Report for ForestQuery into Global Deforestation, 1990 to 2016

ForestQuery is on a mission to combat deforestation around the world and to raise awareness about this topic and its impact on the environment. The data analysis team at ForestQuery has obtained data from the World Bank that includes forest area and total land area by country and year from 1990 to 2016, as well as a table of countries and the regions to which they belong.

The data analysis team has used SQL to bring these tables together and to query them in an effort to find areas of concern as well as areas that present an opportunity to learn from successes.

1. **GLOBAL SITUATION**

Great job all your answers in this section are correct, Kudos.

According to the World Bank, the total forest area of the world was 41,282,694.90 sqkm in 1990. As of 2016, the most recent year for which data was available, that number had fallen to 39,958,245.90 sqkm, a loss of -1,324,449.00 sqkm, or -3.21%%.

The forest area lost over this time period is slightly more than the entire land area of Peru listed for the year 2016 (which is 1,279,995.05 sqkm).

Yes, **Peru i**s the country with the total land area closest to the amount of forest area lost between 1990 and 2016

2. **REGIONAL OUTLOOK**

The regional outlook section contains the correct answers

In 2016, the percent of the total land area of the world designated as forest was 31.38%. The region with the highest relative forestation was Latin America & Caribbean, with 46.16%, and the region with the lowest relative forestation was Middle East & North Africa, with 2.07% forestation.

In 1990, the percent of the total land area of the world designated as forest was 32.42%. The region with the highest relative forestation was Latin America & Caribbean, with 51.03%, and the region with the lowest relative forestation was Middle East & North Africa, with 1.78% forestation.

Table 2.1: Percent Forest Area by Region, 1990 & 2016:

Great job, the forest percentages for all the regions in this table is correct.

Region	1990 Forest Percentage (forestation)	2016 Forest Percentage (forestation)	Absolute Forest Area Change (sqkm) [extra]
Latin America & Caribbean	51.03%	46.16%	-991,745.91
Europe & Central Asia	37.24%	38.04%	238,761.71
North America	35.65%	36.04%	66,694.06

East Asia & Pacific	25.77%	26.36%	141,073.55
Sub-Saharan Africa	29.44%	25.76%	-875,055.88
South Asia	16.51%	17.51%	46,123.39
Middle East & North Africa	1.78%	2.07%	32,838.41

The only regions of the world that decreased in percent forest area from 1990 to 2016 were Latin America & Caribbean (dropped from 51.03% to 46.16%) and Sub-Saharan Africa (29.44% to 25.76%). All other regions actually increased in forest area over this time period. However, the drop in forest area in the two aforementioned regions was so large, the percent forest area of the world decreased over this time period from 32.42% to 31.38%.

3. **COUNTRY-LEVEL DETAIL**

A. SUCCESS STORIES

Country-level detail sections contain the correct answers

There is one particularly bright spot in the data at the country level, China. This country actually increased in forest area from 1990 to 2016 by 527,229.06 sqkm. It would be interesting to study what has changed in this country over this time to drive this figure in the data higher. The country with the next largest increase in forest area from 1990 to 2016 was the United States, but it only saw an increase of 79,200.00 sqkm, much lower than the figure for China.

China and United States are of course very large countries in total land area, so when we look at the largest *percent* change in forest area from 1990 to 2016, we aren't surprised to find a much smaller country listed at the top. Iceland increased in forest area by 213.66% from 1990 to 2016.

Iceland is the country with the largest percent forest increase

B. LARGEST CONCERNS

Which countries are seeing deforestation to the largest degree? We can answer this question in two ways. First, we can look at the absolute square kilometer decrease in forest area from 1990 to 2016. The following 3 countries had the largest decrease in forest area over the time period under consideration:

Table 3.1: Top 5 Amount Decrease in Forest Area by Country, 1990 & 2016:

All the values in this table are correct, Kudos!

Country	Region	Absolute Forest Area Change (sqkm)	2016 Forest Percentage (forestation) [extra]
Brazil	Latin America & Caribbean	-541,510.00	58.93%
Indonesia	East Asia & Pacific	-282,193.98	49.86%
Myanmar	East Asia & Pacific	-107,234.00	43.63%

Nigeria	Sub-Saharan Africa	-106,506.00	7.23%
Tanzania	Sub-Saharan Africa	-102,320.00	51.58%

Consolidated Analysis		Absolute Forest Area Change (sqkm)	2016 Forest Percentage [extra]
Total Top 5		**-1,139,763.98**	**52.59%**
World		**-1,324,449.00**	**31.38%**
Top 5 as % of World		**86.06%**	

The second way to consider which countries are of concern is to analyze the data by percent decrease.

Table 3.2: Top 5 Percent Decrease in Forest Area by Country, 1990 & 2016:

Correct, these are the top five countries with the highest forest percent decrease

Country	Region	Pct Forest Area Change	Absolute Forest Area Change (sqkm) [extra]
Togo	Sub-Saharan Africa	-75.45%	-5,168.00
Nigeria	Sub-Saharan Africa	-61.80%	-106,506.00
Uganda	Sub-Saharan Africa	-59.13%	-28,092.00
Mauritania	Sub-Saharan Africa	-46.75%	-1,940.00
Honduras	Latin America & Caribbean	-45.03%	-36,640.00

Consolidated Analysis		Pct Forest Area Change	Absolute Forest Area Change (sqkm) [extra]
Total Top 5		**-57.12%**	**-178,346.00**
World		**-3.21%**	**-1,324,449.00**
Top 5 as % of World			**13.47%**

When we consider countries that decreased in forest area percentage the most between 1990 and 2016, we find that four of the top 5 countries on the list are in the region of Sub-Saharan Africa. The countries are Togo, Nigeria, Uganda, and Mauritania. The 5th country on the list is Honduras, which is in the Latin America & Caribbean region.

From the above analysis, we see that Nigeria is the only country that ranks in the top 5 both in terms of absolute square kilometer decrease in forest as well as percent decrease in forest area from 1990 to 2016. Therefore, this country has a significant opportunity ahead to stop the decline and hopefully spearhead remedial efforts.

C. QUARTILES

The count of countries in the different quartiles is correct. I like that you excluded the country name denoted as **"World"** and the **NULL** values from being counted.

