Global Warming Due to Albedo & Hydro-Hotspots Humidity Forcing Conflicts with CO2 Theory and A Lack of IPCC Albedo Goals

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Abstract

Understanding root causes is always needed to find proper solutions. In climate change, we must ask, what has historically changed? Besides CO_2, we have a change in the specific and relative humidity, slight decrease in land albedo, and yearly growth of Hydro-HotSpots (HHS). We denote hydro-hotspot as water evaporation and bulk heating from low albedo manmade type roads and cities surfaces (often called urban heat islands), including cars and engine hoods. This includes both Highly Evaporating Surfaces (HES) and bulk warm waste Rain Water Management (RWM) where billions of gallons of water is into rivers and the ocean each year causing numerous concerns. This is Humidity Forcing (HF) related to albedo forcing and the creation of HHS. Most significant is land albedo forcing. Modeling provided are in agreement with other authors that albedo forcing due to cities and roads are a major effect on global warming. This also feeds most of the HHS.

We show in this article that such surfaces, while seemingly covering only about 1% of the Earth, can have very large effective solar and evaporation areas many times the size of the HES and RWM area itself compared with higher albedo absorbing vegetative areas that also include transpiration. This is significant since water vapor is a potent GreenHouse (GH) gas. City surfaces can prove to be enormous when tall buildings are considered. In addition, active hydro-hotspots will decrease relative humidity while increasing specific humidity. We are able to estimate the large percentage of global warming contribution due to albedo and humidity HHS forcing compared to CO_2 increase. This leads to the conclusion that changing the albedo of cities and roads is a main solution to global warming.

This paper, then points to numerous concerns including the lack of IPCC albedo goals for cities and roads. Specifically, it is concluded that there is not enough proof that CO_2 goals will be enough to stop global warming trends in light of the complex influences on global warming from Cities and Roads.

1. Introduction - Highly Evaporation Surface and Rain Water Management Feedback

In this paper we look at the effect of Hydro-HotSpots (HHS) from Highly Evaporating Surfaces (HES) feedback (Figure 1A) and Rain Water Management feedback (Figure 1B) contributions to global warming.

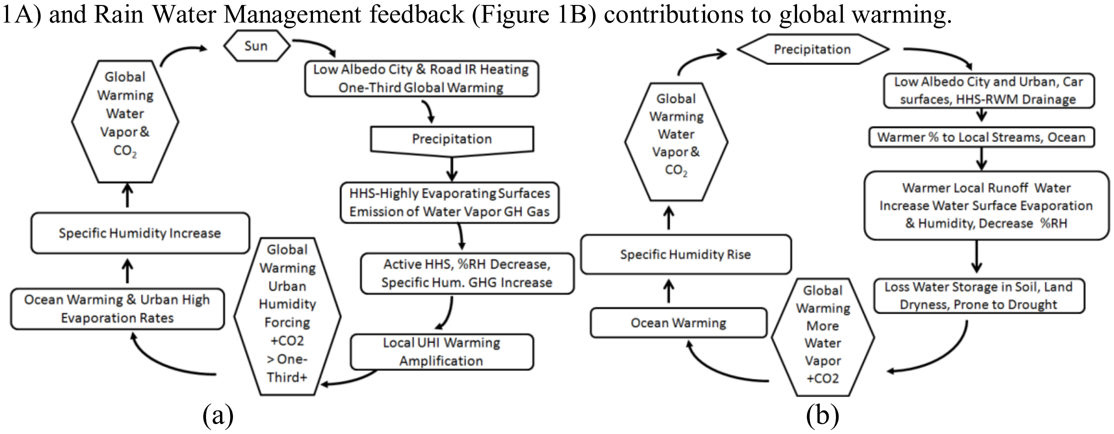

Figure 1 a) HHS- HES feedback view of contribution to global warming, b) HHS Rainwater Management (RWM) high temperature water cycling in Climate Change

Figure 1a shows HHS-HES feedback that may be summarized:

- Low albedo cities and roads emitting infrared radiation (IR), increased warming (approx. 1/3)
- Precipitation occurs, followed by evaporation of HHS-HES moisture, lower %RH increase specific humidity GreenHouse gas in warmed city area
- Local heat amplification, less local cooling with increased specific humidity amplifies heat index
- Local warming radiates heat increasing Global warming more than 1/3 original estimate
- Evaporation increases in cities and ocean primarily from UHI and roads creates lower %RH and higher specific humidity globally along with CO_2 increase more evaporation
- More greenhouse gas in the form of moisture and eventual further warming.

Figure 1b Shows HHS-RWM feedback that may be summarized:

- Higher temperature storm water is collected off of HHS buildings, streets and hot cars
- A large percentage is drained to nearby rivers, lakes or ocean

- Warmer air allows for increase in specific humidity
- The impermeable city building and roads have replaced vegetative land creating lost area that would have stored cooler water in soil keeping the land moist with less generated heat.
- This increases land dryness can mean less land evaporation and more ocean rain.
- The RWM is often warmer from HHS activity raising storm water temperatures from hot city buildings and street cycling each year billions of gallons of rainwater to local streams, lakes and ocean contributing to local surface water temperature increases depending on location. These runoffs affect atmospheric warming trends and GH gases (see Sec. 4).

4. Urbanization Global Warming Estimates Using the Solar Weighted Albedo Model Results

Estimates (Reference in this section need update see Vixra 2001.0415 for valid references)

In order to investigate independently, we took a different approach to ground station assessment with actual radiative forcing values using a straight forward method that can more easily be refined with better data. We developed a simplified global weighted solar albedo model with solar surface area assessed in Appendix A and a formulated albedo model in Appendix B. Our model uses a direct approach that is independent of surface temperature data and only based on solar surface areas and estimated albedo city values. Such a model in review has some advantages, it is non probabilistic and in line with the way typical energy budgets are calculated, it uses only two key parameters (area, and surface albedo). This provides some simplistic transparency. Absolute numbers are obtainable, although the actual numbers are not as important as the conceptual approach and trends to help verify UHI "significance". In review, the role of UHI area forces issues which need to be formulated:

- What is the area of cities (24-26)?
- What is the UHI Solar Heating Area (Appendix A, [27])?
- How much do UHI changes the surface area of the Earth requiring renomalization (Appendix B)?
- What is the average albedo of cities (Appendix B)?

Appendix A describes our estimates for the effective solar area that includes UHI and urbanization extents from a worst case GRUMP area study [24-26,45, 54] and a nominal study of Schneider et. al. [54] projected to 1950 and 2019.

