UNIVERSIDAD EAFIT

ALMACENAMIENTO Y RECUPERACION DE LA INFORMACIÓN

PROYECTO 1

INGENIERIA DE DATOS

ESTUDIANTES:

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ESCUELA DE CIENCIAS APLICADAS E INGENIERÍA

MAESTRÍA EN CIENCIAS DE LOS DATOS Y ANALÍTICA

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MARZO 15, 2024

PROYECTO 1 – Ingeniería de Datos

1. Selección de los diferentes datasets.

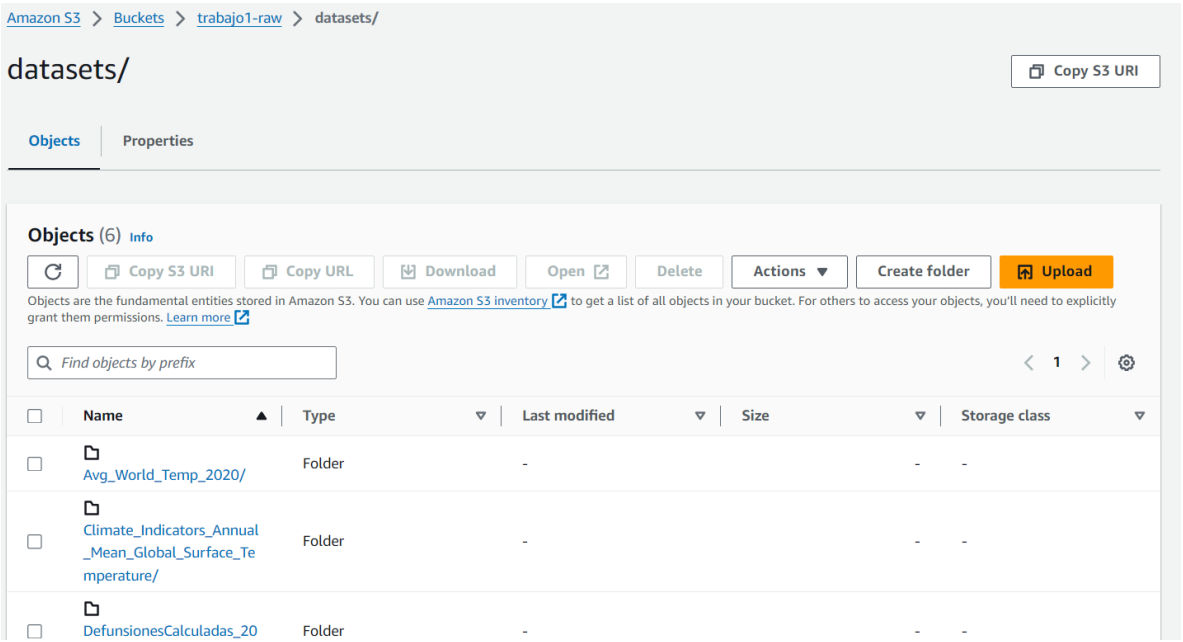
Para la realización del taller nos basamos en extracciones de datasets principalmente de Kaggle, del Portal de Datos Abiertos del Área Metropolitana del Valle de Aburrá y Datos del Cambio Climático del Fondo Monetario Internacional (Climate Change Dashboard – IMF).

Datasets	**URL**
Avg_World_Temp_2020	https://www.kaggle.com/datasets/efradgamer/world-average-temperature?resource=download
DefunsionesCalculadas_2008-2017	https://datosabiertos.metropol.gov.co/dataset/7281fa8e-c666-4fed-a8bd-a4af7d0ea749
Climate_Indicators_Annual_Mean_Global_Surface_Temperature	https://climatedata.imf.org/datasets/4063314923d74187be9596f10d034914_0/explore
global air pollution dataset	https://www.kaggle.com/datasets/hasibalmuzdadid/global-air-pollution-dataset
Water Quality	https://www.kaggle.com/datasets/patricklford/water-and-air-quality?select=Cities1.csv
Temperatura	https://datosabiertos.metropol.gov.co/sites/default/files/uploaded_resources/Datos_SIATA_Vaisala_temperatura.json

2. Ingesta de datos como archivos / datasets desde Almacenamiento de datos en AWS S3

En este paso, se toman los archivos csv descargados previamente y se cargan dentro del bucket creado en S3, en este caso de la zona RAW.

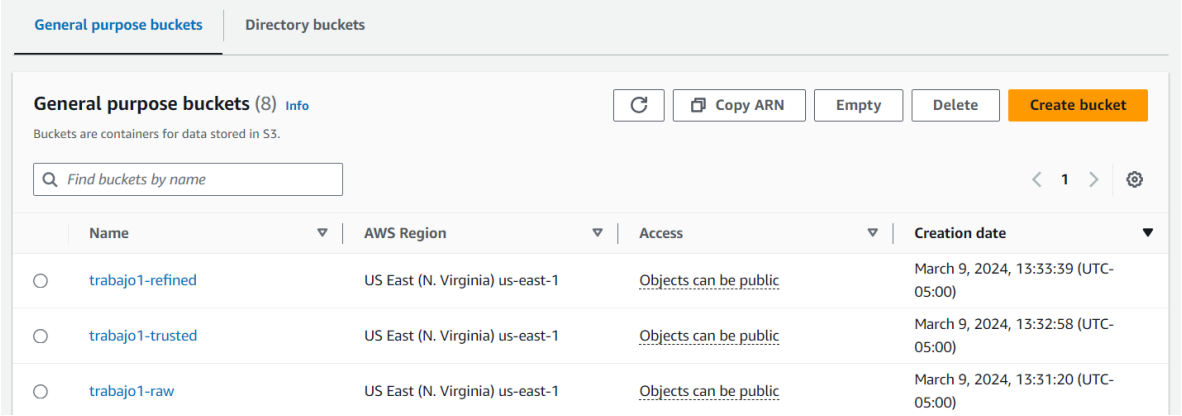
URI S3 Raw: s3://trabajo1-raw/datasets/



3. Diseño de un datalake como almacenamiento de los datos diferentes orígenes, tipos y estructuras.

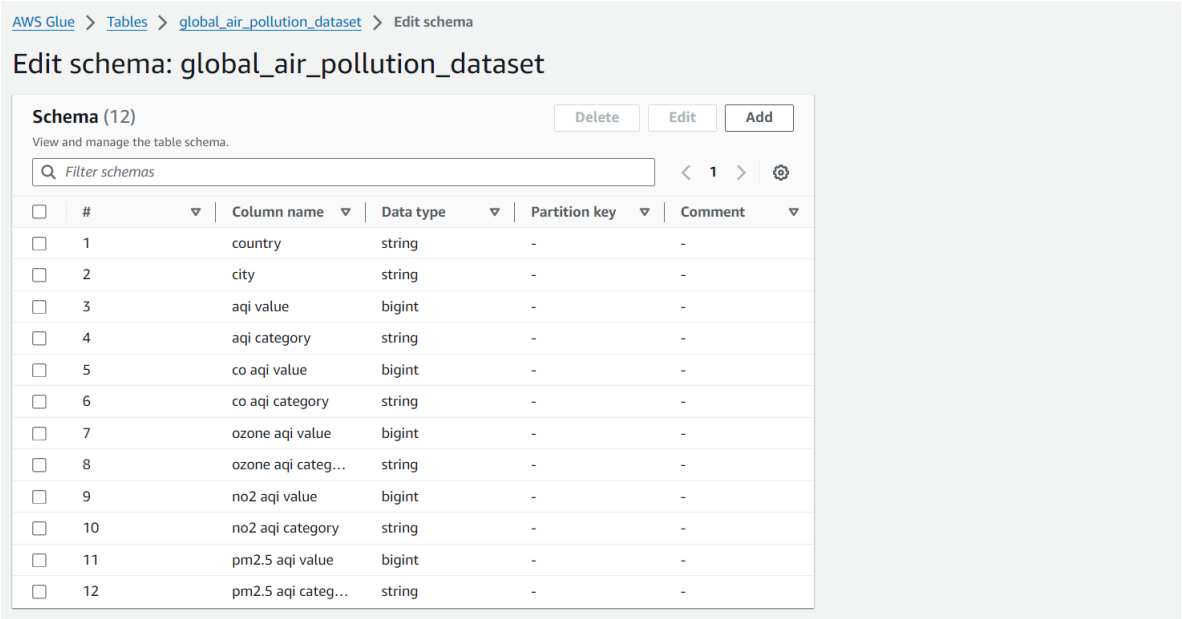
En este paso se crean las 3 diferentes zonas: Raw, Trusted y Refined como se muestra a continuación y se establece la estructura de directorios:

- URI Raw: s3://trabajo1-raw/datasets/
- URI Trusted: s3://trabajo1-trusted/datatrusted/
- URI Refined: s3://trabajo1-refined/datarefine/

