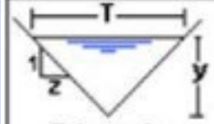
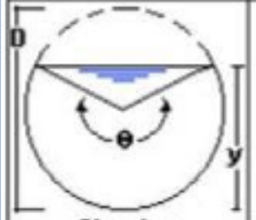
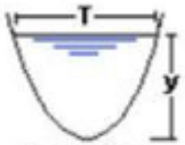


Figure 4. The primary acquisition data system. Ibarreche et al. (2020).

Data interpretation and monitoring

Section	Area $A(m^2)$	Perimeter P(m)	Hydraulic radius Rh (m)	Water depth T (m)
 Rectangular	by	$b+2y$	$\frac{by}{b+2y}$	b
 Trapezoidal	$(b+zy)y$	$b+2y\sqrt{1+z^2}$	$\frac{(b+zy)y}{b+2y\sqrt{1+z^2}}$	$b+2zy$
 Triangular	zy^2	$2y\sqrt{1+z^2}$	$\frac{zy}{2\sqrt{1+z^2}}$	$2zy$
 Circular	$\frac{(\theta - sen\theta)D^2}{8}$	$\frac{\theta D}{2}$	$(1-\frac{sen\,\theta}{\theta})\frac{D}{4}$	$(sen\frac{\theta}{2})D$ ó $2\sqrt{y(D-y)}$
 Parabólica	$2/3\ Ty$	$T+\frac{8y^2}{3T}$ *	$\frac{2T^2y}{3T+8y^2}$ *	$\frac{3A}{2y}$

Water level	Soil moisture	Normal depth	Perimeter	Hydraulic radius	Area	Velocity	River flow