As an example, in 2019 the worst case solar area used in our analysis was 3.81% of the Earth, this is a worst case assessment from a GRUMP study that found 2.7% of land is urbanized in 2the year 2000 (0.027x29%=0.783), this extrapolates to 0.952% in 2019 (see Appendix A). We then estimated the effective climate effect that included city solar heating area increase using an amplification factor of 4 giving 3.81 %. This factor comes from a Zhou et al. [27] (2015) that found UHI changes the climate in area 2–4 times larger than its own area in China. In 1950 the extrapolated area from the GRUMP study was 0.316 using the population growth rate. We chose not to use an amplification effect since 1950 is the baseline reference year that is commonly to estimate global warming change from. The Solar Albedo model for 2019 is shown in Table 3.

The compiled results from the solar albedo model that includes amplification factor of 4, found that

- ***urbanization likely has contributed to global warming between 5.7% and 26.7%.***

The table also includes "what if" estimate we could change urbanization to be more reflective from 0.12 shown in the Table to an albedo of 0.5, we see the results indicates that

- ***global warming can be reduced by 14.4% to 40.3% cooler***

Table 3 Results of GW Temperature Budget Change With City Surface Areas and Albedos

Year	Urban Extent Global Area (App. A)	Effective Global Surface Area of UHI (App. A)	Albedo Roads	Albedo Cities	Global Weighted Albedo	Temperature (no GH gases)*	UHI Radiative Forcing	Percent Of Global Warming
Nominal Case IPCC Schneider Study [33]								
1950	0.059	0.059%	0.04	0.12	30.05%	-18.62°C	0	Par
2019	0.188	0.753	0.04	0.12	29.99	-18.56°C	0.204 W/m^2	**5.7%**
Future	0.188	0.753	0.04	0.5	30.14	-18.7°C	-0.51 W/m^2	-14.4%

Cool Roofs								(Cooler)
Worst Case GRUMP Study [26-28]								
1950	0.316%	0.316	0.04	0.12	30.03	-18.60°C	0	Par
2019	0.952%	3.81%	0.04	0.12	29.75	-18.34°C	0.96 W/m^2	**26.7%**
Future Cool Roofs	0.952%	3.81%	0.04	0.12	30.45	-18.98°C	-1.43 W/m^2	-67.4% (Cooler)

*where Temperature Budget is given by: P_{Total}= 1361W/m2 {0.25 x (1-Albedo)} =σT^4

To summarize the table these findings:

- Nominal case analysis 1950 to 2019 is 0.06C (-18.56-(-0.18.62) due to Cities & Road increases, 5.7% in global warming
- Worst case analysis 1950 to 2019 is 0.26C (-18.34-(-0.18.60) due to Cities & Road increases, 26.7% in global warming in agreement with other authors [17-23] "UHI significance".
- "what if" corrective action results using cool roofs shows that changing city albedos range from 14.4 to 67.4% cooler for reducing global warming

This UHI albedo radiative forcing model provided above for cities and roads worst case (in support of other authors [17-23]) indicate that IPCC global warming goals may be insufficient at the present time.

2.2 Percent of Global Warming Due to Greenhouse Gases and Albedo

In this section we provide basic calculations supporting the conclusions in Table 2 for forcing contributions due to Albedo, CO_2, and water vapor increases (ignoring other GH gases) from 1950 to 2019. Under the contention that global warming is not dominated by CO_2 greenhouse gas (as in doubling theories [29]), but is more of a straight forward function of blackbody spectral absorption probabilities, we provide alternate estimates (to IPCC [29])

THIS TABLE AND SECTION TO BE UPDATED

Table 2 Calculated Forced Effects Causing Global Warming from 1950 to 2019

Forced Effect	Contributing Change	Temperature Increase	Percentage
Albedo (Cities & Roads)	0.3 to 0.2975 worst case	0.06 to 0.26C	5.6 to 26.7%
Water Vapor	225.6-243.9 PPM increase		
CO_2	9-27.4 PPM increase		
Greenhouse Gas Increase	1%=60.3%-59.3		
Totals	430PPM	1.5°F	100%

In Table 1 we concluded the change from 1950 to 2019 due to albedo forcing was 0.5°F. We next note that the Earth's energy budget is 241.58 Watts/m^2 (where P_{Total}= 1361W/m2 {0.25 x (1-0.29)}). In 1950 the average temperature was 57°F. This yields 384.93 Watts/m^2 ($P=\sigma T^4$). This leaves 143.3Watts/m^2 of power emitted back by GH gases which is 59.34% of the 241.58 Watts/m^2. In 2019 Earth energy budget is 242.63 (P_{Total}= 1361W/m2 {0.25 x (1-0.2869)}, see Table 1), the average temperature is taken as 58.5°F yielding 389 Watts/m^2 which leaves 146.36 Watts/m^2 above the Earth's energy budget or 60.3% emitted back by GreenHouse (GH) gases. The difference of the emitted back radiation is 3.1 Watts/m^2 (note we took into account an albedo change in 2019 in the Earth's energy budget that makes this estimate lower than the 4.1 Watts/m^2 typical found) and the difference in the percent of emitted back Greenhouse gases is

$$1\%=143.3/241.58-146.36/242.63=60.3\%-59.3\% \tag{1}$$

Therefore, this must be the percent of GH gases required to increase global temperatures 1.5°F. Using the approximate 300 PPM value for CO_2 in 1950 and an average estimate of 25,000 PPM for water vapor in our atmosphere [22-23], the 1% GH gas increase is estimated to be

$$25{,}300\text{PPM} \times 1\%=253\text{PPM} \tag{2}$$

increase in 2019. In 2019 the estimate increase in CO_2 is 114PPM (currently 414PPM). The typical contribution of blackbody spectrum absorption for CO_2 is 8%-24% leaving 76-92% for water vapor (where we are ignoring other GH gases) [22,23]. It is actually difficult to predict such percent GH gas contribution and we are using values from other authors [22-23]. Using the low 8% value first for CO_2 and the 253 PPM we must have

$$243.9\text{PPM } (H2O\uparrow) + 114\text{PPM}\times 8\% \ (CO_2\uparrow)=253\text{PPM} \tag{3}$$

The effect of water vapor and CO_2 vary depending on a clear day or cloudy day with precipitation. Dividing the LHS by 430 PPM yields the fractional GH of 1°F temperature contribution (1.5°F rise from 1950 with 0.5°F due to albedo). The full temperature sum is then

$$0.96^{o}\text{F } (H_2O\uparrow) + 0.036^{o}\text{F } (CO_2\uparrow) + 0.5^{o}\text{F (Albedo)}=1.5^{o}\text{F (from 1950 to 2019)} \tag{4}$$

Since CO_2 can vary, here taken by a factor of 3 in its GH effect [22,23], this variation yields the estimates to global warming contributions shown in Table 2.