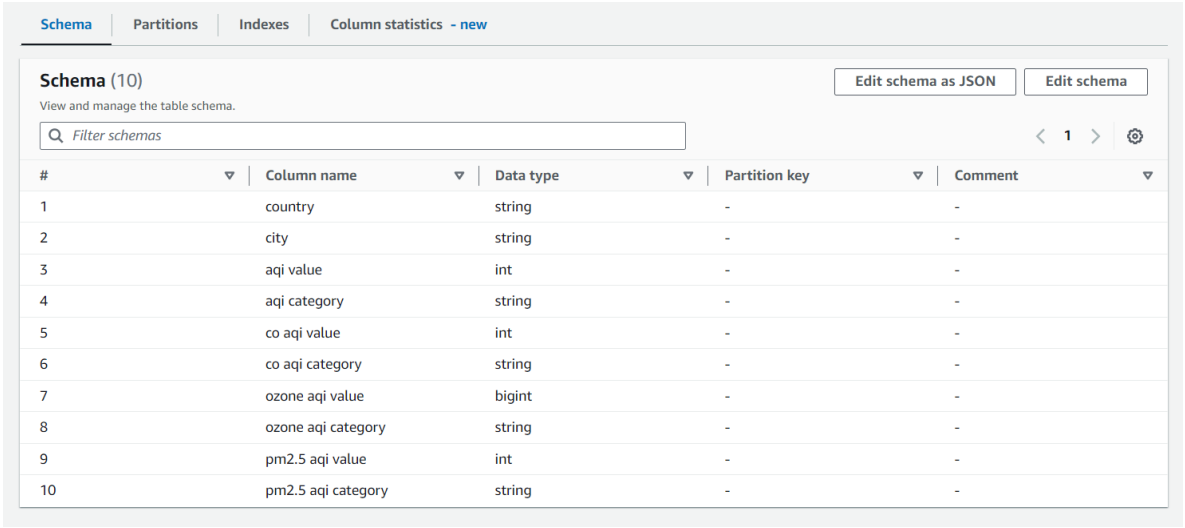


4. Catalogación:

En este paso se transforman los datos utilizando AWS Glue, inicialmente los datos se veían así:



Posterior a la transformación, los datos quedan así, de 12 columnas quedaron 10 con un tipo de data modificado también:



Schema | Partitions | Indexes | Column statistics - new

Schema (10)

View and manage the table schema.

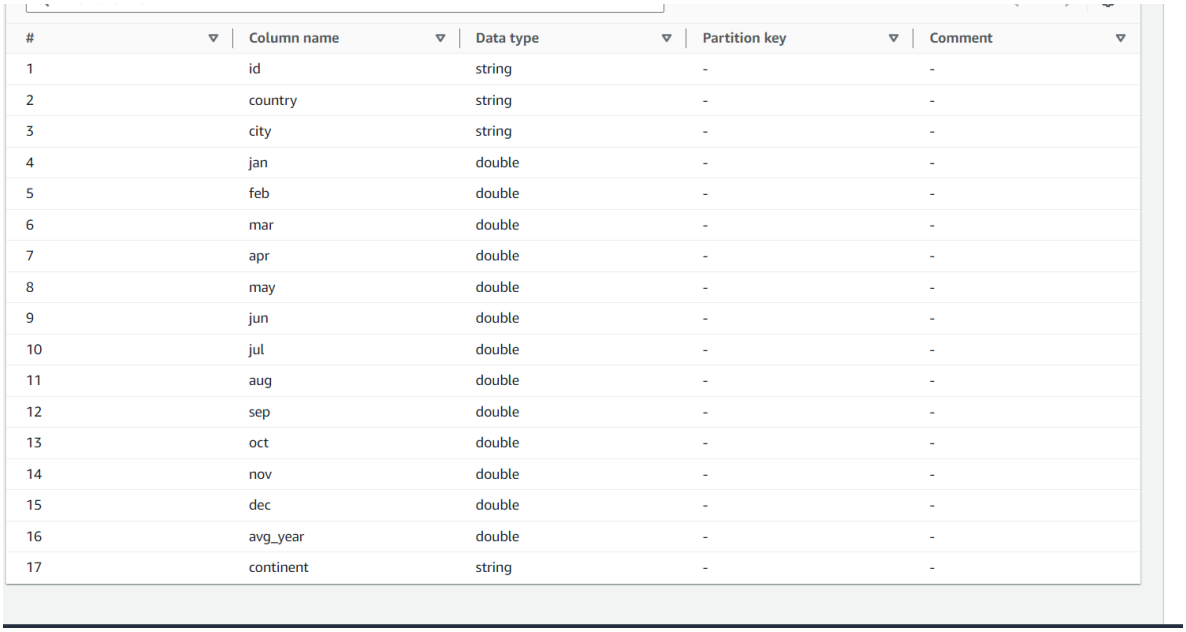
Edit schema as JSON | Edit schema

Filter schemas

1

#	Column name	Data type	Partition key	Comment
1	country	string	-	-
2	city	string	-	-
3	aqi value	int	-	-
4	aqi category	string	-	-
5	co aqi value	int	-	-
6	co aqi category	string	-	-
7	ozone aqi value	bigint	-	-
8	ozone aqi category	string	-	-
9	pm2.5 aqi value	int	-	-
10	pm2.5 aqi category	string	-	-

Esta es una segunda transformación con AWS Glue, los datos inicialmente se cargaron así:



#	Column name	Data type	Partition key	Comment
1	id	string	-	-
2	country	string	-	-
3	city	string	-	-
4	jan	double	-	-
5	feb	double	-	-
6	mar	double	-	-
7	apr	double	-	-
8	may	double	-	-
9	jun	double	-	-
10	jul	double	-	-
11	aug	double	-	-
12	sep	double	-	-
13	oct	double	-	-
14	nov	double	-	-
15	dec	double	-	-
16	avg_year	double	-	-
17	continent	string	-	-

Y así quedaron posterior a la transformación, se redujeron a 16 columnas:

Schema | Partitions | Indexes | Column statistics - new

Schema (16)

View and manage the table schema.

Edit schema as JSON | Edit schema

Filter schemas

1

#	Column name	Data type	Partition key	Comment
1	country	string	-	-
2	city	string	-	-
3	jan	double	-	-
4	feb	double	-	-
5	mar	double	-	-
6	apr	double	-	-
7	may	double	-	-
8	jun	double	-	-
9	jul	double	-	-
10	aug	double	-	-
11	sep	double	-	-
12	oct	double	-	-
13	nov	double	-	-
14	dec	double	-	-

Views (0) 1

Run again | Explain | Cancel | Clear | Create

Reuse query results
up to 60 minutes ago

Query results | Query stats

Completed Time in queue: 101 ms Run time: 566 ms Data scanned: 1.56 MB

Results (4)

Copy | Download results

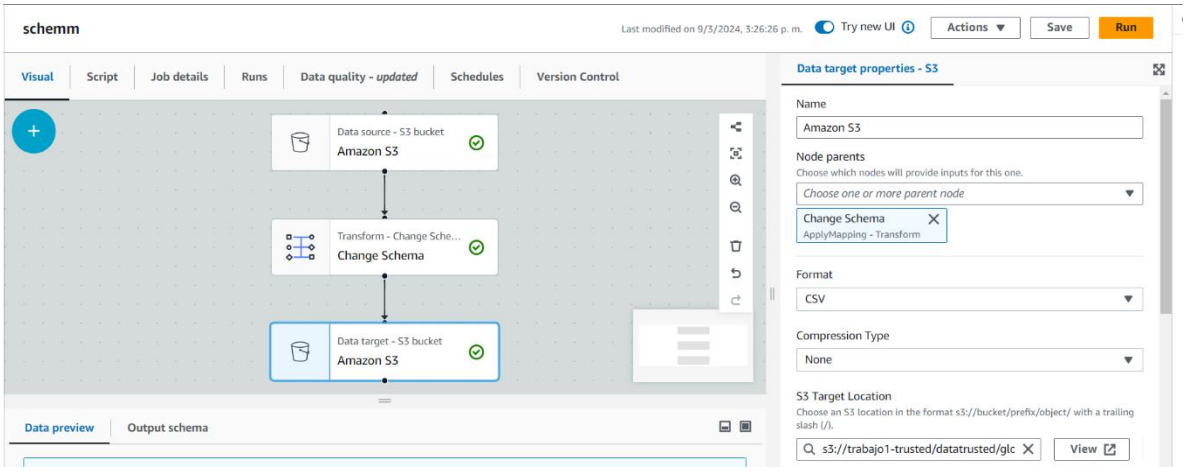
Search rows

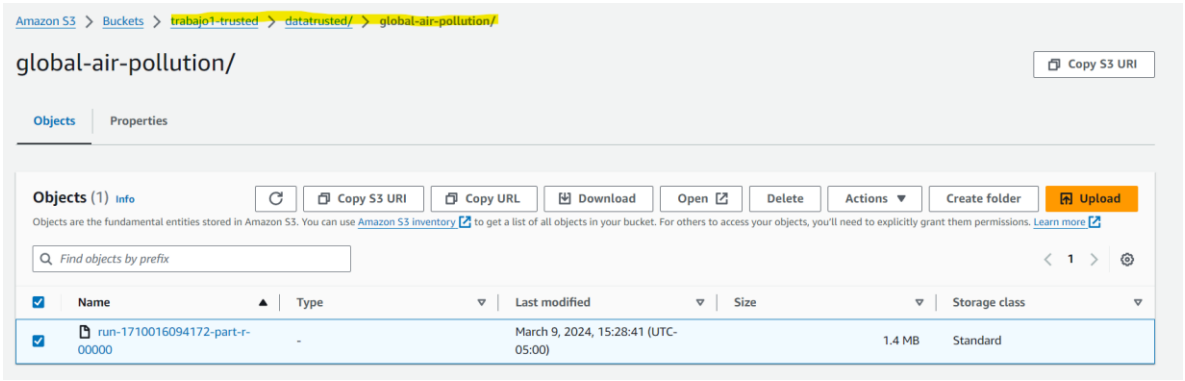
1

#	country	city	aqi value	aqi category	co aqi value	co aqi category	ozone aqi value
1	Republic of Korea	Seoul	421	Hazardous	27	Good	0
2	United States of America	Durango	500	Hazardous	133	Unhealthy for Sensitive Groups	0
3	China	Chengdu	386	Hazardous	28	Good	0
4	China	Xian	307	Hazardous	19	Good	0

