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Say it in 51 bytes: LoRa for hydrological observations

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We are no longer used to worrying about the number of bytes in a message because we tend to measure bandwidth in mbps. However, large bandwidth or high communication speed inevitably comes with high energy costs. LoRa stands for Long-Range Radio and has been designed to communicate over ranges of up to 20 km line-of sight, or 0.5 to 2 km in more realistic natural settings [1]. Communication takes a very small amount of energy and typical nodes can run for years on a few AA batteries. The frequencies used are 433 MHz & 868 MHz (Europe) and 915 MHz (North America), which are free for reasonable use. The downside is that messages have to be small, typically around 100 bytes, with 51 bytes being the general lower limit. For most commercial LoRa networks, message frequency is about one per hour. Clearly, JSON would not be the best way to format measurement data one wants to send with LoRa.

Earlier research shows that the best way to compress hydrological data is by combining disciplinary knowledge about the signal with techniques developed in the realm of information theory [2]. The question (partially) answered here is what the best compression approaches are for different hydrological time series. Compression strategies for series of different environmental variables are presented, such as temperature, relative humidity, intervals between raindrops, and water heights. Different strategies are tried for different variables and heuristic arguments are put forward as a guide towards a general approach. The results, including code examples, will be made available through GitHub.

[1] Sanchez-Iborra, Ramon, Jesus Sanchez-Gomez, Juan Ballesta-Viñas, Maria-Dolores Cano, and Antonio F. Skarmeta. "Performance Evaluation of LoRa Considering Scenario Conditions." Sensors 18, no. 3 (2018): 772.

[2] Weijs, Steven V., Nick van de Giesen, and Marc B. Parlange. "HydroZIP: How hydrological knowledge can be used to improve compression of hydrological data." Entropy 15, no. 4 (2013): 1289-1310.

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