- *In this view changing the albedo of cities is the main solution to global warming. This would require a change of IPCC goal [29].*

2.3 City & Asphalt Hydro-Hotspot Lowering of the Local Relative Humidity Example

Due to the fact that warm air holds more greenhouse gas, then HHS during precipitation periods could also keep city heat in increasing infrared radiation during periods of higher relative humidity. For example, (using the Clausius-Clapeyron relation) if the ambient condition when it rains is 25°C/98%RH and the HHS surface temperature is 60°C (1000Watt/m^2, albedo=0.3, prior to rain cooling) then the local relative humidity at the hotspot surface is reduced from 98%RH to 15.6%RH. This increases temporarily locally humidity concentration building up more city heat amplifying temperature radiation which can contribute to warming anomalies with the root cause due to city surface albedo problems.

2.4 Urban Heat Island Moisture Amplification Effect

Numerous authors have illustrated that global warming is dominated by moisture content in the atmosphere [see Byrne et. al. and references therein]. This can be expressed with relationships of specific humidity h, and relative humidity r. For example, Byrne et al. [1] observe GW_L temperature over land increase of 0.17±0.04°K per decade, a specific humidity (h_L) increase over land of (0.08±0.04g·kg^{-1}per decade), and a relative humidity (r_L) linear decrease trend of −0.22±0.20% per decade. Using these observations, we can formulate some functional relationships to understand global warming change with specific humidity in the atmosphere as

$$\frac{dGW_L}{dh_L}=\frac{dGW_L}{dt}\frac{dt_2}{dh_L}=\frac{0.17}{0.08}=2.13 \tag{6}$$

As well this provides an opportunity to write the time rate of change of Global warming with the time rate of change in specific humidity increase in the atmosphere

$$\frac{dGW_L}{dt}=2.13\frac{dh_L}{dt} \tag{7}$$

Similar to (1) we can write the change in global warming over land with the change in relative humidity r over land

$$\frac{dGW_L}{dr_L}=\frac{dGW_L}{dt}\frac{dt_2}{dr_L}=-\frac{0.17}{0.22}=-0.77 \tag{8}$$

This also provides an opportunity to write the time rate of change of global warming with the time rate of change in relative humidity decrease in the atmosphere as

$$\frac{dGW_L}{dt}=-0.77\frac{dr_L}{dt} \tag{9}$$

We can summarize

$$\frac{dGW_L}{dt}=-k_r\frac{dr_L}{dt}=k_h\frac{dh_L}{dt} \tag{10}$$

Here each k is a rate factor constant (see Appendix A). We can deduce that locally, the warming from UHI is also effected by relative humidity as an amplification effect in the lower troposphere. Locally relative humidity change in the UHI given by dr_{UHI}/dt would be correlated to UHI_w warming change $dUHI_w/dt$ as a warming amplification due to moisture greenhouse gas increase in the lower troposphere effect in the presence of increases in specific humidity with decrease to relative humidity. We deduce from (1) the warming amplification factor

$$A_r=-\frac{dUHI_W}{dt}\Big/\frac{dr_{UHI}}{dt} \tag{11}$$

where $Ar \sim k_r$. Here we make the distinction that lower relative humidity is not simply due to a lack of moisture on dry summer city days, but requires HHS activity. Such activity can influence global relative humidity in a variety of ways as illustrated Figure 1a and 1b.

2.5 UHI Humidity Forcing

UHI from HHS Humidity forcing plays a key role in GW. UHI likely contribute in two ways. Through an amplification effect increasing temperature rise of the UHI during active HHS occurrence as described above. As well the evaporation rate found in Appendix C shows that cities actually have an increase in their evaporation growth rate since 1950 of about a factor of 4. This would imply that, like the ocean, it can be significantly contributing to atmospheric humidity increase as the air warms.

3. HHS-HES Supporting Related Data Trends

The following data and analysis are summarized that supports HHS-HES feedback:

- **HHS-HES Areas on Average are Hotter:** When evaporation occurs from cities and roads, the albedo is on average lower by comparison to vegetative areas that are replaced. Often evaporation is then from hotter surfaces, molecules then have higher kinetic energy, this expands air and decrease relative humidity (see Appendix E). Even when surfaces are not hotter, the evaporation rate increase is associated with higher entropy, higher specific humidity and lower relative humidity. This is discussed in Section 4.

- **HHS-HES area effect**: A simplified analysis is presented in Section 2.3 illustrating when all things are equal, the area lost from soil water storage due to roads and cities, for example is given primarily by the differences in evaporation times between the would be vegetative area and the city or road replacement area. The example is given there that if it takes a road 2 hours to evaporate a volume of water from a road, while it takes soil 48 hours to evaporate the same amount of water in soil, then the effective soil land lost is a factor of 24 times, contributing to the HHS evaporation rate, specific humidity and global warming emitted moisture greenhouse gas. Although we have not formulated this rate related to transpiration, the rate should still apply.

- **HHS-HES city area effects**: As we build cities, we increase the effective solar area of the Earth. The increase is hard to estimate. A rough estimate was provided in Section 2.1.

- **Specific Humidity Rising:** Figure 2A shows the increase in specific humidity not just to warming oceans but also over land mass. Overall, water vapor in the surface atmosphere has increased over land and ocean since the 1970s (specific humidity is rising) [5], while the atmosphere over land is becoming less saturated (relative humidity is dropping) [5].

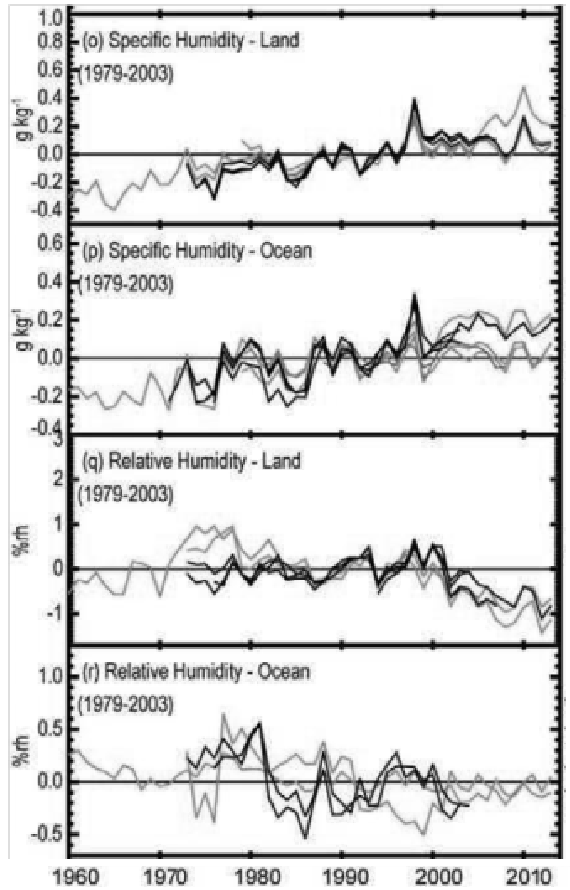

Figure 2A Top two figures shows the specific humidity over land and water both increase while the third figure showing the relative humidity decreasing trend primarily over land while the ocean is more stable but likely harder to measure [5].