5. Proceso transformación con ETL job con AWS Glue

En este paso se usa Glue para la catalogación, indicando como zona de salida el bucket trusted





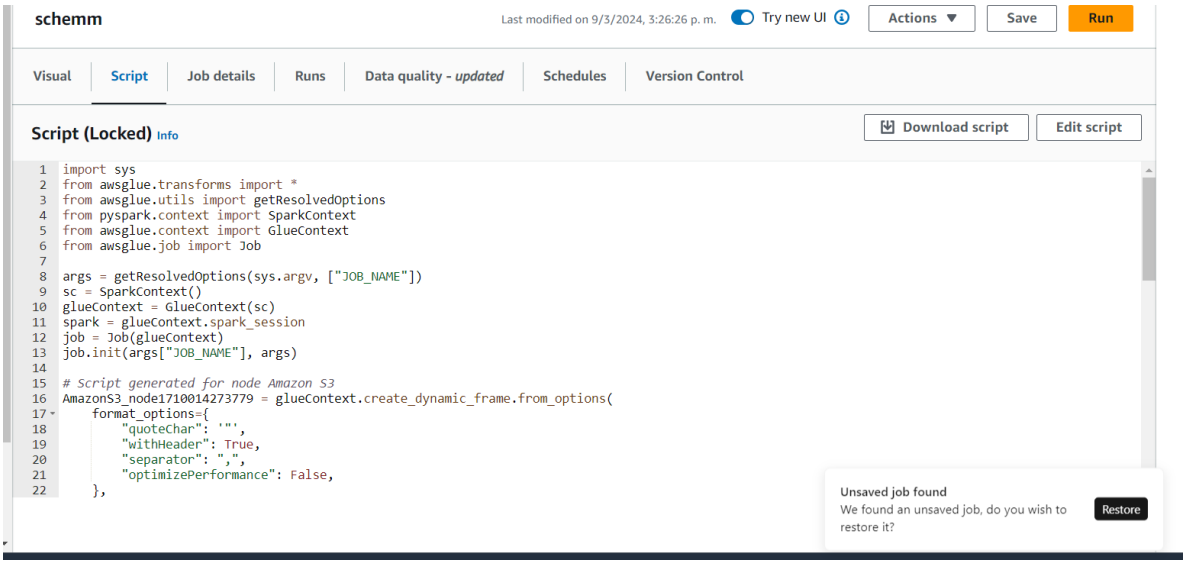
URI S3: s3://aws-glue-assets-891377086651-us-east-1/

Script (catalogación Glue – ETL Jobs)

```
import sys
from awsglue.transforms import *
from awsglue.utils import getResolvedOptions
from pyspark.context import SparkContext
from awsglue.context import GlueContext
from awsglue.job import Job

args = getResolvedOptions(sys.argv, ["JOB_NAME"])
sc = SparkContext()
glueContext = GlueContext(sc)
spark = glueContext.spark_session
```

```
job = Job(glueContext)
job.init(args["JOB_NAME"], args)

# Script generated for node Amazon S3
AmazonS3_node1710014273779 = glueContext.create_dynamic_frame.from_options(
    format_options={
        "quoteChar": '"',
        "withHeader": True,
        "separator": ",",
        "optimizePerformance": False,
    },
    connection_type="s3",
    format="csv",
    connection_options={
        "paths": [
            "s3://trabajo1-raw/datasets/global air pollution dataset/global air pollution dataset.csv"
        ],
        "recurse": True,
    },
    transformation_ctx="AmazonS3_node1710014273779",
)

# Script generated for node Change Schema
ChangeSchema_node1710014282069 = ApplyMapping.apply(
    frame=AmazonS3_node1710014273779,
    mappings=[
        ("Country", "string", "Country", "string"),
        ("City", "string", "City", "string"),
        ("AQI Value", "string", "AQI Value", "int"),
        ("AQI Category", "string", "AQI Category", "string"),
        ("CO AQI Value", "string", "CO AQI Value", "int"),
        ("CO AQI Category", "string", "CO AQI Category", "string"),
        ("NO2 AQI Value", "string", "NO2 AQI Value", "int"),
        ("NO2 AQI Category", "string", "NO2 AQI Category", "string"),
        ("`PM2.5 AQI Value`", "string", "`PM2.5 AQI Value`", "int"),
        ("`PM2.5 AQI Category`", "string", "`PM2.5 AQI Category`", "string"),
    ],
    transformation_ctx="ChangeSchema_node1710014282069",
)

# Script generated for node Amazon S3
AmazonS3_node1710014287417 = glueContext.write_dynamic_frame.from_options(
    frame=ChangeSchema_node1710014282069,
    connection_type="s3",
    format="csv",
    connection_options={
        "path": "s3://trabajo1-trusted/datatrusted/global-air-pollution/",
        "partitionKeys": [],
```

```
    },
    transformation_ctx="AmazonS3_node1710014287417",
)

job.commit()
```

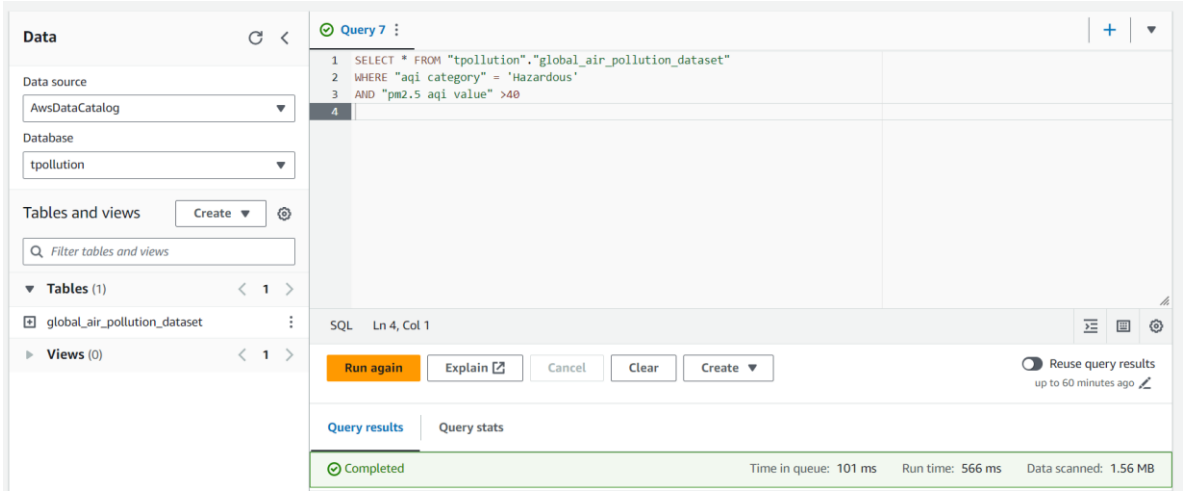


6. Consultas

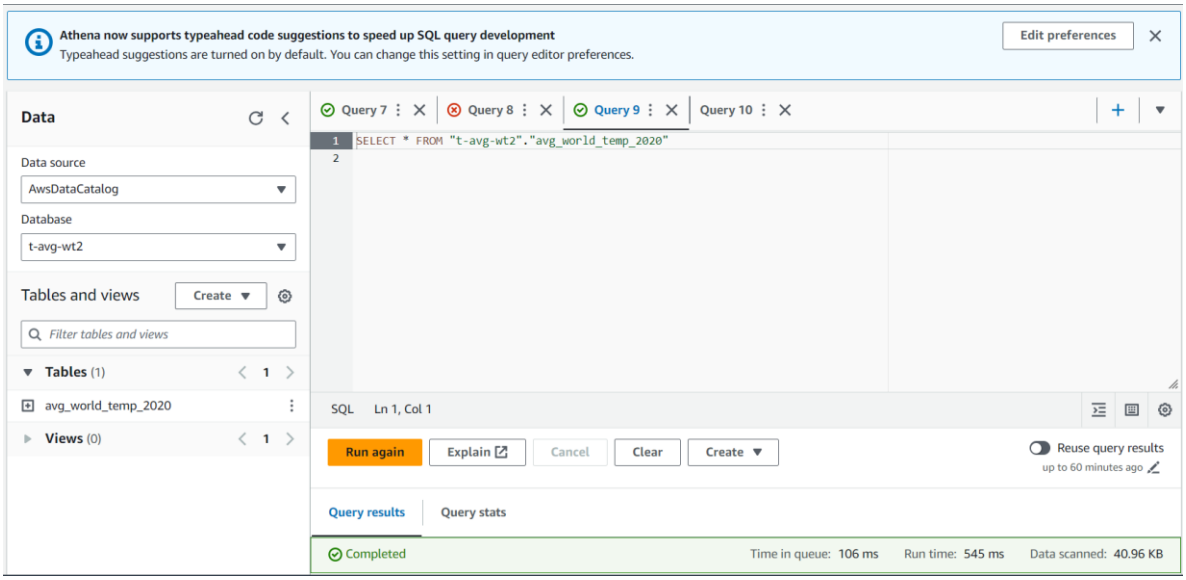
A continuación, se muestran unas consultas realizadas posterior a la catalogación y transformación de los datos en Athena (más adelante se muestran las consultas realizadas en Hive):