Table 3.3: Count of Countries Grouped by Forestation Percent Quartiles, 2016:

Quartile	Number of Countries
q4 75%-100%	9
q3 50%-75%	38
q2 25%-50%	72
q1 0-25%	98

The largest number of countries in 2016 were found in the q1 0-25% quartile.

There were 9 countries in the top quartile in 2016. These are countries with a very high percentage of their land area designated as forest. The following is a list of countries and their respective forest land, denoted as a percentage.

Table 3.4: Top Quartile Countries, 2016:

The top quartile countries below are all correct, kudos!

Country	Region	Pct Designated as Forest (forestation)	Absolute Forest Area Change (sqkm) [extra]
Suriname	Latin America & Caribbean	98.26%	-1,018.00
Micronesia, Fed. Sts.	East Asia & Pacific	91.86%	3.00
Gabon	Sub-Saharan Africa	90.04%	12,000.00
Seychelles	Sub-Saharan Africa	88.41%	0.00
Palau	East Asia & Pacific	87.61%	23.00
American Samoa	East Asia & Pacific	87.50%	-8.90
Guyana	Latin America & Caribbean	83.90%	-1,440.00
Lao PDR	East Asia & Pacific	82.11%	13,056.80
Solomon Islands	East Asia & Pacific	77.86%	-1,446.00

Further Quartile Analysis [extra]:

Quartile	Number of Countries	Pct Designated as Forest (forestation)	Absolute Forest Area Change (sqkm)	Pct Forest Area Change	Net Impact (sqkm)	Net Impact as % of World Impact
World	1	31.38%	-1,324,449.00	-3.21%	1,324,449.00	100.00%
q4 75%-100%	9	87.63%	21,169.90	2.85%	21,169.90	1.60%

q3 50%-75%	38	59.67%	-1,069,754.39	-8.32%	1,069,754.39	80.77%
q2 25%-50%	72	41.30%	-495,495.73	-2.33%	495,495.73	37.41%
q1 0-25%	98	11.08%	202,769.55	3.21%	202,769.55	15.31%

4. RECOMMENDATIONS

Great job, with your recommendations. The recommendations are very elaborate and you made some very good points.

Write out a set of recommendations as an analyst on the ForestQuery team.

- *What have you learned from the World Bank data?*
    - Power Law distribution pre-dominates. Top 5 countries for decreases in forest area represent 86% of worldwide decrease (see Table 3.1) between 1990-2016.
    - Taking Top 40 countries (see 6. APPENDIX: Top 40 Countries by Impact (sqkm)) by impact (sign-less value of increase or decrease in forest area) between 1990-2016 (a minority subset of 18% of total 217 countries) account for net -1,353,193.32 sqkm decline in forest areas or 102% of worldwide net impact (worldwide net decline in forest area -1,324,449.00 sqkm).
    - China's contribution to forest area increase is laudable (+33.55%), but its 2016 forestation is only 22.35% vs Brazil's 58.93%. China's increase (+527,229.06 sqkm) still slightly more than offset by Brazil's decline (-541,510.00 sqkm).
    - Brazil's decline drives more than half of quartile 3 (50%-75%, 2016 forestation) net decline of -1,069,754.39 sqkm in forest area.
    - China's re-forestation efforts have a lot to do with reversing its desertification to boost its stock of arable lands. Acceleration in China's forestation coincides with its substantial economic pivot towards manufacturing (and services) and urbanization, requiring much lower impact on land per dollar of GDP.
    - While not impacted by desertification, Vietnam's economic pivot (similarly to China's) has seen its forest area increase by +59.16%, raising its forestation from 28.77% to 48.06% between 1990-2016. Similar trend for India, though at much slower pace.
    - Countries dependent on agriculture and natural resources for exports (to earn critical foreign reserves) dominate the declines in their forest areas:
        - Primarily these countries drive the net declines in quartile 2 (25%-50%) and quartile 3 (50%-75%) in terms of 2016 forestation levels.
        - Brazil experiences a slow pivot to land-efficient manufacturing and remains reliant on land-hungry agricultural, mining and logging sectors for jobs and foreign reserves, thus eating into its forest. Its program for home ethanol substitute for oil (again to boost net exports of oil for foreign reserves) have resulted in material clearing of the Amazon.
        - After Brazil, next 7 countries with the largest declines in forest areas are also agricultural and natural resources dependent (Indonesia, Myanmar, Nigeria, Tanzania, Zimbabwe, Bolivia and DRC Congo) with combined declines -846,562.32 sqkm between 1990-2016.
        - Indonesia relies heavily on oil palm plantation and mining for jobs, despite a significant pivot to manufacturing.

        - Pressure on land use for housing, also a factor. Nigeria, DRC Congo and Tanzania also doubled (or more) their populations, while Myanmar, Zimbabwe, Brazil, Indonesia, and Bolivia saw population growth in the 30%-60% range.
        - Nigeria's forestation dropped from 18.92% to 7.23% between 1990-2016, making it relatively under-forested.
        - Combined with Brazil's -541,510.00 sqkm decline in forest area, Brazil and the Next 7 account for -1,388,072.04 sqkm in decline in forest area, equivalent to 105% of worldwide net impact.

- *Which countries should we focus on over others?*
    - Given the outsized impacts on reduction in forest areas by Brazil and the Next 7 countries, these countries should be the focus.
    - Perhaps Nigeria could be less of a focus given the relative lack of forestation to preserve and its large population making system-wide improvements all much more difficult.
    - Significant efforts may be needed to elevate these countries towards manufacturing (and planned urbanization) as means to manage populations' impact on land use while balancing their needs to earn foreign reserves needed to pay for critical imports and to manage the stability of their currencies.
    - Without a meaningful economic pivot like the kind seen in China, Vietnam and India, it may be very difficult for these countries to ditch their land-hungry economy.
    - Also, the primacy of USD as the global reserve currency for international trade, means many of these countries are structurally incentivized to over-produce to earn precious USD in their foreign reserves, often through land-based over-exploitation.
    - More field investigation is needed to identify pockets of re-forestation which may not contradict their economic objectives.
    - Additionally, improved agricultural practices such as the use of artificial fertilizers can help increase yields and reduce land use. However, that comes with additional environmental externalities.