- **Precipitation:** Figure 2B illustrates that precipitation has remained constant [5] even though the specific humidity has increased. However in Fig. 7 and 8 we see that in later years it is actually increasing.

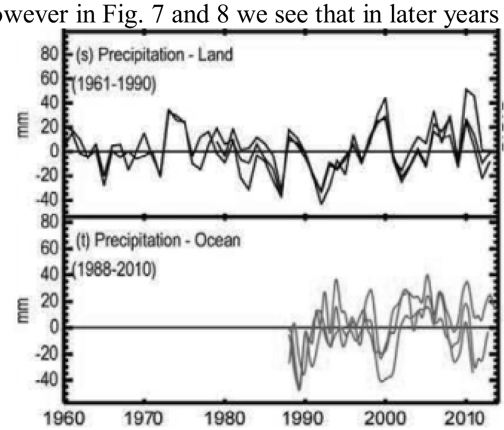

Figure 2B A fairly constant precipitation rate in view of the fact that the specific humidity is increasing [5]. In later years Fig. 7, shows precipitation eventually increasing.

- **Soil Moisture:** Figure 3 shows a decrease in soil moisture [5] likely suggesting a correlation to global warming. This increase in dryness is made worse from HES areas in cities and roads increasing over time.

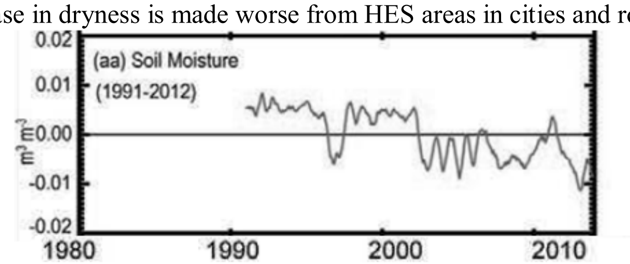

Figure 3 Loss of soil moisture likely due to global warming over land [5]

- **Albedo decline:** In Figure 4, a decline in land albedo [5] is found. One would expect this decrease over land due to the increase in roads and city areas having a much lower albedo value than natural vegetative areas. Global albedo loss has been blamed on glacier loss but here it is illustrated just for land.

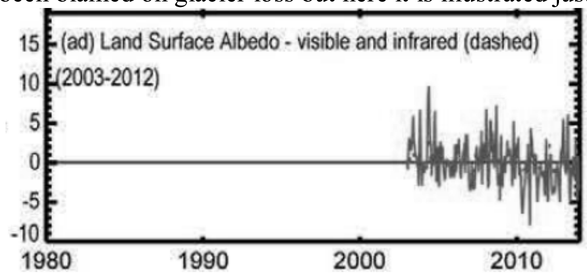

Figure 4 Loss of albedo over land likely due to increase in cities and highways [5]

- **Increase in Asphalt use:** Figures 5 and 6 show an increase in asphalt use (2009-2012) increase in highway miles (1923-2009), respectively [6,7] ,5b building size, and 5c natural aggregate material for buildings and roads (1900-2006). Although most of the data is limited on asphalt and highway growth, the trend is clear. Climatologists correlate the rising CO_2 greenhouse gases to global warming. Here one could just as well correlate the rising use of asphalt to global warming via contributions from the HES effect and emission of greenhouse water vapor gas**.**

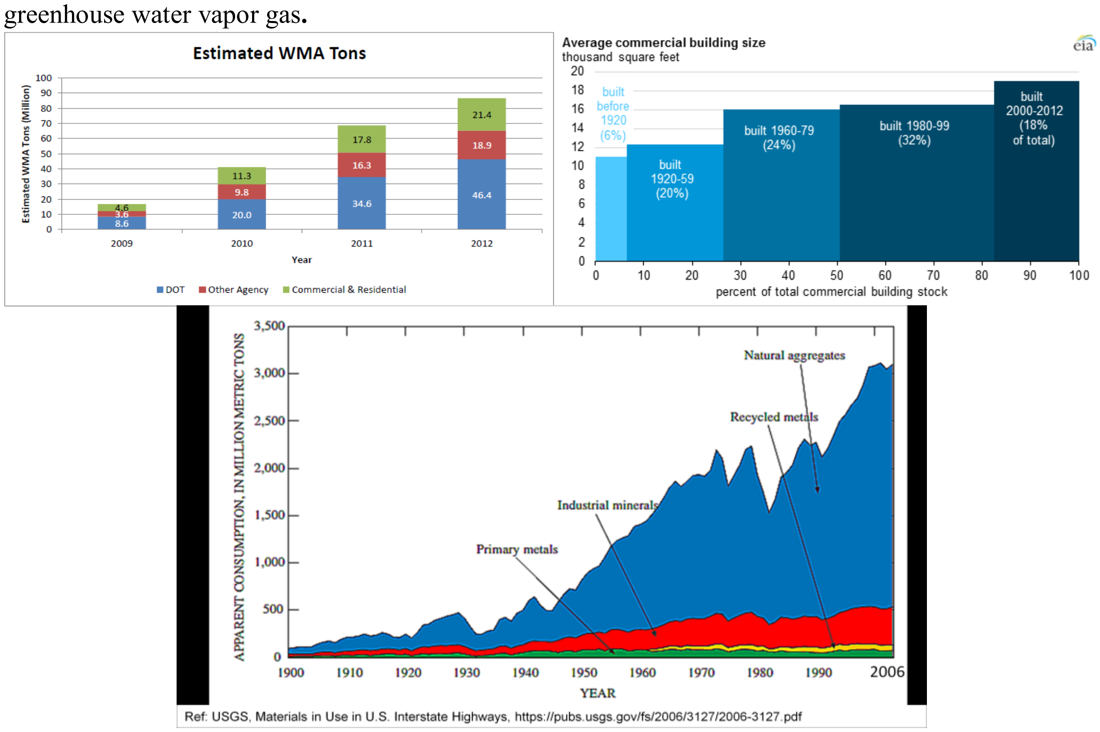

Figure 5 a) Growth of Warm Mixed Asphalt (2009-2012) in USA [6], b) and Commercial Building size [31], c) Natural aggregates mostly used for buildings & Roads 1900-2006 [32]