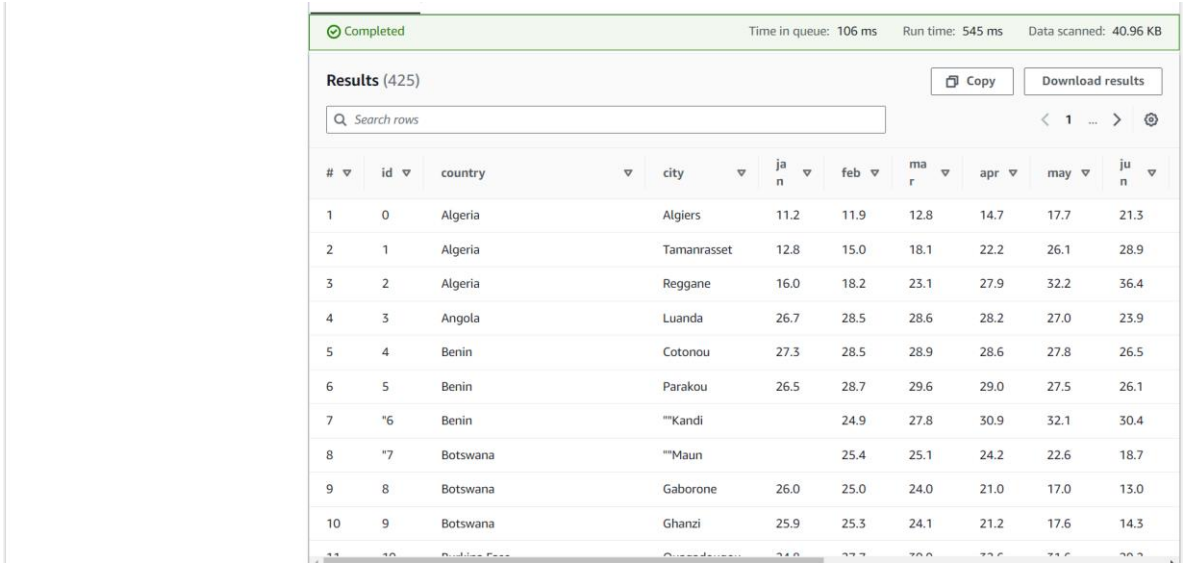
Para el dataset “global_air_pollution_dataset”:

```
SELECT * FROM “tpolution”.”global_air_pollution_dataset”
WHERE “aqi category” = ‘Hazardous’
AND “pm.5 aqi value” >40
```



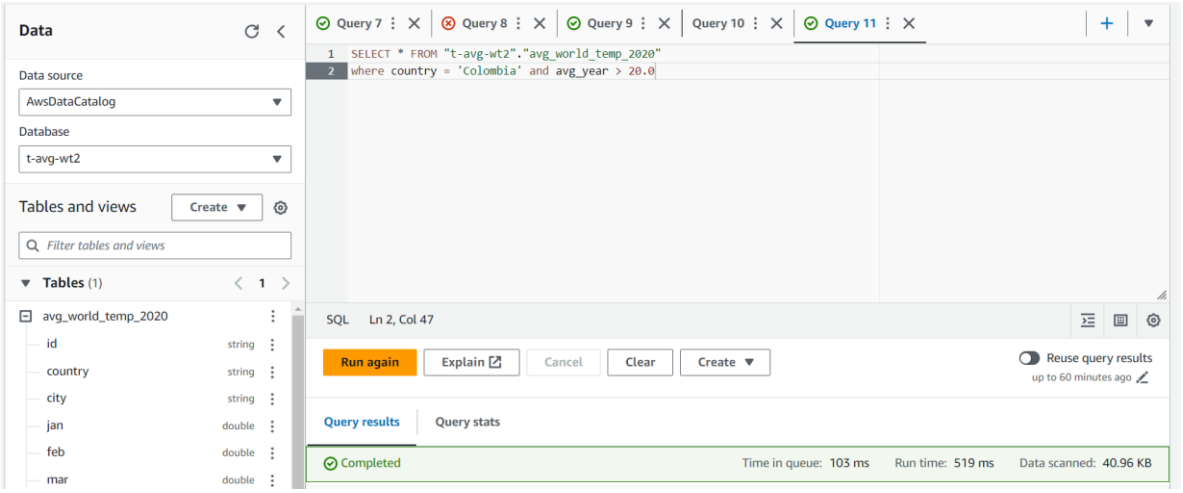
Segunda consulta

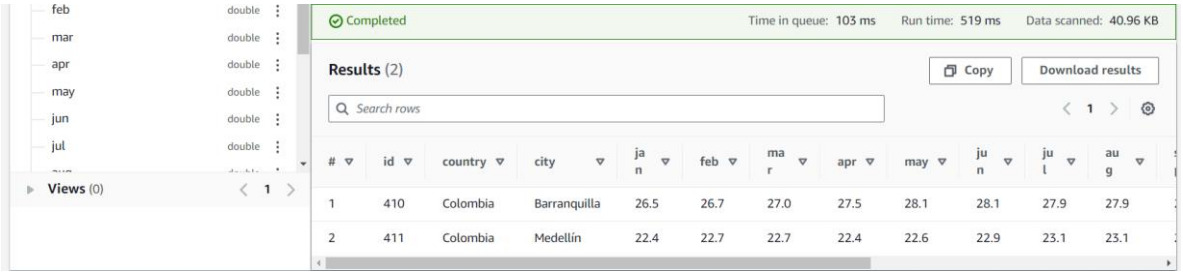




#	id	country	city	jan	feb	mar	apr	may	jun
1	0	Algeria	Algiers	11.2	11.9	12.8	14.7	17.7	21.3
2	1	Algeria	Tamanrasset	12.8	15.0	18.1	22.2	26.1	28.9
3	2	Algeria	Reggane	16.0	18.2	23.1	27.9	32.2	36.4
4	3	Angola	Luanda	26.7	28.5	28.6	28.2	27.0	23.9
5	4	Benin	Cotonou	27.3	28.5	28.9	28.6	27.8	26.5
6	5	Benin	Parakou	26.5	28.7	29.6	29.0	27.5	26.1
7	"6	Benin	""Kandi		24.9	27.8	30.9	32.1	30.4
8	"7	Botswana	""Maun		25.4	25.1	24.2	22.6	18.7
9	8	Botswana	Gaborone	26.0	25.0	24.0	21.0	17.0	13.0
10	9	Botswana	Ghanzi	25.9	25.3	24.1	21.2	17.6	14.3