5. APPENDIX: SQL Queries Used

For extra info, see Syntax tab here

Data correction

```
/*data_correction: to fill gaps in data with data from
data.worldbank.org*/

UPDATE land_area
SET    total_area_sq_mi = 11691.12
WHERE  country_code = 'BEL'
       AND year BETWEEN 1990 AND 1999;

UPDATE land_area
SET    total_area_sq_mi = 938.22
WHERE  country_code = 'LUX'
       AND year BETWEEN 1990 AND 1999;

UPDATE land_area
SET    total_area_sq_mi = 69.5
WHERE  country_code = 'MHL'
       AND year = 1990;

UPDATE land_area
SET    total_area_sq_mi = 270.27
WHERE  country_code = 'FSM'
       AND year = 1990;

UPDATE land_area
SET    total_area_sq_mi = 177.61
WHERE  country_code = 'MNP'
       AND year = 1990;

UPDATE land_area
SET    total_area_sq_mi = 177.61
WHERE  country_code = 'PLW'
       AND year = 1990;

UPDATE forest_area
SET    forest_area_sqkm = 10
WHERE  country_code = 'MAF'
       AND year = 2016;

UPDATE forest_area
SET    forest_area_sqkm = CASE
                            WHEN year = 1990 THEN 204085.6
                            WHEN year = 1991 THEN 203324
                            WHEN year = 1992 THEN 202562.4
                          END
WHERE  country_code = 'ETH'
       AND year IN ( 1990, 1991, 1992 );

UPDATE forest_area
SET    forest_area_sqkm = 10
WHERE  country_code = 'SMR';

UPDATE forest_area
SET    forest_area_sqkm = 0.7
WHERE  country_code = 'CUW'
       AND year >= 2011;

UPDATE forest_area
SET    forest_area_sqkm = 3.7
WHERE  country_code = 'SXM'
       AND year >= 2011;

UPDATE land_area
SET    total_area_sq_mi = 631930 / 2.58999
WHERE  country_code = 'SSD'
       AND year >= 2011;

UPDATE land_area
SET    total_area_sq_mi = 1868000 / 2.58999
WHERE  country_code = 'SDN'
       AND year >= 2011;

UPDATE forest_area
SET    forest_area_sqkm = 0
WHERE  country_code IN ( 'GIB', 'HKG', 'XKX',
'MAC',
                         'MCO', 'NRU', 'QAT' );
```

View tables

```
/*create_view_forestation: to consolidate land_area,
forest_area, regions plus calulated values (start point
(t0), end point (t1), total_area_sqkm,
pct_forest_ctry)*/

CREATE OR replace VIEW forestation
AS
  WITH fo
       AS (SELECT fa.*,
                  la.total_area_sq_mi,
                  la.total_area_sq_mi * 2.58999
                    total_area_sqkm,
  Round(
  ( fa.forest_area_sqkm * 100 / ( la.total_area_sq_mi *
2.59 ) ) :: NUMERIC, 2)
                  pct_forest_ctry,
  re.region,
  re.income_group
   FROM   forest_area fa
          INNER JOIN land_area la
            ON fa.country_code = la.country_code
               AND fa.year = la.year
          INNER JOIN regions re
            ON fa.country_code = re.country_code),
       timer
       AS (SELECT country_name,
                  Min(year) t0_yr,
                  Max(year) t1_yr
           FROM   fo fo
           WHERE  forest_area_sqkm IS NOT NULL
                  AND total_area_sqkm IS NOT NULL
           GROUP  BY country_name),
       start_vs_end
       AS (SELECT fo.country_code,
                  fo.country_name,
                  t.t0_yr,
                  t.t1_yr
           FROM   fo fo
                  LEFT JOIN timer t
                         ON fo.country_name =
t.country_name
           UNION
           SELECT fo.country_code,
                  fo.country_name,
                  t.t0_yr,
                  t.t1_yr
           FROM   fo fo
                  RIGHT JOIN timer t
                          ON fo.country_name =
t.country_name
           WHERE  fo.country_code IS NULL)
  SELECT fo.*,
         se.t0_yr,
         se.t1_yr
  FROM   fo fo
         LEFT JOIN start_vs_end se
                ON fo.country_code = se.country_code;
```

This creates a View successfully.

```
/*create_view_delta: analysis of change in forestation
between start point (t0) and end point (t1) including
various calculated values*/

CREATE OR replace VIEW delta
AS
  WITH d2
       AS (WITH d1
                 AS (WITH fo1
                           AS (SELECT country_code
ctry_code,
                                      country_name     country,
                                      region,
                                      income_group,
                                      t0_yr,
                                      t1_yr,
                                      forest_area_sqkm forest_t0,
                                      total_area_sqkm  total_t0
                               FROM   forestation fo
                               WHERE  year = t0_yr),
                           fo2
                           AS (SELECT country_code
ctry_code,
                                      forest_area_sqkm forest_t1,
                                      total_area_sqkm  total_t1
                               FROM   forestation fo
                               WHERE  year = t1_yr)
                      SELECT fo1.*,
                             fo2.forest_t1,
                             fo2.total_t1
                      FROM   fo1
                             FULL JOIN fo2
                                    ON fo1.ctry_code =
fo2.ctry_code)
             SELECT ctry_code,
                    country,
                    region,
                    income_group,
                    forest_t0,
                    forest_t1,
                    total_t0,
                    total_t1,
                    forest_t1 - forest_t0
ctry_diff_forest_sqkm,
                    Abs(forest_t1 - forest_t0)
ctry_impact_sqkm,
                    CASE
                      WHEN forest_t0 = 0
                           AND forest_t1 = 0 THEN 0
                      ELSE ( forest_t1 / forest_t0 - 1 ) * 100
                    END                      ctry_pct_diff_forest,
                    forest_t0 * 100 / total_t0
ctry_pct_forest_t0,
                    forest_t1 * 100 / total_t1
ctry_pct_forest_t1,
                    CASE
                      WHEN ctry_code = 'WLD' THEN 'World'
                      WHEN forest_t1 / total_t1 > 0.75 THEN
'q4 75%-100%'
                      WHEN forest_t1 / total_t1 > 0.5 THEN
'q3 50%-75%'
                      WHEN forest_t1 / total_t1 > 0.25 THEN
'q2 25%-50%'
                      ELSE 'q1 0-25%'
                    END                      quartile,
                    CASE
                      WHEN forest_t1 - forest_t0 > 0 THEN
'up'
                      WHEN forest_t1 - forest_t0 < 0 THEN
'down'
                      ELSE 'stable'
                    END                      ctry_trend
             FROM   d1
             ORDER  BY country),
         world_abs_delta
         AS (SELECT ctry_impact_sqkm
             FROM   d2
             WHERE  country = 'World')
  SELECT *,
         ctry_impact_sqkm * 100 / (SELECT *
                                   FROM   world_abs_delta)
         ctry_impact_as_pct_world_delta
  FROM   d2
  ORDER  BY ctry_impact_sqkm DESC;
```

