

# **Basics of Environmental Data**

EN5423 | Spring 2024

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(Week 2)

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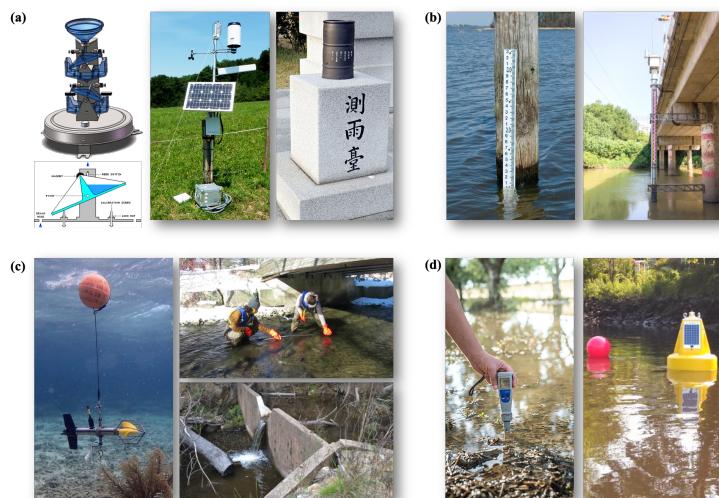


# 1 The Characteristics of Environmental Data

## 1.1 Time-Series Data

Time-series data is a sequence of data points collected or recorded at successive time intervals. These intervals can be regular (e.g., hourly, daily, monthly) or irregular. In the context of water resources, time-series data is invaluable for tracking changes over time, such as:

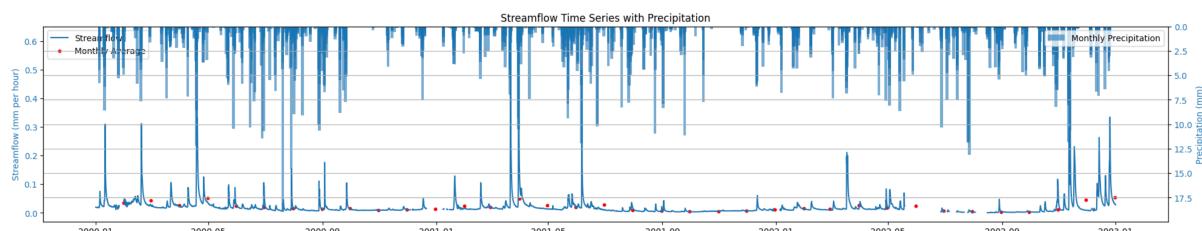
- **Rainfall patterns** across different seasons/years (e.g., tipping bucket, 측우기, etc.; **Fig. 1a**).
- **Water levels** in rivers, lakes, or reservoirs (e.g., staff gauges, weirs, etc.; **Fig. 1b**).
- **Flow rates** of rivers or streams (e.g., current meters, weirs, etc.; **Fig. 1c**).
- **Water quality parameters** like pH, turbidity, or contaminant levels (e.g., pH meters, turbidity meters, etc. **Fig. 1d**).



**Figure 1.** (a) Tipping bucket and 측우기(AC1442), (b) staff gauges, (c) current meters and weirs, and (d) pH meters and turbidity meters

Characteristics of time-series data include:

- **Temporal Dependency:** The value of a data point is dependent on or related to the time at which it was collected (**Figure 2**) (**Exercise 1**).
- **Seasonality:** Patterns that repeat over a known, fixed period, such as increased river flow during precipitation event.
- **Trend:** Long-term increase or decrease in the data, like the gradual depletion of groundwater in certain areas.