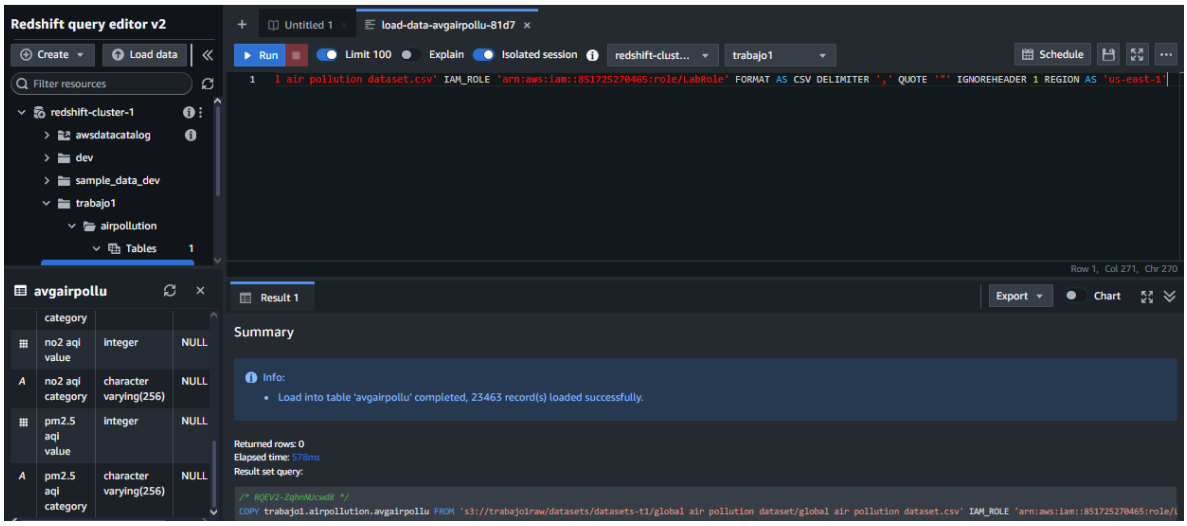
Tercera consulta





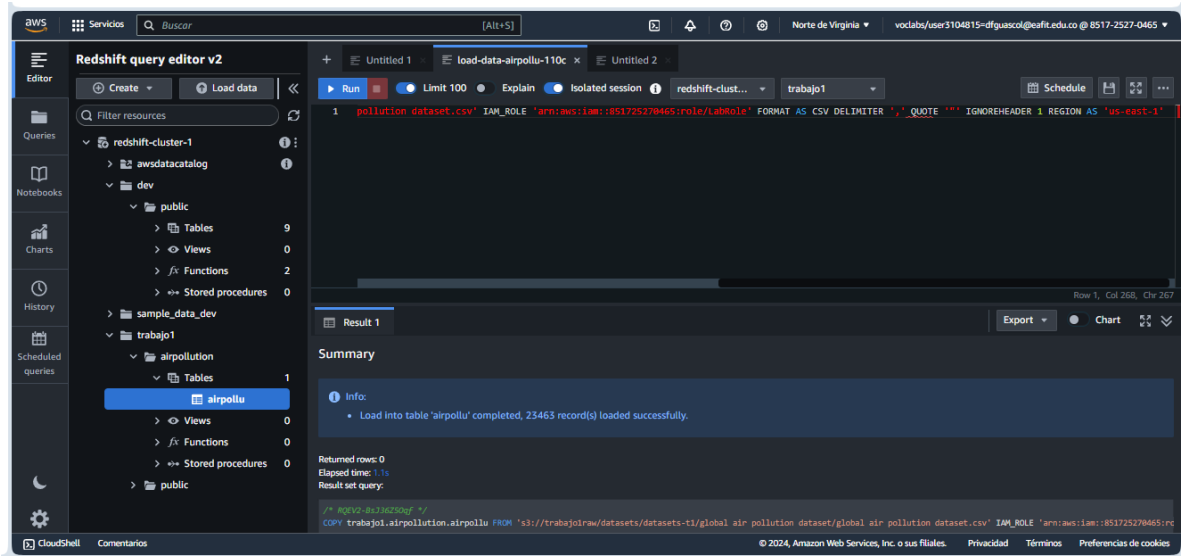
7. Tablas almacenadas en Redshift desde S3 y su respectiva consulta:

Archivo cargado en Redshift

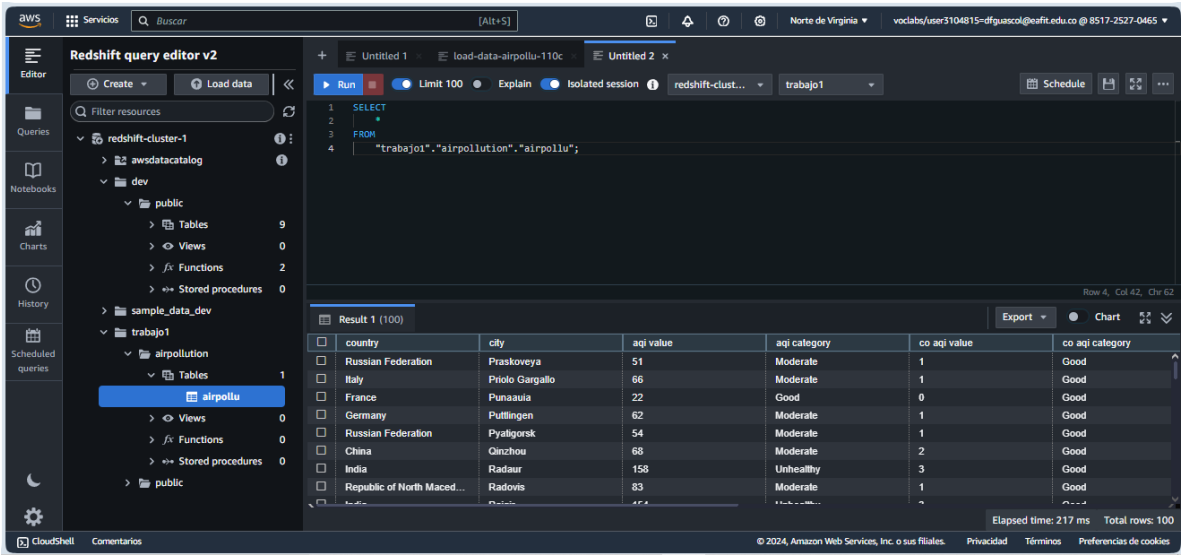


Accediendo a los datos en S3

COPY trabajo1.airpollution.airpollu FROM 's3://trabajo1raw/datasets/datasets-t1/global air pollution dataset/global air pollution dataset.csv' IAM_ROLE 'arn:aws:iam::851725270465:role/LabRole' FORMAT AS CSV DELIMITER ',' QUOTE '"' IGNOREHEADER 1 REGION AS 'us-east-1'

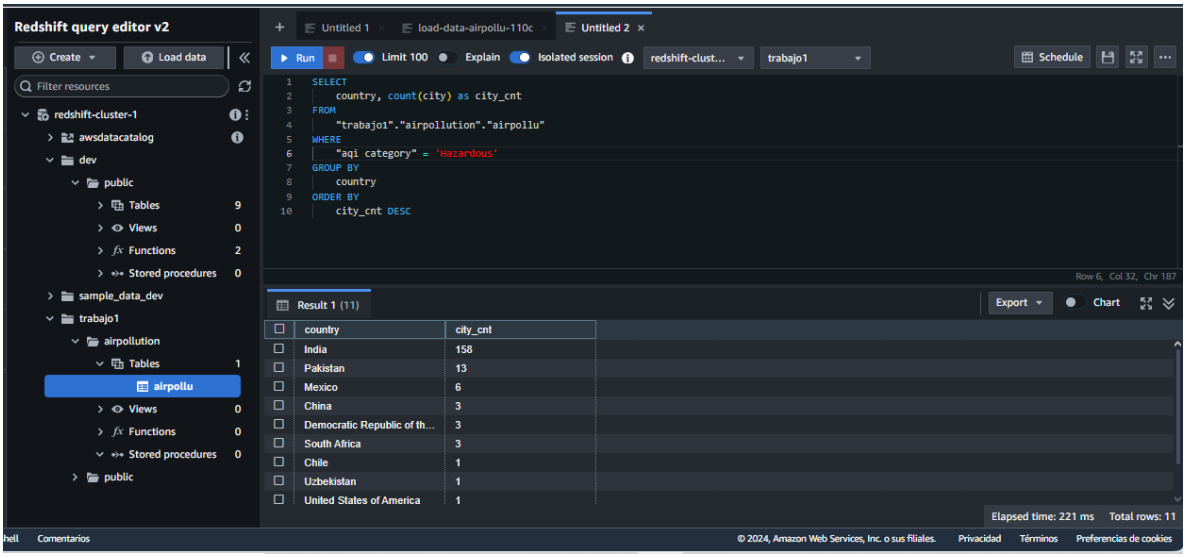


Consultas



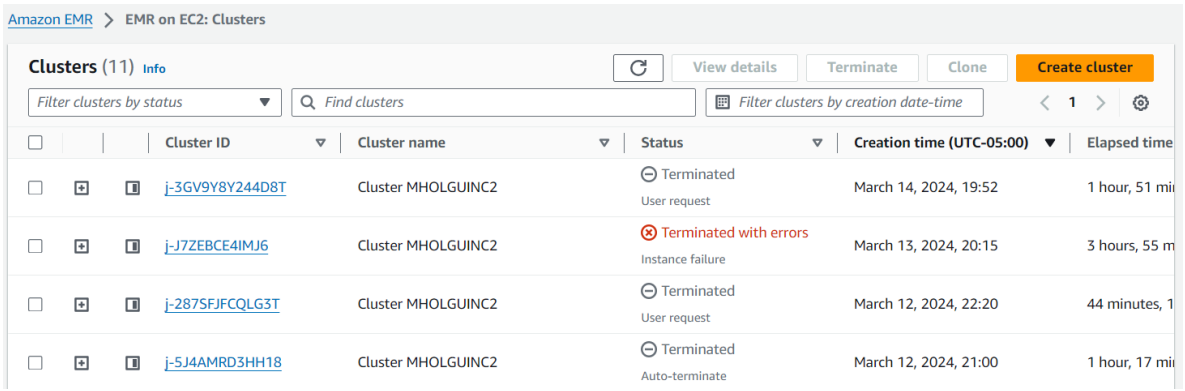

```
SELECT
   country, count(city) as city_cnt
FROM
   "trabajo1"."airpollution"."airpollu"
WHERE
   "aqi category" = 'Hazardous'
GROUP BY
```