To answer 1. GLOBAL SITUATION

```
/*world: consolidate analysis to world level*/

WITH region_world
     AS (SELECT region,
                Round(SUM(total_t1) :: NUMERIC, 2)
total_t1_sqkm,
                Round(SUM(forest_t0) :: NUMERIC, 2)
forest_t0_sqkm,
                Round(SUM(forest_t1) :: NUMERIC, 2)
forest_t1_sqkm,
                Round(SUM(ctry_diff_forest_sqkm) ::
NUMERIC, 2) diff_forest_sqkm
                ,
                Concat(Round((
SUM(ctry_diff_forest_sqkm) * 100
                              / SUM(forest_t0) ) ::
                             NUMERIC, 2
                      ), '%')
pct_diff_forest,
                Concat(Round(( SUM(forest_t0) * 100 /
SUM(total_t0) ) :: NUMERIC
                       , 2),
                '%')
                                                    pct_forest_t0,
                Concat(Round(( SUM(forest_t1) * 100 /
SUM(total_t1) ) :: NUMERIC
                       , 2),
                '%')
                                                    pct_forest_t1
         FROM   delta
         GROUP  BY region
         ORDER  BY SUM(forest_t1) / SUM(total_t1)
DESC)
SELECT *
FROM   region_world
WHERE  region = 'World';
```

```
/*ref_ctry_to_world_diff_forest: calculate country for
its area is slightly less than change in world forest
area regardless of sign*/

WITH world_abs_delta
     AS ( SELECT ctry_impact_sqkm
       FROM   delta
       WHERE  country = 'World')
SELECT   country,
         Round(total_t1::numeric,2) total_t1_sqkm
FROM     delta
WHERE    total_t1 <
         (
                SELECT *
                FROM   world_abs_delta)
ORDER BY total_t1 DESC limit 1;
```

To answer 2. REGIONAL OUTLOOK

/*region: consolidate analysis to region level*/

```
WITH region_world
    AS (SELECT region,
               Round(SUM(total_t1) :: NUMERIC, 2)
total_t1_sqkm,
               Round(SUM(forest_t0) :: NUMERIC, 2)
forest_t0_sqkm,
               Round(SUM(forest_t1) :: NUMERIC, 2)
forest_t1_sqkm,
               Round(SUM(ctry_diff_forest_sqkm) ::
NUMERIC, 2) diff_forest_sqkm
               ,
               Concat(Round((
SUM(ctry_diff_forest_sqkm) * 100
                             / SUM(forest_t0) ) ::
                           NUMERIC, 2
                    ), '%')
pct_diff_forest,
               Concat(Round(( SUM(forest_t0) * 100 /
SUM(total_t0) ) :: NUMERIC
                      , 2),
               '%')
                                                  pct_forest_t0,
               Concat(Round(( SUM(forest_t1) * 100 /
SUM(total_t1) ) :: NUMERIC
                      , 2),
               '%')
                                                  pct_forest_t1
        FROM   delta
        GROUP  BY region
        ORDER  BY SUM(forest_t1) / SUM(total_t1)
DESC)
SELECT *
FROM   region_world
WHERE  region <> 'World';
```

/*2_1_pct_forest_by_region: for table 2.1*/

```
WITH region_world
    AS (SELECT region,
               Round(SUM(total_t1) :: NUMERIC, 2)
total_t1_sqkm,
               Round(SUM(forest_t0) :: NUMERIC, 2)
forest_t0_sqkm,
               Round(SUM(forest_t1) :: NUMERIC, 2)
forest_t1_sqkm,
               Round(SUM(ctry_diff_forest_sqkm) ::
NUMERIC, 2) diff_forest_sqkm
               ,
               Concat(Round((
SUM(ctry_diff_forest_sqkm) * 100
                             / SUM(forest_t0) ) ::
                           NUMERIC, 2
                    ), '%')
pct_diff_forest,
               Concat(Round(( SUM(forest_t0) * 100 /
SUM(total_t0) ) :: NUMERIC
                      , 2),
               '%')
                                                  pct_forest_t0,
               Concat(Round(( SUM(forest_t1) * 100 /
SUM(total_t1) ) :: NUMERIC
                      , 2),
               '%')
                                                  pct_forest_t1
        FROM   delta
        GROUP  BY region
        ORDER  BY SUM(forest_t1) / SUM(total_t1)
DESC)
SELECT region,
       pct_forest_t0,
       pct_forest_t1,
       diff_forest_sqkm
FROM   region_world
WHERE  region <> 'World';
```

Also use /*world: consolidate analysis to world level*/
mentioned

To answer: 3. COUNTRY-LEVEL DETAIL

/*top_5_ctry_increase_diff_forest_sqkm: top 5 countries with largest abs increase in forest area*/

```
WITH country_detail AS
(
      SELECT country,
            region,
            income_group,
            ctry_trend
trend,
            Round(forest_t0::           numeric,2)
forest_t0_sqkm,
            Round(forest_t1::           numeric,2)
forest_t1_sqkm,
            Round(ctry_diff_forest_sqkm::numeric,2)
diff_forest_sqkm,
            Round(ctry_impact_sqkm::    numeric,2)
impact_sqkm,
                  Concat(Round(ctry_pct_diff_forest::
numeric,2),'%') pct_diff_forest,
                  Concat(Round(ctry_pct_forest_t0::
numeric,2),'%') pct_forest_t0,
                  Concat(Round(ctry_pct_forest_t1::
numeric,2),'%') pct_forest_t1,

Concat(Round(ctry_impact_as_pct_world_delta::num
eric,2),'%') impact_as_pct_world_delta,
            quartile
      FROM   delta)
SELECT   country,
        region,
        diff_forest_sqkm,
        pct_diff_forest,
        pct_forest_t1
FROM     country_detail
WHERE  country <> 'World'
ORDER BY diff_forest_sqkm DESC limit 5;
```