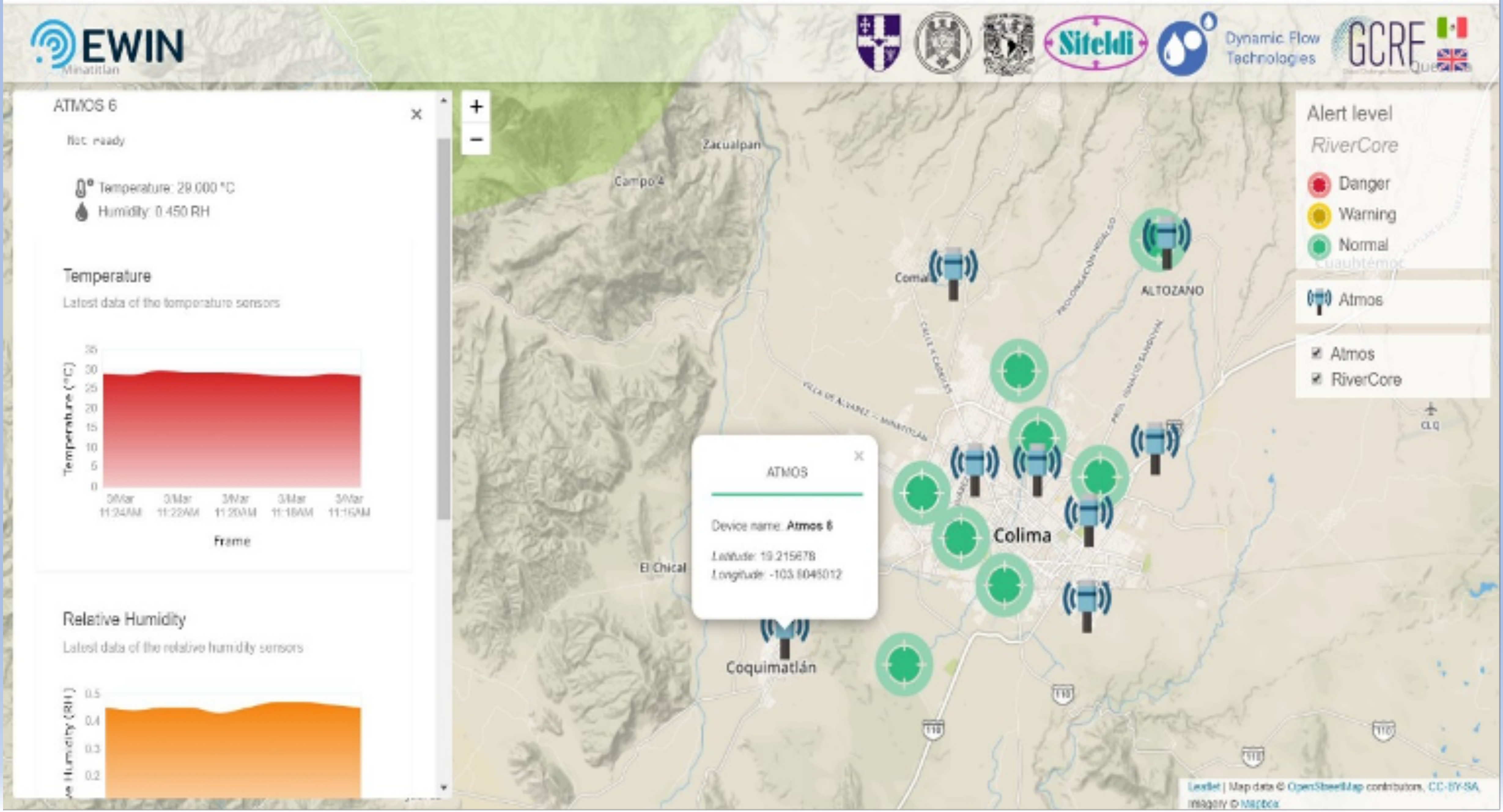


Figure 5. Public Web platform. Ibarreche et al. (2020).

Gaps related to the implementation/application of AI within the domain "Natural Disaster Management."

- The use of IoT technology, along with data analysis, can help monitor floods and provide useful information needed to predict future flooding; however, this technology requires significant data processing resources due to large amount of incoming data, which can result in important delays when measuring real-time scenarios.

- In order to develop an effective flood monitoring system, IoT technology may be used along with sensors and other technologies, such as machine learning and artificial intelligence techniques, to improve data acquisition and real-time measurement.

Gaps related to the implementation/application of AI within the domain “Natural Disaster Management.”

- The ability of neural networks (AI) to analyse large data sets quickly and intelligently makes it an invaluable resource in critical moments of a natural disaster.
- The use of neural networks in critical situations and decisive moments provide specialists in the field and researchers with time to make decisions based and validated on all available data sets.
- Neural networks do not eliminate the need to be prepared for disasters, but they help make decisions to evacuate or alert the population before a flood.

Future work

- It is essential to check the findings on neural networks' precision through their application for the prediction of water flow in subsequent events and its comparison with other intelligent prediction computing techniques such as neuro-fuzzy systems.
- Test our first Flash Flooding prediction model.
- Seek funding to increase the quantity and capacity of the Flash Flood Monitoring System.

References

- Mendoza-Cano, O, Aquino-Santos R, López-de la Cruz J, Edwards RM, Khouakhi, A, Pattison I, Rangel-Licea V, Esli Castellanos, Martinez-Preciado MA, Rincón-Avalos P, Paul Lepper, Gutiérrez-Gómez A, Uribe-Ramos JM, José Ibarreche and Ismael Pérez. (2021). **Experiments of an IoT based wireless sensor network for flood monitoring in Colima, Mexico**. Journal of Hydroinformatics, **Accepted for publication.**
- Ibarreche, J, Aquino, R, Edwards, R, Rangel, V, Pérez, I, Martínez, M, Castellanos, E, Álvarez, E, Jimenez, S, Rentería, R, Edwards, A, Álvarez, O (2020) Flash Flood Early Warning System in Colima, Mexico, *Sensors*, 20(18), pp.5231-5231, DOI: 10.3390/s20185231.
- Khouakhi, A, Pattison, I, Cruz, JL-DL, Mendoza-Cano, O, Edwards, R, Aquino, R, Lepper, P, Rangel, V, Ibarreche, J, Perez, I, Clark, B, Davis, J, Martínez, M (2020) An internet of things system for urban flood monitoring and short-term flood forecasting in Colima, Mexico. In *EGU General Assembly 2020*, Online. DOI: 10.5194/egusphere-egu2020-21079.
- Moreno, C, Aquino, R, Ibarreche, J, Pérez, I, Castellanos, E, Álvarez, E, Rentería, R, Anguiano, L, Edwards, A, Lepper, P, Edwards, R, Clark, B (2019) RiverCore: IoT Device for River Water Level Monitoring over Cellular Communications, *Sensors*, 19(1), pp.127-127, DOI: 10.3390/s19010127.
- Edwards, R, Santos, RA, Lepper, P, Mendoza-Cano, O, Pattison, I, Rangel, V, Jimenez, F, Adegoke, E, Clark, B, Davis, J, Falahati, A, Khouakhi, A (2019) *Emergency Water Information Network (EWIN)*.

THANK YOU

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