

# Data Tile Schema Specification

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## Abstract

This specification defines a metadata schema for raster data tiles (such as elevation tiles, population density tiles, etc.) that enables map libraries to automatically decode and visualize tile data without hardcoded processing logic.

The schema extends TileJSON 3.0.0, adding encoding information that describes how RGB pixel values should be converted to meaningful data values.

## Motivation

Current data tile formats (Mapbox Terrain-RGB, Terrarium, etc.) encode numerical values into RGB pixels, but the decoding logic must be hardcoded into each client implementation. This creates several problems:

- New data tile formats require client-side code changes
- Visualization parameters are not discoverable
- Interoperability between different providers is limited

By providing a machine-readable schema, map libraries can automatically decode any compliant data tile without format-specific implementations.

## Schema Definition

### Root Object

This specification extends TileJSON 3.0.0. All TileJSON properties are supported, with additional properties for data tile encoding.

### TileJSON Base Properties (from TileJSON 3.0.0)

Property	Type	Required	Description
tilejson	string	Yes	Version of TileJSON spec (e.g., "3.0.0")
tiles	array	Yes	Array of tile endpoint URLs. <code>{z}</code> , <code>{x}</code> , <code>{y}</code> are replaced with tile coordinates
name	string	No	Human-readable name of the tileset
description	string	No	Text description of the tileset
version	string	No	Semver version of the tiles. Default: "1.0.0"
attribution	string	No	Attribution string (may contain HTML)
scheme	string	No	"xyz" or "tms". Default: "xyz"
minzoom	integer	No	Minimum zoom level. Default: 0
maxzoom	integer	No	Maximum zoom level. Default: 30
bounds	array	No	[west, south, east, north] in WGS84. Default: [-180, -85.05112877980659, 180, 85.0511287798066]
center	array	No	[longitude, latitude, zoom] for default view
fillzoom	integer	No	Zoom level for generating overzoomed tiles

## Data Tile Schema Extensions

Property	Type	Required	Description
datatileschema	string	Yes	Version of this specification (e.g., "0.1.0")
encoding	object	Yes	Encoding configuration (see below)
data_range	object	No	Expected range of decoded values
nodata	object	No	No-data value configuration
visualization	object	No	Recommended visualization parameters

## Encoding Object

The encoding object describes how RGB pixel values are converted to data values.

Property	Type	Required	Description
channels	object	Yes	Channel multipliers (see below)
offset	number	Yes	Value added after channel calculation
unit	string	No	Unit of the decoded value (e.g., "meters", "celsius")
precision	number	No	Smallest representable value difference

## Channels Object

Property	Type	Required	Description
R	object	Yes	Red channel configuration
G	object	Yes	Green channel configuration
B	object	Yes	Blue channel configuration
A	object	No	Alpha channel configuration (optional)

Each channel object contains:

Property	Type	Required	Description
multiplier	number	Yes	Value to multiply the channel value (0-255) by

## Decoding Formula

The decoded value is calculated as:

```
value = R × channels.R.multiplier
      + G × channels.G.multiplier
      + B × channels.B.multiplier
      + offset
```

If alpha channel is defined:

```
value = R × channels.R.multiplier
      + G × channels.G.multiplier
```

```
+ B × channels.B.multiplier
+ A × channels.A.multiplier
+ offset
```

## Data Range Object

Property	Type	Required	Description
min	number	No	Minimum expected value
max	number	No	Maximum expected value

## No-Data Object

Property	Type	Required	Description
rgb	array	No	RGB values indicating no-data (e.g., [0, 0, 0])
rgba	array	No	RGBA values indicating no-data
value	any	No	Value to return for no-data pixels (typically null)

## Visualization Object

Property	Type	Required	Description
recommended_styles	array	No	List of recommended visualization styles
color_ramps	object	No	Named color ramp definitions
hillshade	object	No	Hillshade parameters

## Hillshade Object

Property	Type	Default	Description
azimuth	number	315	Light source azimuth in degrees
altitude	number	45	Light source altitude in degrees
exaggeration	number	1.0	Vertical exaggeration factor

# Examples

## Mapbox Terrain-RGB

```
{  
  "tilejson": "3.0.0",  
  "datatileschema": "0.1.0",  
  "name": "Mapbox Terrain-RGB",  
  "description": "Mapbox global elevation tiles",  
  "version": "1.0.0",  
  "attribution": "<a href=\"https://www.mapbox.com/\">© Mapbox</a>",  
  "scheme": "xyz",  
  "tiles": [  
    "https://api.mapbox.com/v4/mapbox.terrain-rgb/{z}/{x}/{y}.png?access_token  
  ],  
  "minzoom": 0,  
  "maxzoom": 15,  
  "bounds": [-180, -85.051129, 180, 85.051129],  
  "encoding": {  
    "channels": {  
      "R": { "multiplier": 6553.6 },  
      "G": { "multiplier": 25.6 },  
      "B": { "multiplier": 0.1 }  
    },  
    "offset": -10000,  
    "unit": "meters",  
    "precision": 0.1  
  },  
  "data_range": {  
    "min": -10000,  
    "max": 1667721.5  
  },  
  "visualization": {  
    "recommended_styles": ["hillshade", "elevation_color"],  
    "hillshade": {  
      "azimuth": 315,  
      "altitude": 45,  
      "exaggeration": 1.0  
    }  
  }  
}
```