/*top_5_ctry_increase_pct_diff_forest: top 5 countries with largest percentage increase in forest area*/

```
WITH country_detail AS
(
      SELECT country,
            region,
            income_group,
            ctry_trend
trend,
            Round(forest_t0::           numeric,2)
forest_t0_sqkm,
            Round(forest_t1::           numeric,2)
forest_t1_sqkm,
            Round(ctry_diff_forest_sqkm::numeric,2)
diff_forest_sqkm,
            Round(ctry_impact_sqkm::    numeric,2)
impact_sqkm,
                  Concat(Round(ctry_pct_diff_forest::
numeric,2),'%') pct_diff_forest,
                  Concat(Round(ctry_pct_forest_t0::
numeric,2),'%') pct_forest_t0,
                  Concat(Round(ctry_pct_forest_t1::
numeric,2),'%') pct_forest_t1,

Concat(Round(ctry_impact_as_pct_world_delta::num
eric,2),'%') impact_as_pct_world_delta,
            quartile
      FROM   delta)
SELECT   cd.country,
        cd.region,
        pct_diff_forest,
        diff_forest_sqkm,
        pct_forest_t1
FROM     country_detail cd
INNER JOIN     delta d
ON       d.country = cd.country
WHERE  cd.country <> 'World'
ORDER BY d.ctry_pct_diff_forest DESC limit 5;
```

```
/*3_1_top_5_ctry_decrease_diff_forest_sqkm: top 5
countries with largest absolute decline in forest area*/

WITH country_detail AS
(
      SELECT country,
            region,
            income_group,
            ctry_trend
trend,
            Round(forest_t0::           numeric,2)
forest_t0_sqkm,
            Round(forest_t1::           numeric,2)
forest_t1_sqkm,
            Round(ctry_diff_forest_sqkm::numeric,2)
diff_forest_sqkm,
            Round(ctry_impact_sqkm::    numeric,2)
impact_sqkm,
                  Concat(Round(ctry_pct_diff_forest::
numeric,2),'%') pct_diff_forest,
                  Concat(Round(ctry_pct_forest_t0::
numeric,2),'%') pct_forest_t0,
                  Concat(Round(ctry_pct_forest_t1::
numeric,2),'%') pct_forest_t1,

Concat(Round(ctry_impact_as_pct_world_delta::num
eric,2),'%') impact_as_pct_world_delta,
            quartile
      FROM   delta)
SELECT   country,
        region,
        diff_forest_sqkm,
        pct_diff_forest,
        pct_forest_t1
FROM     country_detail
WHERE  country <> 'World'
ORDER BY diff_forest_sqkm limit 5;
```

```
/*3_2_top_5_ctry_decrease_pct_diff_forest: top 5
countries with largest pct decline in forest area*/

WITH country_detail AS
(
      SELECT country,
            region,
            income_group,
            ctry_trend
trend,
            Round(forest_t0::           numeric,2)
forest_t0_sqkm,
            Round(forest_t1::           numeric,2)
forest_t1_sqkm,
            Round(ctry_diff_forest_sqkm::numeric,2)
diff_forest_sqkm,
            Round(ctry_impact_sqkm::    numeric,2)
impact_sqkm,
                  Concat(Round(ctry_pct_diff_forest::
numeric,2),'%') pct_diff_forest,
                  Concat(Round(ctry_pct_forest_t0::
numeric,2),'%') pct_forest_t0,
                  Concat(Round(ctry_pct_forest_t1::
numeric,2),'%') pct_forest_t1,

Concat(Round(ctry_impact_as_pct_world_delta::num
eric,2),'%') impact_as_pct_world_delta,
            quartile
      FROM   delta)
SELECT   cd.country,
        cd.region,
        pct_diff_forest,
        diff_forest_sqkm,
        pct_forest_t1
FROM     country_detail cd
INNER JOIN     delta d
ON       d.country = cd.country
WHERE  cd.country <> 'World'
ORDER BY d.ctry_pct_diff_forest limit 5;
```

/*3_3_qtl: detail analysis at quartile level*/

```
WITH world_abs_delta
    AS (SELECT ctry_impact_sqkm
        FROM   delta
        WHERE  country = 'World'),
    qtl
    AS (SELECT quartile,
               Count(*)                  count,
               SUM(ctry_diff_forest_sqkm)
diff_forest_sqkm,
               Concat(Round((
SUM(ctry_diff_forest_sqkm) * 100 / SUM(forest_t0)
                            ) ::
                            NUMERIC, 2
                        ), '%')           pct_diff_forest,
               Concat(Round(( SUM(forest_t1) * 100 /
SUM(total_t1) ) :: NUMERIC
                        , 2),
               '%')
                                          pct_forest_t1
        FROM   delta
        GROUP  BY 1)
SELECT quartile,
       count,
       pct_forest_t1,
       Round(diff_forest_sqkm :: NUMERIC, 2)
diff_forest_sqkm,
       pct_diff_forest,
       Round(Abs(diff_forest_sqkm) :: NUMERIC, 2)
net_impact_sqkm,
       Concat(Round(( Abs(diff_forest_sqkm) * 100 /
(SELECT *
                                               FROM
world_abs_delta) )
                    ::
                    NUMERIC, 2), '%')
net_impact_as_pct_world_delta
FROM   qtl
ORDER  BY quartile DESC;
```