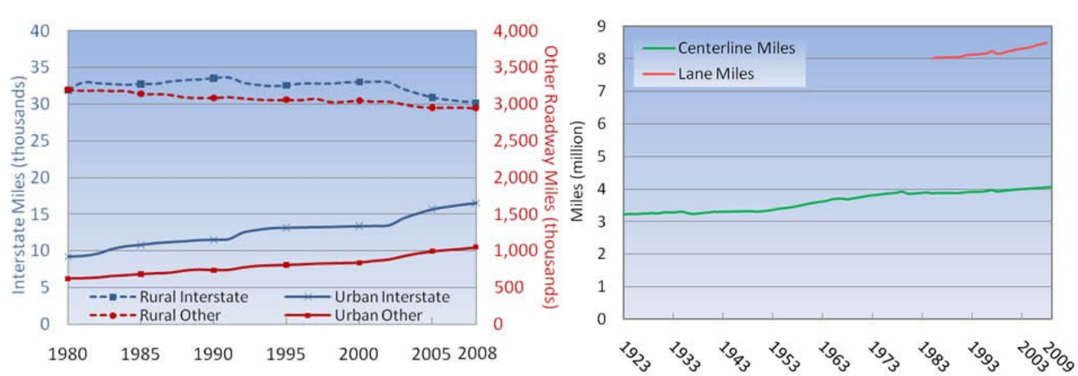

Figure 6 Interstate Miles versus yearly increase in US [7]

- **Specific Humidity Trends and Correlation to Global Warming:** Figure 7 shows specific humidity trends and Figure 8 illustrates the correlation through 2017 from various sources [8]. Here the author does not differentiate between specific humidity and precipitation.

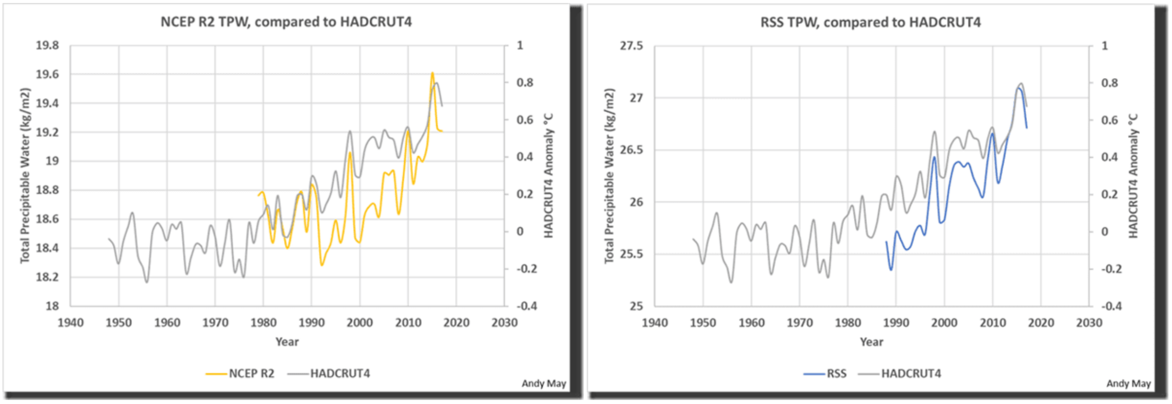

Figure 7 Specific humidity and global warming trends from two different agencies [8]. Here the author does not differentiate between specific humidity and atmospheric precipitation.

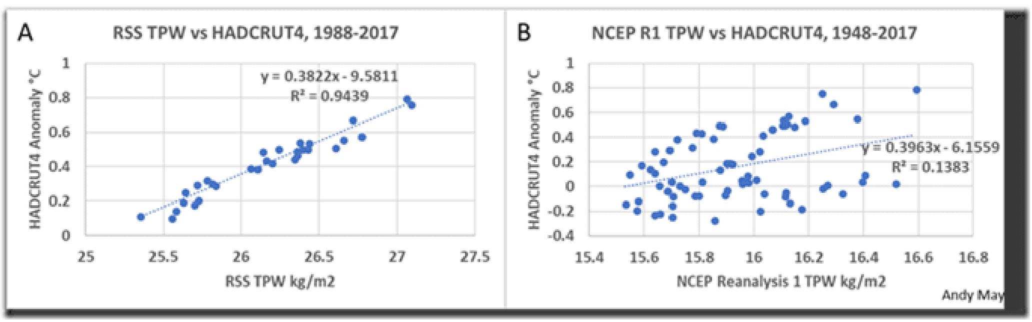

Figure 8 Correlation of specific humidity - Total Precipitation Water (TPW) for different data with global warming [8]. Here the author does not differentiate between specific humidity and atm. precipitation.

The primary effect that we are looking at with respect to data is a possible contribution to the evaporation rate and its effect on the rising specific humidity in the troposphere (lower 10 miles of atmosphere). Other related effects are likely dry conditions that are a necessary but not sufficient condition for drought. Hot roads and city walls also expand air and not only drive up specific humidity during precipitation but lower %RH (Appendix E). One other critical effect that is hard to calculate is loss of plant water storage and transpiration. When impermeable surfaces replace vegetation, the rate of evaporation is exceedingly high compared to transpiration which is said to account for 10% of all evaporation [9]. Climate change is then hard to predict. Lost wet lands can lead to dry condition with less increase in specific humidity.

4. Data on Rain Water Management (RWM), Drought, Global Warming Trends

Rainwater management may be an important factor. It can also impact where it rains! Rain follows local evapotranspiration. Apart from precipitation, evapotranspiration is the major component in the hydrologic budget. If ocean precipitation increases, then land precipitation can decrease.

When it rains in a city, much of the land in urban areas is covered by pavement or asphalt. Because rain can't soak into the soil underneath, these covered areas are impermeable surfaces. As the amount of impermeable surface increases with urbanization, so too does the amount of runoff. As an example, in urban cities 30% is often estimated for evapotranspiration, 10% shallow soil infiltration, 5% deep soil infiltration, and RWM takes 55% into runoff.