**Figure 2.** Streamflow Time series

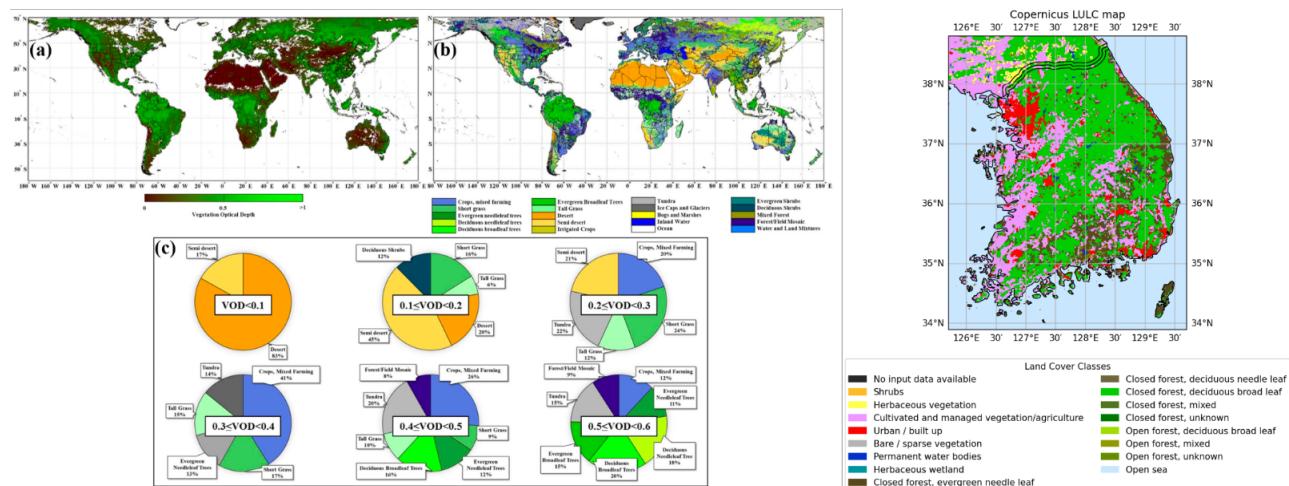
## 1.2 Spatial Data

Spatial data, or geospatial data, refers to information that has a geographical or locational component. This data is crucial for mapping and analyzing phenomena that have a specific location on the earth's surface. In water resources, spatial data helps in:

- **Mapping water bodies** like rivers, lakes, and aquifers.
- **Assessing land use** and its impact on water quality and quantity.
- **Identifying potential sites** for water infrastructure projects.
- **Erosion and sedimentation studies.**

Characteristics of spatial data include:

- **Location:** Defined by coordinates (latitude and longitude) or other geographic references.
- **Attribute Information:** Details about the location, such as water quality or land use lanc cover (LULC) type (**Figure 3**). ([Exercise 2](#)) ([HW2 #1](#))
- **Spatial variations in water body** across different days (Sentinel satellites; [link1](#)).
- **Spatial Relationship:** Information about how objects are spatially related to each other (e.g., adjacency, containment).



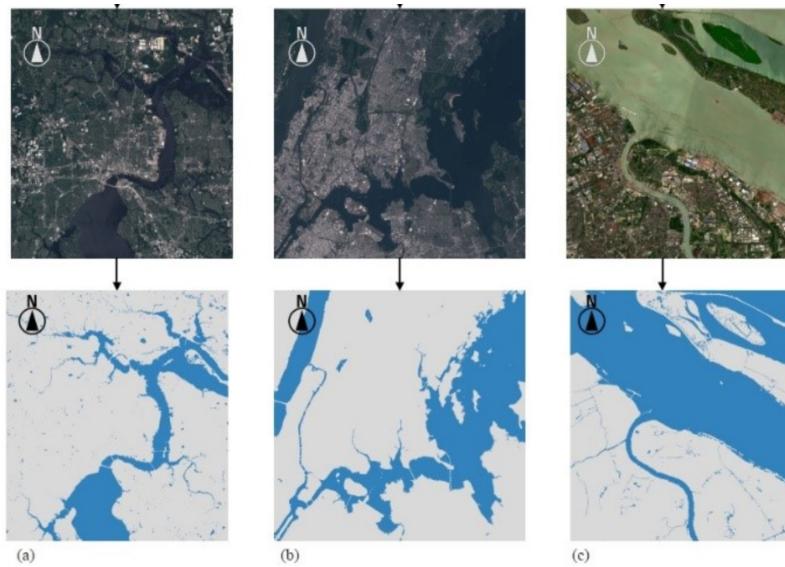
**Figure 3.** (left) (a) Global map of average vegetation optical depth (VOD). (b) Global land cover classification from the BATS model. (c) Pie charts indicating land cover classification from the BATS model based on six VOD ranges. (right) Global land cover classification from Copernicus LULC.

### Your Turn #1

What are the three majority land cover classes in South Korea?

- 1)
- 2)
- 3)

- Water body from satellites ([GEE link](#))