/*3_4_qtl_4_ctry: detail analysis at quartile level*/

```
WITH country_detail AS
(
       SELECT country,
              region,
              income_group,
              ctry_trend
trend,
              Round(forest_t0::           numeric,2)
forest_t0_sqkm,
              Round(forest_t1::           numeric,2)
forest_t1_sqkm,
              Round(ctry_diff_forest_sqkm::numeric,2)
diff_forest_sqkm,
              Round(ctry_impact_sqkm::    numeric,2)
impact_sqkm,
                     Concat(Round(ctry_pct_diff_forest::
numeric,2),'%') pct_diff_forest,
                     Concat(Round(ctry_pct_forest_t0::
numeric,2),'%') pct_forest_t0,
                     Concat(Round(ctry_pct_forest_t1::
numeric,2),'%') pct_forest_t1,

Concat(Round(ctry_impact_as_pct_world_delta::num
eric,2),'%') impact_as_pct_world_delta,
              quartile
       FROM   delta)
SELECT country,
       region,
       pct_forest_t1,
       diff_forest_sqkm,
       pct_diff_forest,
       quartile,
       impact_as_pct_world_delta
FROM   country_detail
WHERE  country <> 'World'
AND quartile = 'q4 75%-100%'
ORDER  BY pct_forest_t1 DESC;
```

For evidence the syntax for quartile works see screenshot next page

Input

HISTORY MENU

SCHEMA

- delta
- forest_area
- forestation
- land_area
- regions

```
1  /*3_3_qtl: detail analysis at quartile level*/
2
3  WITH world_abs_delta
4       AS (SELECT ctry_impact_sqkm
5           FROM   delta
6           WHERE  country = 'World'),
7       qtl
8       AS (SELECT quartile
```

Success!

EVALUATE

Output 5 results

Download CSV

quartile	count	pct_forest_t1	diff_forest_sqkm	pct_diff_forest	net_impact_sqkm	net_impa
World	1	31.38%	-1324449.00	-3.21%	1324449.00	100.00%
q4 75%-100%	9	87.63%	21169.90	2.85%	21169.90	1.60%
q3 50%-75%	38	59.67%	-1069754.39	-8.32%	1069754.39	80.77%
q2 25%-50%	72	41.30%	-495495.73	-2.33%	495495.73	37.41%
q1 0-25%	98	11.08%	202769.55	3.21%	202769.55	15.31%

Input

HISTORY MENU

SCHEMA

- delta
- forest_area
- forestation
- land_area
- regions

```
1  /*3_4_qtl_4_ctry: detail analysis at quartile level*/
2
3  WITH country_detail AS
4  (
5         SELECT country,
6                region,
7                income_group,
8                ctry_trend
```

Success!

EVALUATE

Output 9 results

Download CSV

country	region	pct_forest_t1	diff_forest_sqkm	pct_diff_forest	quartile
Suriname	Latin America & Caribbean	98.26%	-1018.00	-0.66%	q4 75%-
Micronesia, Fed. Sts.	East Asia & Pacific	91.86%	3.00	0.47%	q4 75%-
Gabon	Sub-Saharan Africa	90.04%	12000.00	5.45%	q4 75%-
Seychelles	Sub-Saharan Africa	88.41%	0.00	0.00%	q4 75%-
Palau	East Asia & Pacific	87.61%	23.00	6.05%	q4 75%-
American Samoa	East Asia & Pacific	87.50%	-8.90	-4.84%	q4 75%-
Guyana	Latin America & Caribbean	83.90%	-1440.00	-0.86%	q4 75%-
Lao PDR	East Asia & Pacific	82.11%	13056.80	7.40%	q4 75%-
Solomon Islands	East Asia & Pacific	77.86%	-1446.00	-6.22%	q4 75%-

6. APPENDIX: Top 40 Countries by Impact (sqkm)

/*top_40_impact: top 40 countries ranked by the size of their change in forest area regardless of sign*/

```
WITH country_detail AS
(
      SELECT country,
            region,
            income_group,
            ctry_trend
trend,
            Round(forest_t0::          numeric,2)
forest_t0_sqkm,
            Round(forest_t1::          numeric,2)
forest_t1_sqkm,
            Round(ctry_diff_forest_sqkm::numeric,2)
diff_forest_sqkm,
            Round(ctry_impact_sqkm::    numeric,2)
impact_sqkm,
                  Concat(Round(ctry_pct_diff_forest::
numeric,2),'%') pct_diff_forest,
                  Concat(Round(ctry_pct_forest_t0::
numeric,2),'%') pct_forest_t0,
                  Concat(Round(ctry_pct_forest_t1::
numeric,2),'%') pct_forest_t1,

Concat(Round(ctry_impact_as_pct_world_delta::num
eric,2),'%') impact_as_pct_world_delta,
            quartile
      FROM   delta)
SELECT   *
FROM    country_detail
WHERE  country <> 'World'
ORDER BY impact_sqkm DESC limit 40;
```

/*world_impact: world equivalent data to compare against the country view*/

```
WITH country_detail AS
(
      SELECT country,
            region,
            income_group,
            ctry_trend
trend,
            Round(forest_t0::          numeric,2)
forest_t0_sqkm,
            Round(forest_t1::          numeric,2)
forest_t1_sqkm,
            Round(ctry_diff_forest_sqkm::numeric,2)
diff_forest_sqkm,
            Round(ctry_impact_sqkm::    numeric,2)
impact_sqkm,
                  Concat(Round(ctry_pct_diff_forest::
numeric,2),'%') pct_diff_forest,
                  Concat(Round(ctry_pct_forest_t0::
numeric,2),'%') pct_forest_t0,
                  Concat(Round(ctry_pct_forest_t1::
numeric,2),'%') pct_forest_t1,

Concat(Round(ctry_impact_as_pct_world_delta::num
eric,2),'%') impact_as_pct_world_delta,
            quartile
      FROM   delta)
SELECT   *
FROM    country_detail
WHERE  country = 'World';
```