- The New York Environment Report, in 2014 reported [10], "Every year, old sewers flooded by storm water release more than 27 billion gallons of untreated sewage into the New York Harbor alone."
- Fry et al [11] reported that in February of 2019 California estimated that 18 trillion gallons of rain in February alone had most of the water going to the Pacific Ocean. The article goes on to point out the LA dept. of water captured 22 billion gallons of water during recent storm.
- In August 2001, rains over Cedar Rapids, Iowa, led to a 10.5C rise in the nearby stream within one hour, which led to a fish kill. Similar events have been documented across the American Midwest, as well as Oregon and California [25, 26]

- Sydney Paper reported [27]: "Every year around 132 billion gallons of storm water – enough to fill Sydney Harbor – runs from Sydney to the sea."

It is of course very difficult to tell the global thermodynamic influences of higher temperature water cycling. However, Australia might be a good extreme example, on the Sydney-Melbourne South-East side, the Tasman Sea is about 1 to 2 deciles range warmer (NOAA Sea Map [28]) than the South -West coast of Australia and about 5 deciles range warmer that the far south west coast. This might in part be an example of cyclic ocean heating. We tend to think of the ocean as an infinite temperature sink, but over 70 years of cycling, it can take a toll and perhaps this is somewhat of what we are seeing on the Sydney – Melbourne side and costal issues.

Here we cite examples on some studies that found correlations to wetland and rain. Such studies can depend obviously on climate of the area. However, these examples show the importance in losing wet land (water storage).

5. Poor Rainwater Management (RWM) Can Lead to Increase in Dry Days

As an example of the importance in losing wet land (water storage), Cao et. al. [12] did a study on wet land reduction in China and correlation to drought with the following conclusion

- "The wetland distributions and areas of the five provinces of southwestern China in the 1970s, 1990, 2000 and 2008 show that the total reduction of wetland area was 3553.21 km^2 in the five provinces of southwestern China from 1970 to 2008, accounting for about 17% of the ground area, and thus the average annual reduction area is about 88.83 km^2. The reduction rate was comparatively fast from 2000 to 2008 with an average annual reduction of 329.31 km^2. The changes to the wetland area show a negative correlation with temperature (i.e. wetland decrease, increase in temperature), and a positive correlation with precipitation (i.e. wetland decrease, precipitation decrease)." [12]

Hirshi et al. [13] did the following study

- "We analyzed observational indices based on measurements at 275 meteorological stations in central and southeastern Europe, and on publicly available gridded observations. We find a relationship between soil-moisture deficit, as expressed by the standardized precipitation index, and summer hot extremes in southeastern Europe. This relationship is stronger for the high end of the distribution of temperature extremes. We compare our results with simulations of current climate models and find that the models correctly represent the soil-moisture impacts on temperature extremes in southeastern Europe, but overestimate them in central Europe."

Below is the graph from their study [13]. It shows a negative linear relationship between wet land decrease and dry day increase

$$\%HD = -k\ WL(\text{Water Runoff and/or Loss of Wet Land}) + b \qquad (12)$$

where k is the slope related to the dryness. Here we have taken some liberties and generalized it to include water runoff.

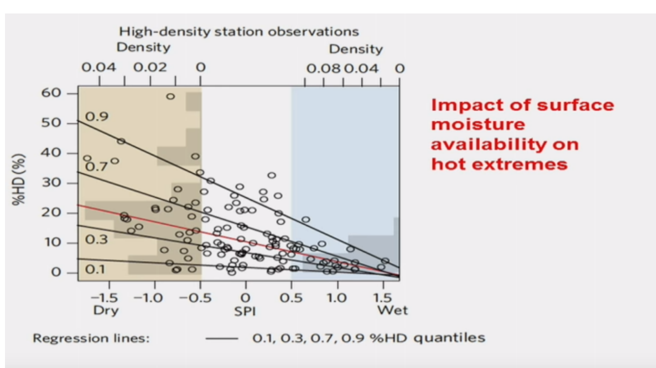

Figure 9 Percent Hot Days (HD) correlated to dry vs wet areas [13]

- Hiyama et. al, investigated the origins of rain- and subsurface waters of north-central Namibia's seasonal wetlands, analyzed natural stable water isotopes (SWIs) of hydrogen (HDO) and oxygen ($H_2{}^{18}O$) in rainwater, surface water and shallow groundwater. Rainwater samples were collected during every rainfall event of the rainy season from October 2013 to April 2014. The isotopic ratios of HDO and oxygen $H_2{}^{18}O$ were analyzed in each rainwater sample and then used to derive the annual mean value in precipitation weighted by each rainfall volume. Results showed that around three-fourths of rainwater was derived from recycled water at local–regional scales.

As another example, it is found that in large areas of the Southwest, evapotranspiration is virtually equal to 100 percent of the precipitation, which is only about 10 inches per year [9].

By contrast, in the conterminous United States, the estimated mean annual evapotranspiration is greatest in the Southeast (about 35 inches per year or about 70 percent of the precipitation), which is an area of abundant precipitation, permeable soils, and substantial solar radiation; it is least in the semiarid region of the Southwest where precipitation is limited. The ratio of estimated mean annual evapotranspiration to precipitation is least in the mountains of the Pacific Northwest and New England where evapotranspiration is about 40 percent of the precipitation [9].

Some efforts have been made to improve storm water innovation in RWM. The effort is called LID [14], "Low Impact Development (LID) is a planning and design approach that aims to mimic naturalized water balances. It combines infiltration, evaporation and transpiration while limiting runoff. The goal of LID is to restore processes that are lost in a built-up urban environment. LID includes several types of low-level new and innovative storm water technologies that together let water infiltrate the ground and evapotranspire into the air. However, no efforts have been made to cooling HHS.

5.1 HHS-HES Effective Area of Evaporation Change from Soil

When land is converted to impermeable surfaces, the evaporation rate is an indication of the lost soil. This increase moisture evaporation is tied to the increase area and the effective evaporation change since 1950 which occurs due to replacing soil with impermeable surfaces.

A simplified expression for the equivalent HHS-HES area found in Appendices A roughly given by

$$A_{EfHES} = \left(\frac{t_{Soil}}{t_{HES}}\right) A_{Soil} = \left(\frac{t_{Soil}}{t_{HES}}\right)\left(A_{HES} - A_{HES-\%IG}\right) \tag{5}$$

Where

A_{EfHES}=Effective HHS-HES area,

A_{Soil}=soil area, this is set equal to an equivalent to A_{HES} area, subtract from

$A_{HES\text{-}\%IG}$ any % run off of irrigated water falling on the roads or city surface areas to vegetation areas

t_{Soil} is the evaporation time of the soil

t_{HES} is the evaporation time of the asphalt or city surface after precipitation occurs.