country
ORDER BY
city_cnt DESC

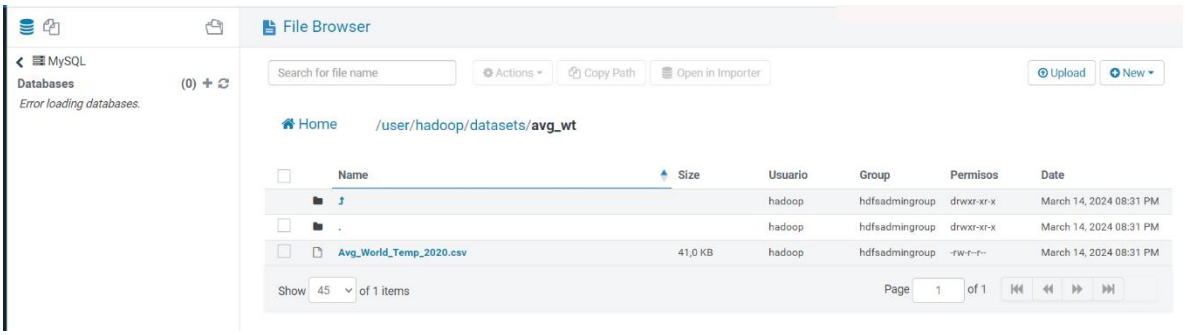


8. Ecosistema Hadoop/Spark basado en AWS EMR

Desplegar clústeres EMR



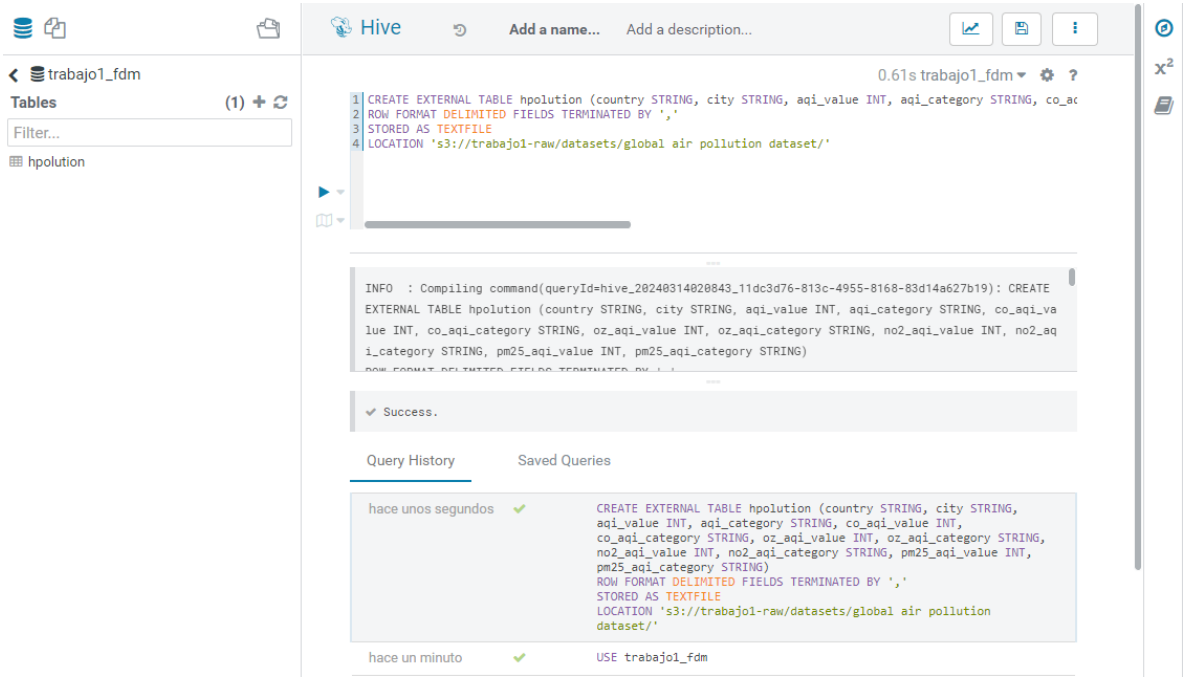
Almacenamiento de datos temporales en HDFS



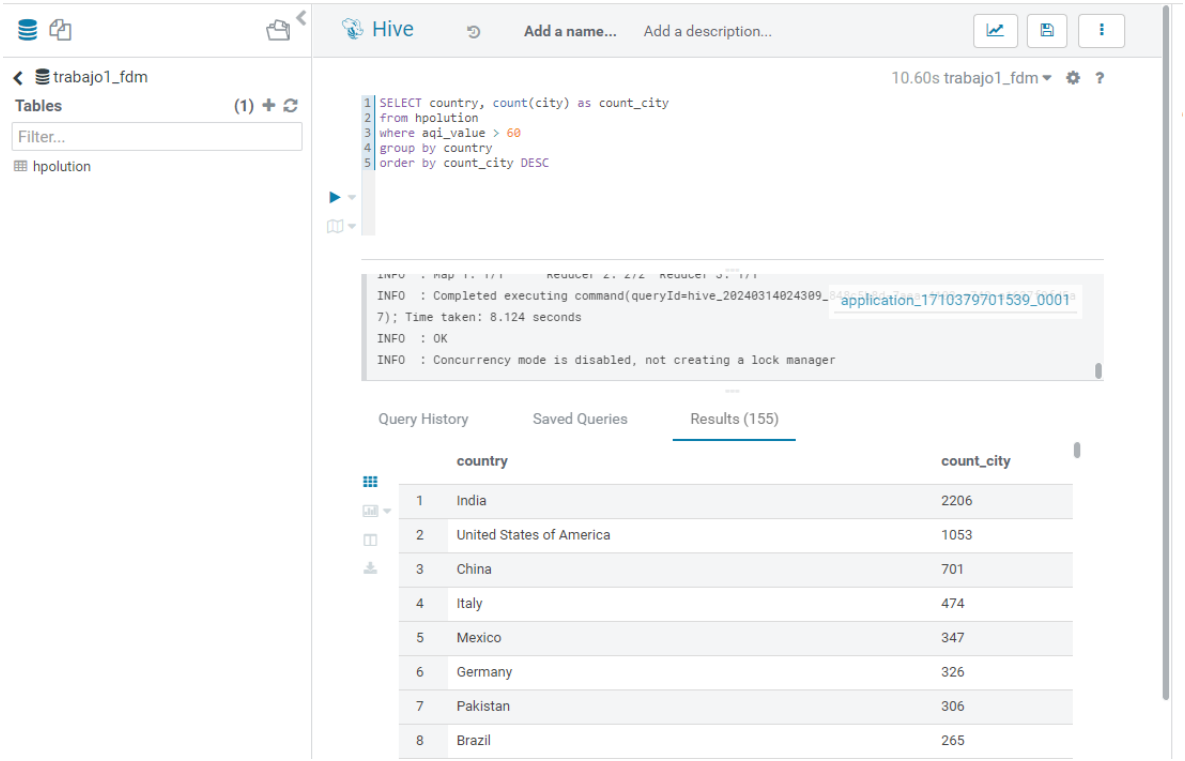
Creación de tabla externa en Hive desde S3 (catalogación)

USE trabajo1_fdm

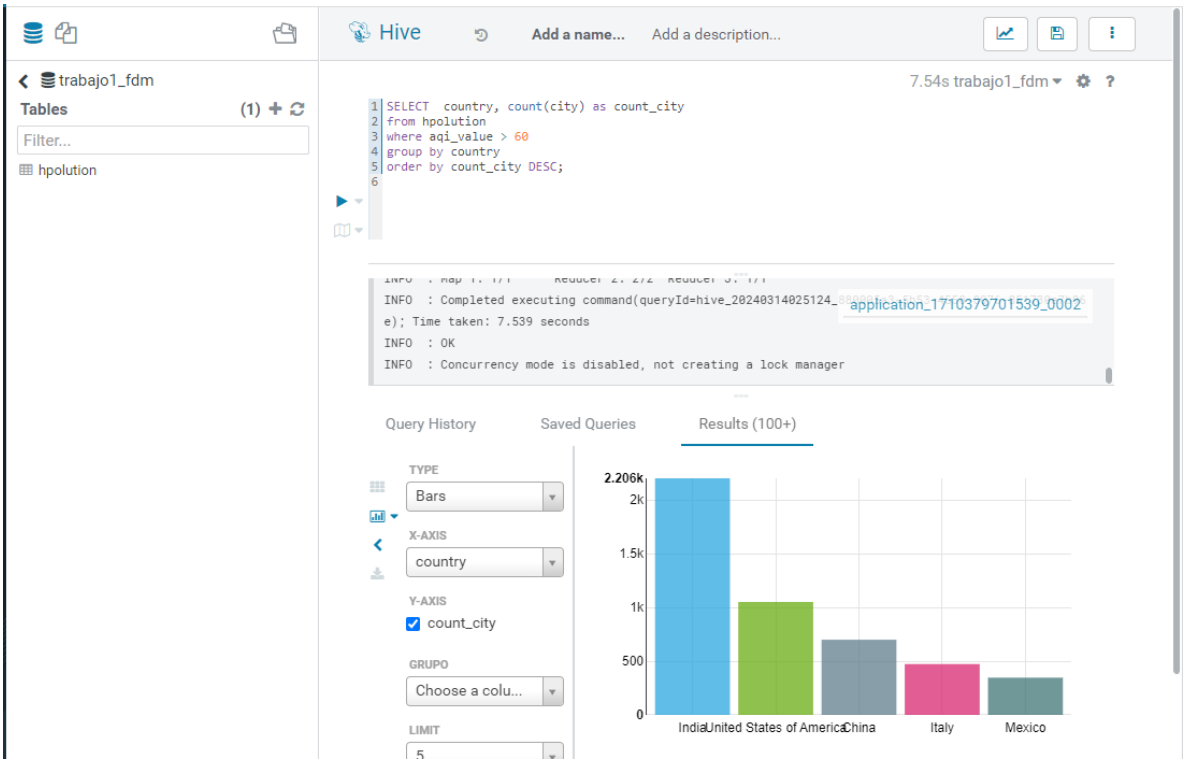
CREATE EXTERNAL TABLE HDI (country STRING, city STRING, aqi_value INT, aqi_category STRING, co_aqi_value INT, co_aqi_category STRING, oz_aqi_value INT, oz_aqi_category STRING, no2_aqi_value INT, no2_aqi_category STRING, pm25_aqi_value INT, pm25_aqi_category STRING)
ROW FORMAT DELIMITED FIELDS TERMINATED BY ','
STORED AS TEXTFILE
LOCATION 's3://trabajo1-raw/datasets/global air pollution dataset/'