Country	Absolute Forest Area Change (sqkm)	Impact (sqkm)	Pct Forest Area Change	1990 Forest Percentage (forestation)	2016 Forest Percentage (forestation)	Net Impact as % of World Impact	Quartile
Brazil	-541,510.00	541,510.00	-9.90%	65.41%	58.93%	40.89%	q3 50%-75%
China	527,229.06	527,229.06	33.55%	16.74%	22.35%	39.81%	q1 0-25%
Indonesia	-282,193.98	282,193.98	-23.80%	65.44%	49.86%	21.31%	q2 25%-50%
Myanmar	-107,234.00	107,234.00	-27.34%	60.01%	43.63%	8.10%	q2 25%-50%
Nigeria	-106,506.00	106,506.00	-61.80%	18.92%	7.23%	8.04%	q1 0-25%
Tanzania	-102,320.00	102,320.00	-18.30%	63.13%	51.58%	7.73%	q3 50%-75%
Zimbabwe	-84,144.00	84,144.00	-37.96%	57.29%	35.54%	6.35%	q2 25%-50%
Bolivia	-83,200.00	83,200.00	-13.25%	57.97%	50.29%	6.28%	q3 50%-75%
Congo, DR	-80,964.06	80,964.06	-5.05%	70.74%	67.17%	6.11%	q3 50%-75%
Argentina	-79,778.01	79,778.01	-22.93%	12.71%	9.80%	6.02%	q1 0-25%
United States	79,200.00	79,200.00	2.62%	33.02%	33.93%	5.98%	q2 25%-50%
Ethiopia	-78,689.60	78,689.60	-38.56%	20.41%	12.54%	5.94%	q1 0-25%
India	69,213.98	69,213.98	10.83%	21.51%	23.83%	5.23%	q1 0-25%
Paraguay	-61,594.00	61,594.00	-29.11%	53.25%	37.75%	4.65%	q2 25%-50%
Colombia	-59,419.80	59,419.80	-9.22%	58.06%	52.70%	4.49%	q3 50%-75%
Russia	59,395.00	59,395.00	0.73%	49.36%	49.76%	4.48%	q2 25%-50%
Cameroon	-57,200.00	57,200.00	-23.52%	51.44%	39.34%	4.32%	q2 25%-50%
Mozambique	-56,443.98	56,443.98	-13.01%	55.16%	47.98%	4.26%	q2 25%-50%
Vietnam	55,390.00	55,390.00	59.16%	28.77%	48.06%	4.18%	q2 25%-50%
Venezuela	-55,073.98	55,073.98	-10.59%	58.98%	52.74%	4.16%	q3 50%-75%
Spain	46,425.10	46,425.10	33.62%	27.65%	36.94%	3.51%	q2 25%-50%
Zambia	-43,316.02	43,316.02	-8.20%	71.03%	65.20%	3.27%	q3 50%-75%
Peru	-41,156.02	41,156.02	-5.28%	60.88%	57.66%	3.11%	q3 50%-75%
Mexico	-38,116.02	38,116.02	-5.46%	35.89%	33.93%	2.88%	q2 25%-50%
Honduras	-36,640.00	36,640.00	-45.03%	72.71%	39.97%	2.77%	q2 25%-50%
Cambodia	-36,144.00	36,144.00	-27.92%	73.33%	52.85%	2.73%	q3 50%-75%
Australia	-34,820.00	34,820.00	-2.71%	16.73%	16.26%	2.63%	q1 0-25%
Korea, DPR	-32,970.00	32,970.00	-40.20%	68.11%	40.73%	2.49%	q2 25%-50%
Angola	-32,448.01	32,448.01	-5.32%	48.91%	46.31%	2.45%	q2 25%-50%
Botswana	-29,802.00	29,802.00	-21.72%	24.21%	18.95%	2.25%	q1 0-25%
Uganda	-28,092.00	28,092.00	-59.13%	23.78%	9.68%	2.12%	q1 0-25%
Chile	27,728.01	27,728.01	18.17%	20.53%	24.26%	2.09%	q1 0-25%
France	26,660.00	26,660.00	18.47%	26.36%	31.23%	2.01%	q2 25%-50%
Thailand	24,240.00	24,240.00	17.31%	27.41%	32.16%	1.83%	q2 25%-50%
Turkey	21,954.00	21,954.00	22.82%	12.50%	15.35%	1.66%	q1 0-25%
Ecuador	-21,616.99	21,616.99	-14.77%	52.85%	50.21%	1.63%	q3 50%-75%
Mali	-20,540.00	20,540.00	-30.70%	5.48%	3.80%	1.55%	q1 0-25%
Somalia	-19,958.00	19,958.00	-24.10%	13.20%	10.02%	1.51%	q1 0-25%
Chad	-19,566.00	19,566.00	-29.18%	5.32%	3.77%	1.48%	q1 0-25%
Namibia	-19,172.00	19,172.00	-21.88%	10.64%	8.31%	1.45%	q1 0-25%

7. APPENDIX: Data Quality

- Data in the set appears to miss some data on data.worldbank.org, but overall, low materiality impact from data quality issues.
- For 2016 the sum of all forest area of the countries of 39,867,188.05 sq km are -0.23% less compared to the world forest area of 39,958,245.90 sqkm in the data provided.
- NULL found in *forest_area_sqkm* and *total_area_sq_mi* fields patched with data from data.worldbank.org or by adapting data in the set to the trend seen on data.worldbank.org and ourworldindata.org. Idiosyncrasies, mostly in small countries:
    - Belgium and Luxembourg's land areas NULL (1990-1999).
    - For 1990, land areas are NULL for Marshall Islands, Micronesia, Northern Mariana Islands and Palau.
    - Forest areas are NULL for San Marino, Curacao and Sint Maarten for all periods (or NULL for 2016 for French St. Martin).
    - Other small locations (HK SAR, Macao SAR and Kosovo), no data available for forest areas in the set or data.worldbank.org or ourworldindata.org.
    - Major gaps are NULL in land areas for relatively large Sudan/South Sudan (for all periods) and for forest areas for Ethiopia (1990-1992).
    - Measured as % versus World net impact (of 1,324,449 sqkm), corrections made to most countries result in little effect, except for Ethiopia.