As an example, if it takes a road 2 hours to evaporate a volume of water from a road, while it take soil 48 hours to evaporate the same amount of water in soil, than the effective soil land lost is a factor of 24 times contributing to the evaporation rate and specific humidity. This example is for roads with zero percent irrigation-equivalent area running off water to adjacent land. If for example 60% of the water is runoff far away, then the lost soil area effect is even large by the now shorter evaporation time. For example the 2 hours reduced by 60% to 0.8 hours, so the lost land in now a factor of 60 in terms of the local hydrologic budget.

4.1 RWM Effect on Oceans

Rising oceans' levels are anticipated with global warming due to the fact that the ocean expands as it warms. Its levels also will increase due to glacier melting. However, it doesn't help to have RWM also contributing from cities all over the world with water runoffs into the ocean. Prior to the industrial revolution, much of this water went to natural vegetation, streams and lakes. Urban and city are typically few degrees hotter and HHS-RWM may be instrumental in local water temperatures. RWM runoff into the ocean's of course also created a reduction of wet lands. Shifting precipitation from land to over oceans is a large concern. Most climate models do not agree on precipitation and drought areas as climate is hard to predict [15].

"The average of the models shows large increases in precipitation near the equator, particularly in the Pacific Ocean [15]" It would be close to impossible to tell if RWM has a direct bearing on precipitation in certain areas. However, we have illustrated a number of studies that suggest logically that HHS-RWM is very important.

5. The Contention against CO_2 Feedback Being Solely Responsible for Specific Humidity Increase

There are certainly difficulties in understanding the CO_2 effect relative to moisture. What is needed is a very good simulation experiment. While there are an abundant number of CO_2 complex experiments in the literature, it is hard to point to a few that demonstrated simply that going from 300 to 400 ppm could produce the appropriate temperature rise. This experiment, if it does not exist, seems hard to find in the literature. Certainly while non trivial, such an experiment seems feasible and important. Here are some logical reasons why a precise experiment, which may have already been done properly somewhere in the literature, but it would be helpful to understand CO_2 exact contribution to GW:

- Many authors have argued that CO_2 is 400 PPM while water vapor is 25,000 ppm (on average at 25km). Yet climatologist claim that roughly 1/3 of the GW increase is due to CO_2. In light of the conclusion of Sec. 2.3, we cannot ignor humidity forcing which diminishes the contention that evaporation is a feedback mechanism not a forcing one.
- One can also estimate the fossil fuel contribution to global warming, and it is negligible since 1950. It adds <0.02 W/m2 out of the 4.1 W/m2 which would be the global warming energy change today. If one translates this in terms of CO_2 energy, the energy to create a CO_2 byproduct of fossil fuel increase from 300 to 400 ppm, is significantly small amount of creation energy compared to the global warming energy needed. That is, we have a miniscule amount of global warming energy creating CO_2 byproduct, which in turn is believed to create a major global warming energy change? Although the mechanisms are completely different, it does show the difficulties in understanding how CO_2 could have such a GW amplification strength impact.

6. Summary - Solutions

Global warming is commonly illustrated with CO_2 correlation to population growth and global warming trends. Similarly, one could argue that city growth is correlated to population growth which in-turn then would also be correlated to global warming. We find (See also our Critical Review of IPCC Goals [33]) that it is highly likely that albedo decrease due to cities and its combined effect form HHS-HES areas and HHS-RWM are contributing to global warming.

From data and analysis presented, it is our opinion that the IPCC goals focused solely on CO_2 reduction [29] is highly risky as IPCC is not: 1) working on UHI albedo obvious data trends, 2) looking at forcing or all feedback humidly sources from UHI HHS and 3) recognizing UHI albedo forcing conflicts with CO_2 theory. ***It seems highly unlikely that focusing only on CO_2 reduction will not stop global warming trends from occurring*** as has been critically assessed here and elsewhere [33]. Albedo reduction goals of UHI have been ignored by IPCC committees long enough even in very latest meetings by the IPCC [7, COP 25]. The IPCC has wasted valuable time as albedo goals could have been set early on for cities. City design efforts of "cool roofs" for example have lagged far behind compared to say automotive efforts to reduce CO_2 emission standards. The IPCC goals are highly influential and are suppose to speak for all of mankind. Possibly they are so concerned that city buildings with higher albedo changes might create a need for more fossil heating fuel in the winter months, biased by CO_2 theory, thus ignoring UHI albedo serious issues. We conclude with a number of IPCC suggestions that should be occurring:

HHS-HES and HHS-RWM Reduction Suggested Solutions

- Further studies are required in this area to understand the effect and contribution to GW
- Change Albedo of roads and cities will reducing HHS and the area effect dramatically, i.e. paint roads and building with reflective colors (minimally higher than albedo of 0.25)
- Mandate albedo design requirement in city and road future designs
- Engineering roads to be more HHS eco-friendly
- Reduce driving speeds during rain to reduce evaporation rates can also reduce KE molecules
- Change to electric cars with HHS - cooler hoods
- Paint all cars silver or white
- Move car engines to the back of the car with as little rain surface area as possible
- Improve HHS-HES irrigation to soil
- Improve vegetation in run off areas by planting millions of trees in HHS-HES areas
- Require negative population growth to reduce increase HHS-HES surfaces
- Adopt Low Impact Development (LID) in city planning and improvements for design approach aiming to mimic naturalized water balances
- Reverse trends possibly by also cooling rainwater runoff possibly with green electricity prior to releasing it to streams, rivers, lakes and oceans

- Severe HHS-RWM changes are required to stop runoff into the ocean worldwide

Appendix A: ***Solar Urbanization Surface Amplification Area Estimates*** ***(Reference need update see Vixra 2001.0415 for valid references)***

Estimating urbanization that include UHI areas of cities globally with amplification effects is a non trivial task. However, the method we used greatly simplifies these estimates. We are interested in providing a worst case and a nominal scenario for the albedo modeling to estimate global warming from 1950 to 2019. Estimates of how much of our land has been urbanized vary widely in the literature and this is in part due to the definition of what is urban and the datasets studies use. Despite the growing importance of urban land in regional to global scale environmental studies, it remains extremely difficult to map urban areas at coarse scales due to the heterogeneous mix of land cover types in urban environments, the small area of urban land relative to the total land surface area, and the significant differences in how different groups and disciplines define the term 'urban'.