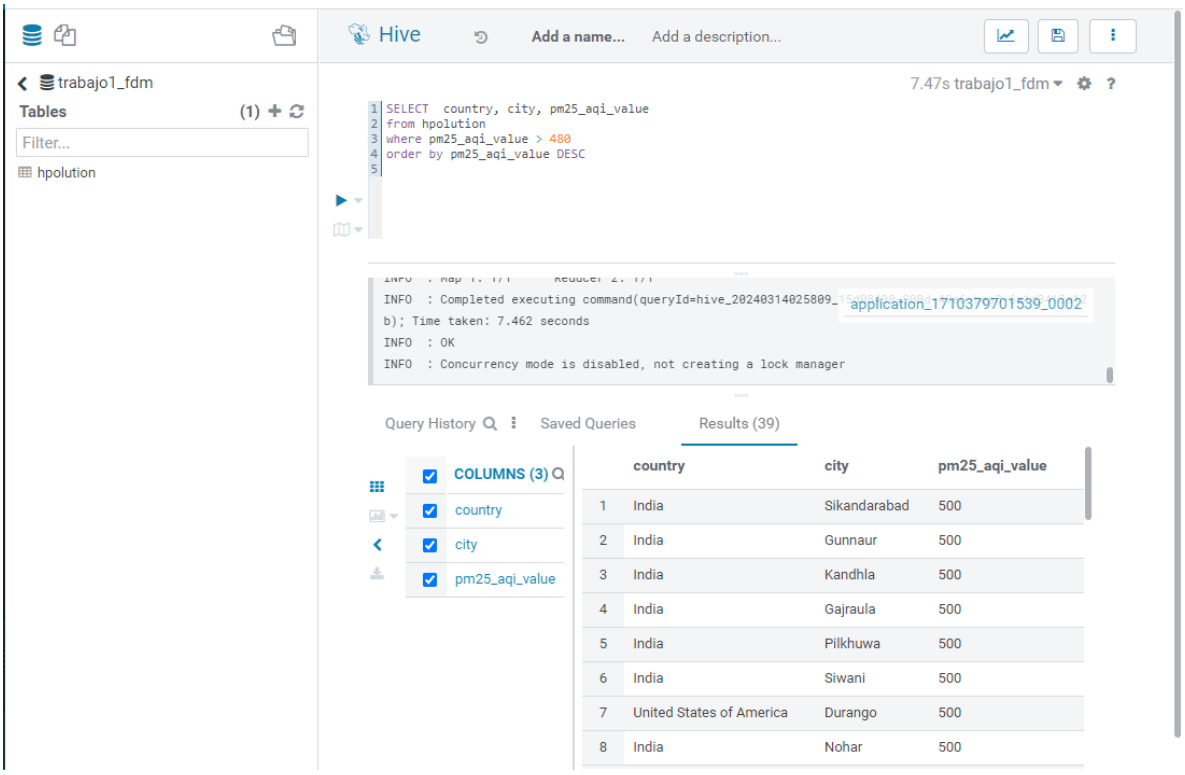


Consultas:

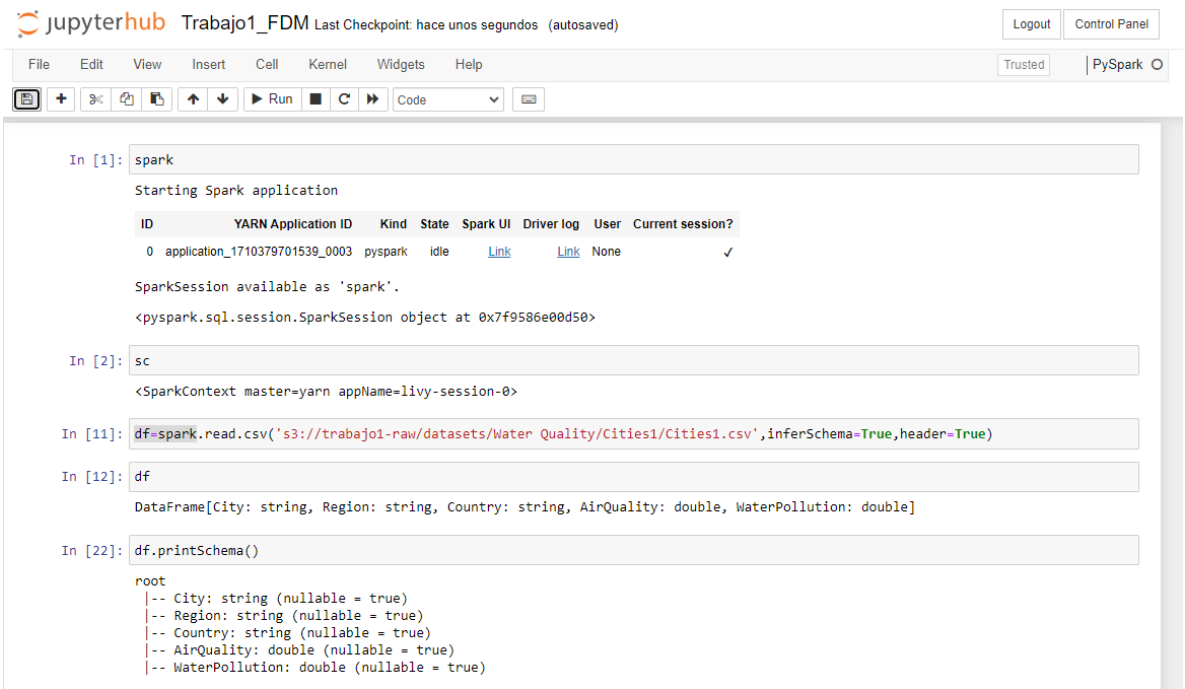


	country	count_city
1	India	2206
2	United States of America	1053
3	China	701
4	Italy	474
5	Mexico	347
6	Germany	326
7	Pakistan	306
8	Brazil	265





Instalación de un ambiente de procesamiento en Spark con pyspark (se adjunta notebook con scripts)



jupyterhub Trabajo1_FDM Last Checkpoint: hace unos segundos (autosaved)

Logout | Control Panel

File Edit View Insert Cell Kernel Widgets Help | Trusted | PySpark

Run | Code

In [23]:
```
df.show(5)
```

```
+----------------+--------------------+--------------------+-----------+--------------+
|            City|              Region|             Country| AirQuality|WaterPollution|
+----------------+--------------------+--------------------+-----------+--------------+
|   New York City|            New York|United States of ...|46.81603774|    49.5049505|
|Washington, D.C.|District of Columbia|United States of ...|66.12903226|   49.10714286|
|   San Francisco|          California|United States of ...|60.51401869|          43.0|
|          Berlin|                null|             Germany|62.36413043|   28.61271676|
|     Los Angeles|          California|United States of ...|36.62162162|   61.29943503|
+----------------+--------------------+--------------------+-----------+--------------+
only showing top 5 rows
```

In [24]:
```
df.describe().show()
```

```
+-------+------+-----------------+----------+-----------------+-----------------+
|summary|  City|           Region|   Country|       AirQuality|    WaterPollution|
+-------+------+-----------------+----------+-----------------+-----------------+
|  count|  3963|             3538|      3963|             3963|             3963|
|   mean|   NaN|              NaN|      null| 62.2534517395642| 44.63537214186169|
| stddev|  null|             null|      null|30.94475340271576|25.663910130285892|
|    min|Aachen|    ???il Province|Afghanistan|              0.0|              0.0|
|    max|Zywiec|canton of Fribourg|  Zimbabwe|            100.0|            100.0|
+-------+------+-----------------+----------+-----------------+-----------------+
```

jupyterhub Trabajo1_FDM Last Checkpoint: hace un minuto (autosaved)

Logout | Control Panel

File Edit View Insert Cell Kernel Widgets Help | Trusted | PySpark

Run | Code


```
|   mean|   NaN|              NaN|      null| 62.2534517395642| 44.63537214186169|
| stddev|  null|             null|      null|30.94475340271576|25.663910130285892|
|    min|Aachen|    ???il Province|Afghanistan|              0.0|              0.0|
|    max|Zywiec|canton of Fribourg|  Zimbabwe|            100.0|            100.0|
+-------+------+-----------------+----------+-----------------+-----------------+
```