**Figure 4.** Mapping water body typologies from Sentinel-2 (ESA).

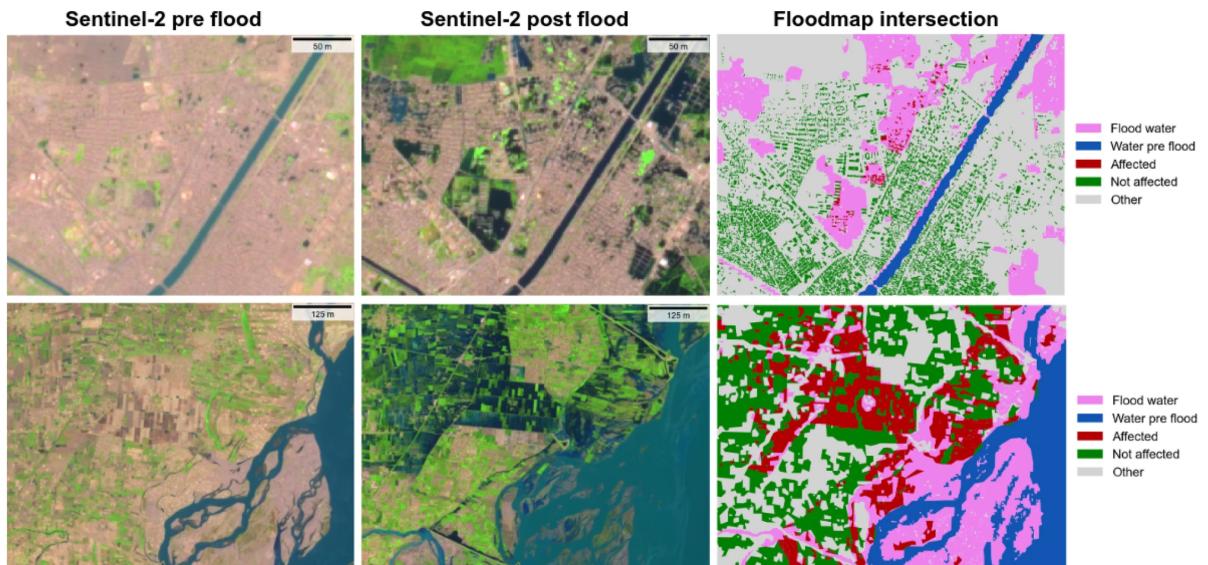
### 1.3 Spatio-Temporal Data

Spatio-temporal data combines both spatial and temporal information, offering a dynamic view of how environmental phenomena change over both space and time. This type of data is crucial for understanding complex environmental processes, such as:

- **Rainfall patterns** across different seasons/years (e.g., Global Precipitation Mission (GPM); [link2](#); [link3](#)).
- **Changes in land use** and its impact on our society over time (**Figure 4**).
- **Temporal variations in water quality** across different parts of a watershed ([link4](#)).
- **Seasonal movements** of aquatic species in relation to water temperature and quality.

Characteristics of spatio-temporal data include:

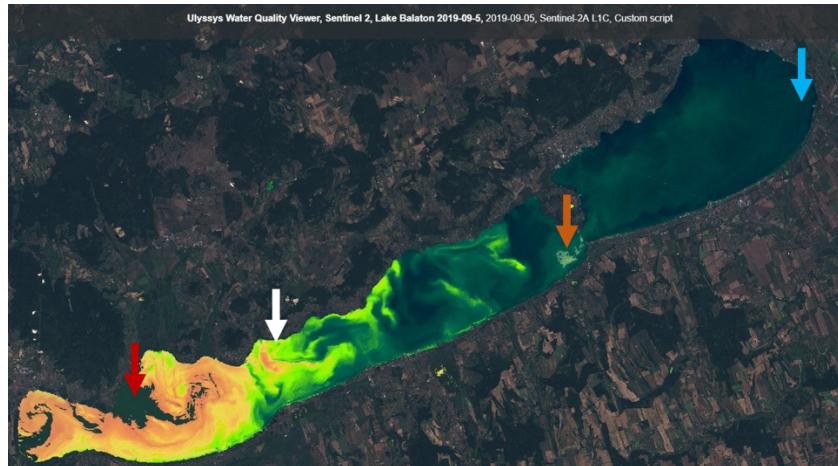
- **Dynamic Location Information:** The location of the phenomenon can change over time.
- **Temporal Changes:** Observations about how the attributes of a particular location change over time.
- **Complex Data Structure:** Requires sophisticated methods for analysis due to the integration of spatial and temporal dimensions.



**Figure 5.** Example of the intersection of the flood product with selected land-cover and building delineation products. In the top row, Larkana, a major city in Sindh province.

- What kind of information can we infer from these images? “*In the top row, 36,000 buildings and approximately 240,000 people were potentially affected by the flood within this grid tile. In the bottom row, an agricultural area near Layyah, located in the Punjab region. In this grid tile, the intersection indicates an estimated 107 km of potentially damaged cropland (Portalés-Julíà et al. 2023).*”

- Water quality from satellites ([GIF link1](#))



**Figure 6.** Distribution of color dissolved organic matter (CDOM) in Kariba Lake in Africa, between Zambia and Zimbabwe, showing large areas of values above 5 mg/l (Se2WaQ).

- Other hydrometeorological variables (e.g., soil moisture, vegetation, ground water) ([GIF link2](#))

In summary, each type of environmental data plays a pivotal role in Environmental management, offering unique insights into the temporal, spatial, and dynamic aspects of Environemnt-related phenomena. Understanding these characteristics helps in designing effective monitoring, management, and conservation strategies.