## Terrarium (AWS/Mapzen)

```
{
  "tilejson": "3.0.0",
  "datatileschema": "0.1.0",
  "name": "Terrarium",
  "description": "Terrarium elevation tiles (AWS/Mapzen format)",
  "version": "1.0.0",
  "attribution": "<a href=\"https://registry.opendata.aws/terrain-tiles/\">Terrai",
  "scheme": "xyz",
  "tiles": [
    "https://s3.amazonaws.com/elevation-tiles-prod/terrarium/{z}/{x}/{y}.png"
  ],
  "minzoom": 0,
  "maxzoom": 15,
  "bounds": [-180, -85.051129, 180, 85.051129],
  "encoding": {
    "channels": {
      "R": { "multiplier": 256 },
      "G": { "multiplier": 1 },
      "B": { "multiplier": 0.00390625 }
    },
    "offset": -32768,
    "unit": "meters",
    "precision": 0.00390625
  },
  "data_range": {
    "min": -32768,
    "max": 32768
  }
}
```

## GSI (Geospatial Information Authority of Japan) Elevation Tiles

```
{
  "tilejson": "3.0.0",
  "datatileschema": "0.1.0",
  "name": "GSI Elevation Tiles",
  "description": "国土地理院標高タイル (DEM10B)",
  "version": "1.0.0",
  "attribution": "<a href=\"https://maps.gsi.go.jp/development/ichiran.html\">国土地理院",
  "scheme": "xyz",
  "tiles": [
    "https://cyberjapandata.gsi.go.jp/xyz/dem_png/{z}/{x}/{y}.png"
  ],
  "minzoom": 1,
  "maxzoom": 14,
```

```

"bounds": [122.0, 20.0, 154.0, 46.0],
"center": [139.7, 35.7, 10],
"encoding": {
  "channels": {
    "R": { "multiplier": 655.36 },
    "G": { "multiplier": 2.56 },
    "B": { "multiplier": 0.01 }
  },
  "offset": -100000,
  "unit": "meters",
  "precision": 0.01
},
"nodata": {
  "rgb": [128, 0, 0],
  "value": null
},
"visualization": {
  "recommended_styles": ["hillshade", "elevation_color"],
  "color_ramps": {
    "elevation": {
      "stops": [
        [0, "#0000ff"],
        [500, "#00ff00"],
        [2000, "#ffff00"],
        [4000, "#ff0000"]
      ]
    }
  }
}
}

```

## Population Density Tile (Hypothetical)

```
{
  "tilejson": "3.0.0",
  "datatileschema": "0.1.0",
  "name": "Population Density",
  "description": "Population per square kilometer",
  "version": "1.0.0",
  "attribution": "Example Data Provider",
  "scheme": "xyz",
  "tiles": [
    "https://example.com/tiles/population/{z}/{x}/{y}.png"
  ],
  "minzoom": 0,
  "maxzoom": 12,
}
```

```

"bounds": [-180, -85.051129, 180, 85.051129],
"encoding": {
  "channels": {
    "R": { "multiplier": 65536 },
    "G": { "multiplier": 256 },
    "B": { "multiplier": 1 }
  },
  "offset": 0,
  "unit": "people/km2",
  "precision": 1
},
"data_range": {
  "min": 0,
  "max": 16777215
},
"nodata": {
  "rgb": [0, 0, 0],
  "value": null
},
"visualization": {
  "recommended_styles": ["choropleth"],
  "color_ramps": {
    "density": {
      "stops": [
        [0, "#f7fbff"],
        [100, "#c6dbef"],
        [1000, "#6baed6"],
        [10000, "#2171b5"],
        [50000, "#08306b"]
      ]
    }
  }
}
}

```

## File Location

The schema file SHOULD be served at one of the following locations:

1. **As the tileset metadata itself** (recommended): The JSON file at the tileset root serves as both TileJSON and Data Tile Schema

<https://example.com/tiles/elevation.json>

2. **Alongside existing TileJSON**: If modifying existing TileJSON is not possible, a separate

schema file

<https://example.com/tiles/elevation/datatileschema.json>

## Backwards Compatibility

This specification is designed as a superset of TileJSON 3.0.0. Clients that do not support Data Tile Schema will simply ignore the extension properties (`datatileschema`, `encoding`, `data_range`, `nodata`, `visualization`) and can still use the standard TileJSON properties.

## Specification Identification

To identify that a TileJSON file includes Data Tile Schema extensions, check for the presence of the `datatileschema` property. The value indicates the version of this specification.

## Client Implementation Guidelines

### Decoding

1. Fetch the schema from either TileJSON or standalone endpoint
2. For each pixel, apply the decoding formula
3. Check for no-data values before decoding
4. Return the calculated value with appropriate unit

### Caching

Clients SHOULD cache the schema alongside tile metadata, as encoding parameters do not change frequently.

### Error Handling

If the schema is not available, clients MAY fall back to hardcoded implementations for known formats (identified by source URL patterns), but SHOULD prefer schema-based decoding when available.

## Security Considerations

Clients SHOULD validate that multiplier and offset values are within reasonable bounds to

prevent numerical overflow.

## Future Extensions

Potential future additions to this specification:

- Support for multi-band tiles (beyond RGBA)
- Logarithmic or other non-linear encoding schemes
- Tile-level metadata (e.g., actual min/max values per tile)
- Compression hints

## References

- [TileJSON Specification](#)
- [Mapbox Terrain-RGB](#)
- [Terrarium Format](#)

## License

This specification is released under [CC0 1.0 Universal](#).