In [40]:
```
from pyspark.sql.functions import udf
```

In [42]:
```
## Creando una columna con datos 1 = mayor que la media y 0 = menor que la media

AQMean = udf(lambda AirQuality: "0" if AirQuality <= 62.25 else "1")

df.withColumn("AQ>Mean", AQMean(df.AirQuality)).show(10,False)
```

```
+----------------+--------------------+------------------------+-----------+--------------+-------+
|City            |Region              |Country                 |AirQuality |WaterPollution|AQ>Mean|
+----------------+--------------------+------------------------+-----------+--------------+-------+
|New York City   |New York            |United States of America|46.81603774|49.5049505    |0      |
|Washington, D.C.|District of Columbia|United States of America|66.12903226|49.10714286   |1      |
|San Francisco   |California          |United States of America|60.51401869|43.0          |0      |
|Berlin          |null                |Germany                 |62.36413043|28.61271676   |1      |
|Los Angeles     |California          |United States of America|36.62162162|61.29943503   |0      |
|Bern            |Canton of Bern      |Switzerland             |94.31818182|12.5          |1      |
|Geneva          |Canton of Geneva    |Switzerland             |71.53846154|17.37288136   |1      |
|Zurich          |Canton of Zurich    |Switzerland             |83.80952381|10.71428571   |1      |
|Basel           |null                |Switzerland             |81.66666667|26.92307692   |1      |
|London          |England             |United Kingdom          |37.04225352|40.71637427   |0      |
+----------------+--------------------+------------------------+-----------+--------------+-------+
only showing top 10 rows
```

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In [72]:
```
## No se guarda la columna AQMean

df.show(5)
```

```
+----------------+--------------------+--------------------+-----------+--------------+
|            City|              Region|             Country| AirQuality|WaterPollution|
+----------------+--------------------+--------------------+-----------+--------------+
|   New York City|            New York|United States of ...|46.81603774|    49.5049505|
|Washington, D.C.|District of Columbia|United States of ...|66.12903226|   49.10714286|
|   San Francisco|          California|United States of ...|60.51401869|          43.0|
|          Berlin|                null|             Germany|62.36413043|   28.61271676|
|     Los Angeles|          California|United States of ...|36.62162162|   61.29943503|
+----------------+--------------------+--------------------+-----------+--------------+
only showing top 5 rows
```

In [12]:
```
## Ciudades de Colombia que tienen contaminanción del agua superior a la media mundial

df.filter(df['Country']=='Colombia').filter(df['WaterPollution'] >44.63).show()
```

```
+----------------+--------------------+--------+-----------+--------------+
|            City|              Region| Country| AirQuality|WaterPollution|
+----------------+--------------------+--------+-----------+--------------+
|          Bogota|                null|Colombia|23.35025381|   48.15789474|
|         Pereira|Risaralda Department|Colombia|       25.0|          75.0|
|     Barranquilla|Atlantico Department|Colombia|52.77777778|          50.0|
|      Santa Marta|Magdalena Department|Colombia|       50.0|   71.42857143|
|          Ibague|   Tolima Department|Colombia|56.61764706|   79.04411765|
|           Tunja|   Boyaca Department|Colombia|      100.0|          75.0|
|San Juan de Pasto|   Narino Department|Colombia|       70.0|          75.0|
|       Valledupar|    Cesar Department|Colombia|       50.0|          50.0|
|           Neiva|    Huila Department|Colombia|       75.0|          75.0|
|       Cartagena|  Bolivar Department|Colombia|       60.0|          65.0|
+----------------+--------------------+--------+-----------+--------------+
```

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In [13]:
```
## Regiones con más ciudades en dataframe

df.groupBy('Country','Region').count().orderBy('count',ascending=False).show(20,False)
```

```
+----------------------+----------------------+-----+
|Country               |Region                |count|
+----------------------+----------------------+-----+
|United Kingdom        |England               |142  |
|United States of America|California            |122  |
|Czech Republic        |null                  |57   |
|United States of America|Texas                 |51   |
|United States of America|Florida               |48   |
|Canada                |Ontario               |47   |
|France                |null                  |42   |
|Canada                |British Columbia      |38   |
|Philippines           |null                  |36   |
|Brazil                |Sao Paulo             |32   |
|United States of America|Georgia               |31   |
|United States of America|New York              |31   |
|Germany               |North Rhine-Westphalia|30   |
|United States of America|Washington            |29   |
|United States of America|North Carolina        |27   |
|United States of America|Indiana               |26   |
|United States of America|Illinois              |26   |
|United States of America|Michigan              |24   |
|Finland               |null                  |23   |
|Germany               |Bavaria               |23   |
+----------------------+----------------------+-----+
only showing top 20 rows
```

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In [14]:
```
from pyspark.sql.types import StringType,DoubleType,IntegerType
```

In [15]:
```
df.filter(df['Country']=='Colombia').filter(df['AirQuality'] >30).show()
```

```
+----------------+--------------------+--------+-----------+--------------+
|            City|              Region| Country| AirQuality|WaterPollution|
+----------------+--------------------+--------+-----------+--------------+
|            Cali|Valle del Cauca D...|Colombia|67.04545455|       42.1875|
|    Barranquilla|Atlantico Department|Colombia|52.77777778|          50.0|
|     Santa Marta|Magdalena Department|Colombia|       50.0|   71.42857143|
|          Ibague|   Tolima Department|Colombia|56.61764706|   79.04411765|
|           Tunja|   Boyaca Department|Colombia|      100.0|          75.0|
|     Bucaramanga|Santander Department|Colombia|       40.0|          25.0|
|San Juan de Pasto|   Narino Department|Colombia|       70.0|          75.0|
|         Armenia|  Quindio Department|Colombia|       62.5|          37.5|
|         Popayan|    Cauca Department|Colombia|      100.0|          25.0|
|      Valledupar|    Cesar Department|Colombia|       50.0|          50.0|
|           Neiva|    Huila Department|Colombia|       75.0|          75.0|
|       Cartagena|  Bolivar Department|Colombia|       60.0|          65.0|
|   Villavicencio|                Meta|Colombia|      100.0|          25.0|
+----------------+--------------------+--------+-----------+--------------+
```

In [17]:
```
from pyspark.sql.functions import pandas_udf, PandasUDFType
```

In [18]:
```
def critical_airq(AirQuality):
    quality_left= 2 * df.mean()-AirQuality

    return quality_left
```

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```
|           Neiva|    Huila Department|Colombia|       75.0|          75.0|
|       Cartagena|  Bolivar Department|Colombia|       60.0|          65.0|
|   Villavicencio|                Meta|Colombia|      100.0|          25.0|
+----------------+--------------------+--------+-----------+--------------+
```

click to scroll output; double click to hide

In [17]:
```
from pyspark.sql.functions import pandas_udf, PandasUDFType
```

In [18]:
```
def critical_airq(AirQuality):
    quality_left= 2 * df.mean()-AirQuality

    return quality_left
```

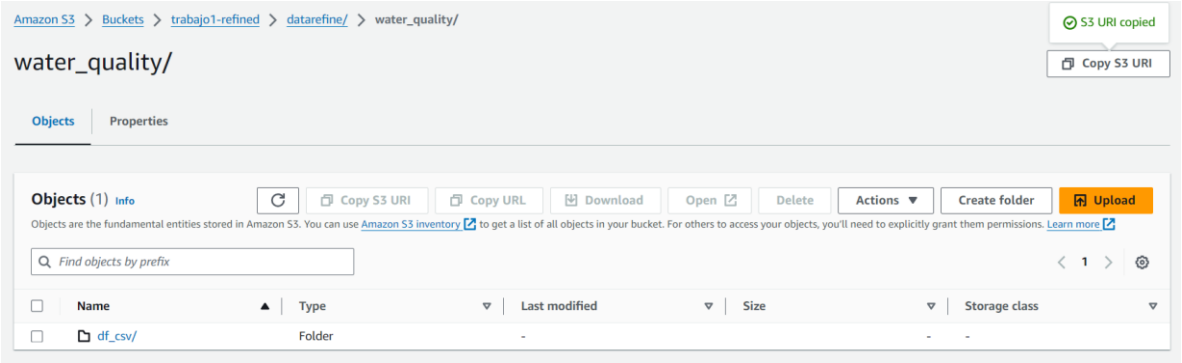
In [73]:
```
## Intentamos guardar el DataFrame con la nueva columna en una nueva variable, pero al correr el código nos mostró el siguiente e

Rdf.write.format('csv').option('header','true').save('s3://trabajo1-refined/datarefine/water_quality/Rdf_csv',mode='overwrite')
```

```
An error was encountered:
'NoneType' object has no attribute 'write'
Traceback (most recent call last):
AttributeError: 'NoneType' object has no attribute 'write'
```

In [74]:
```
df.write.format('csv').option('header','true').save('s3://trabajo1-refined/datarefine/water_quality/df_csv',mode='overwrite')
```

URI S3 archivo exportado: s3://trabajo1-refined/datarefine/water_quality/



Notebook creado en S3 desde jupyterhub

URI S3: s3://mholguinc2notebooks/jupyter/