/*correct_pop_ctry: ad-hoc calculation for corrected population*/ (see next page for syntax)

Country	Absolute Forest Area Change (sqkm)	Impact (sqkm)	Impact as % of World Impact	Impact from correction
Marshall Islands	-3.60	3.60	0.00%	Only land area
Palau	23.00	23.00	0.00%	Only land area
Luxembourg	-3.00	3.00	0.00%	Only land area
Sudan	-8,720.70	8,720.70	0.66%	Only land area
Ethiopia	-78,689.60	78,689.60	5.94%	Only forest area
Micronesia, Fed. Sts.	3.00	3.00	0.00%	Only land area
Northern Mariana Islands	-46.60	46.60	0.00%	Only land area
Belgium	168.40	168.40	0.01%	Only land area

/*correct_pop_cons: ad-hoc calculation for corrected population*/ (see next pages for syntax)

	Absolute Forest Area Change (sqkm)	Impact (sqkm)	Impact as % of World Impact	
Overall of above	-87,269.10	87,269.10	6.59%	

- Insufficient data for forest areas even after patching in from data.worldbank.org for Sint Maarten (Dutch part) and Curacao and only starting point of 2011 is available.
- For Sudan and South Sudan, given both nations' separation in 2011, only the starting point of 2011 is possible, after patching into respective total areas.
- Fortunately, overall net impact is insignificant and primarily in decrease in Sudan forest area, equivalent to 0.66% of the world impact wise.

/*non_std_start_end: list countries with non-standard start point and end point*/ (see next pages for syntax)

Country	Starting Year	Ending Year	Absolute Forest Area Change (sqkm) [extra]	Impact (sqkm)	Impact as % of World Impact

Curacao	2011	2016	0.00	0.00	0.00%
Sint Maarten (Dutch part)	2011	2016	0.00	0.00	0.00%
South Sudan	2011	2016	0.00	0.00	0.00%
Sudan	2011	2016	-8,720.70	8,720.70	0.66%

/*correct_pop_ctry: ad-hoc calculation for corrected population*/

```
WITH world_abs_delta
    AS (SELECT ctry_impact_sqkm
        FROM   delta
        WHERE  country = 'World'),
    correct_pop
    AS (SELECT country,
               Round(SUM(ctry_diff_forest_sqkm) ::
NUMERIC, 2)
               diff_forest_sqkm
               ,
               Round(ABS(SUM(ctry_diff_forest_sqkm)) ::
NUMERIC, 2)
               net_impact_sqkm,
               CONCAT(Round((
ABS(SUM(ctry_diff_forest_sqkm)) * 100 / (SELECT *
                                                FROM
                           world_abs_delta)
                          ) ::
                                NUMERIC, 2), '%')
                 net_impact_as_pct_world_delta
        FROM   delta
        WHERE  ctry_code IN ( 'QAT', 'NRU', 'MCO',
'MAC',
                              'XKX', 'HKG', 'GIB', 'SDN',
                              'SSD', 'SXM', 'CUW', 'SMR',
                              'ETH', 'MAF', 'PLW', 'MNP',
                              'FSM', 'MHL', 'LUX', 'BEL' )
        GROUP  BY 1)
SELECT country,
       SUM(diff_forest_sqkm)      diff_forest_sqkm,
       ABS(SUM(diff_forest_sqkm)) ctry_impact_sqkm,
       CONCAT(ROUND(( ABS(SUM(diff_forest_sqkm))
* 100 /
                     (SELECT *
                      FROM   world_abs_delta) ) ::
                     NUMERIC
              , 2), '%')
ctry_impact_as_pct_world_delta
FROM   correct_pop
WHERE  diff_forest_sqkm <> 0
GROUP  BY 1;
```

/*correct_pop_cons: ad-hoc calculation for corrected population*/

```
WITH world_abs_delta
    AS (SELECT ctry_impact_sqkm
        FROM   delta
        WHERE  country = 'World'),
    correct_pop
    AS (SELECT country,
               Round(SUM(ctry_diff_forest_sqkm) ::
NUMERIC, 2)
               diff_forest_sqkm
               ,
               Round(ABS(SUM(ctry_diff_forest_sqkm)) ::
NUMERIC, 2)
               net_impact_sqkm,
               CONCAT(Round((
ABS(SUM(ctry_diff_forest_sqkm)) * 100 / (SELECT *
                                                FROM
                           world_abs_delta)
                          ) ::
                                NUMERIC, 2), '%')
                 net_impact_as_pct_world_delta
        FROM   delta
        WHERE  ctry_code IN ( 'QAT', 'NRU', 'MCO',
'MAC',
                              'XKX', 'HKG', 'GIB', 'SDN',
                              'SSD', 'SXM', 'CUW', 'SMR',
                              'ETH', 'MAF', 'PLW', 'MNP',
                              'FSM', 'MHL', 'LUX', 'BEL' )
        GROUP  BY 1)
SELECT
       SUM(diff_forest_sqkm)      diff_forest_sqkm,
ABS(SUM(diff_forest_sqkm)) net_impact_sqkm,
       CONCAT(ROUND(( ABS(SUM(diff_forest_sqkm))
* 100 /
                     (SELECT *
                      FROM   world_abs_delta) ) ::
                     NUMERIC
              , 2), '%')
net_impact_as_pct_world_delta
FROM correct_pop;
```

```
/*non_std_start_end: list countries with non-standard
start point and end point*/

WITH max_yr
     AS (SELECT Max(t1_yr)
         FROM   forestation),
     min_yr
     AS (SELECT Min(t0_yr)
         FROM   forestation),
     non_std_start_end
     AS (SELECT country_name,
                t0_yr,
                t1_yr,
                ROUND(ctry_diff_forest_sqkm :: NUMERIC,
2) diff_forest_sqkm,
                ROUND(ctry_impact_sqkm :: NUMERIC, 2)
impact_sqkm,

CONCAT(Round(ctry_impact_as_pct_world_delta ::
NUMERIC, 2), '%')
                impact_as_pct_world_delta
         FROM   delta de
                INNER JOIN forestation fo
                  ON de.country = fo.country_name
         WHERE  ( t0_yr <> (SELECT *
                            FROM   min_yr)
                   OR t1_yr <> (SELECT *
                                FROM   max_yr) )
                AND ( fo.year = t0_yr
                       OR fo.year = t1_yr )
                AND ( country_name <> 'World' )
         GROUP  BY 1,2,3,4,5,6
         ORDER  BY 1)
SELECT *
FROM   non_std_start_end;
```