To be consistent, we use satellite data from two studies. For the worst case estimate, we usedd a GRUMP v3 [24-26, 45, 54] study released in 2005 (which has its critics [45,54]) indicate the surface area relative to the Earth's land coverage is 2.7% (or 0.027 x 29%=0.783% area of the Earth) in the table below. For the nomial case we looked at the reference used by the IPCC in Urban Area report 2014 [1] quoted a 2009 study by Schneider et al. [54] of 0.5% of land (0.0051x29%=0.15% area of Earth) and 1% in western Europe. The IPCC also said "their physical and ecological footprints are much larger". In general there have been numerous studies and these are summarized in Table A2.

Using the GRUMP, worst-case study in 2005, we project it to 1950 and 2019 by using the world population growth rate [57] which varies by year as shown in Figure A1. We chose the average rate per ½ decade for iterative projection from 1950-2019.

In order to estimate the UHI amplification effect such as solar surface heat capacities, which must include average building side areas (note also buildings have gotten taller [58] since 1950), and humidity effects, we use a study by Zhou et al. [27] (2015). In this study [27] they found UHI changes the climate in an area 2–4 times larger than its own area. Then for the worst case scenario, a factor of 4 was used in 2019. Since 1950 is taken as the reference year (for most global warming estimates) we did not use any amplification factor. Results are shown in the table below. The last column shows the results of the effective area used in the solar albedo model.

Table A1 Values used to estimate the Solar Surface area in cities

Year	Percent of Earth	UHI Amplification Factor effect Zhou et. al. [17]	UHI Surface Amplification Area Effect
Worst Case GRUMP Study [24-26,45]			
1950	0.316%	1	**0.316*** **
2000	0.027**x29%=0.783%		
2019	0.952%*	4	**3.81%**
IPCC Schneider Study [54]			
1950	0.059*	1	0.059
2000-2001	0.0051*29%=0.148		
2019	0.188*	4	**0.753**

*Growth rate of cities using non linear world population growth rate per year Fig A1, ** GRUMP (2005) study,***not increased as this is considered global temp. reference year.

Note that Table A2 summarizes the GRUMP and Schneider study used here. As well, we also list a number of other urbanization studies. A 2010 study indicates it's much lower to 0.3% [46]. OECD Green Growth Studies Indicators 2014 [59] showed about 1.8% of land (0.018x29%=0.52%). A global map from a 2000 NASA data set [55,56] showed people live on 1% of the land [55,56] (0.29 of Earth). A 2015 study based on 2000 data set shows about 0.5% of the total land area but ranges widely [40].

Table A2 Summarizing Literature Urbanization Area Estimates

Percent of Land	Percent of Earth	Reference and Issues
2.7	0.783	(2005) GUMP (NASA Satellite, Light study, blooming issues) [24-26,45]
1.8	0.52	(2014) OECD [59]
1%	0.29	(2000) NASA data set [Satellite, 55, 56].
0.5	0.15	(2009) Schneider et al. based on 2000-2001 data [54] from IPCC 2014 reference [1]

0.5%	0.145	(2015) based on a 2000 data set [60]
0.3	0.09	(2010) only most populated about 50% estimated [46]

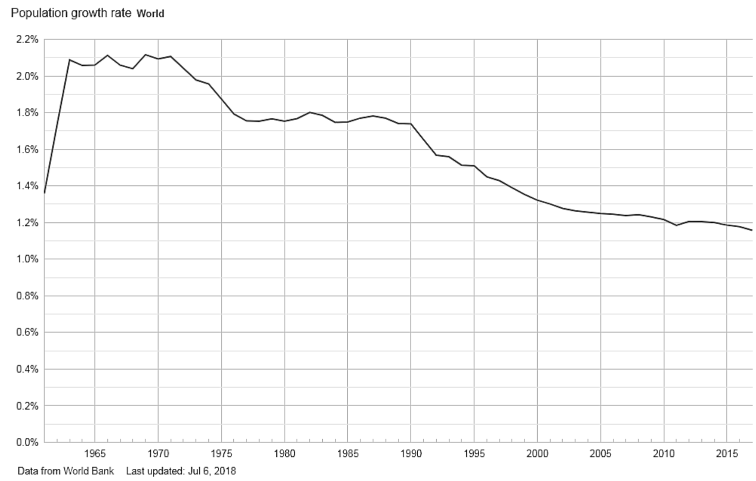

Figure A1 Population growth rate by year from 1960 to 2018 [57]

A.1 Some information on the GRUMP study vs. the Schneider study

We note the GRUMP study incorporates population estimate from 1990, 1995, and 2000, it combines census data with satellite data. Schneider study uses satellite data, a map the global distribution of urban land use at 500 m spatial resolution using remotely sensed data from the Moderate Resolution Imaging Spectroradiometer (MODIS) from 2000-2001. The Schneider study criticizes the GRUMP noting, "The extreme variability in these estimates calls into question the accuracy of each map's depiction of urban and built-up land, and yet past efforts to validate the maps have been minimal". They also note, regionally, our results reveal that previous estimates of urban extent (2–3%, CIESIN 2004, i.e. GRUMP) drawn from global urban maps may over-estimate the true extent of built-up areas. However, the Schneider study does show that the GRUMP study has the highest producer accuracy, which is a measure of omission.

Appendix B: ***Simplified Weighted Albedo Model 1950 & 2020***

Below is a simplified author's Albedo model to estimate the Earth's total albedo decrease with increase in city and road solar areas and a decrease in grass lands. Note in our albedo modeling we hold ice and snow changes constant, that is the Earth weighted Albedo since 1950 is only a function of changes to roads and cities. This allows us to focus on causes and not effects. The goal of the simplified global albedo model is to illustrate the sensitivity of global albedo change from 1950 to 2019 in order to show global UHI cause feasibility. The simplistic model allows for later refinement and aids one's ability to argue the importance of UHI cause issue on a global scale.

Results of the simplified model are exemplified in Table B1-B3 with the full estimates provided in Table 3.

Table B1: Albedo=0.30, 1950

Surface	Enter % of Earth Area	Enter Albedo (0-1)	Weighted Albedo in % Results
Water	71		
Sea Ice	15	0.66	9.90
Open Ocean	56	0.06	3.36
Land	29.006		
Roads (0.04)	0.09	0.04	0.00
Urban Cov (0.12)	0.316	0.12	0.04
Forest (0.17)	3.3	0.17	0.56
Forest (Snow)	5	0.81	4.05
Grass lands (0.26)	3.7	0.26	0.96
Grass Lands Snow	7	0.81	5.67
Desert (0.4)	9.6	0.4	3.84
Sum % of Earth Area	100.006		
Weighted Earth			28.38
Clouds (0.47)	60	0.472	31.68
			Global Weighted Albedo in
Global=Average(Clouds & Weighted Earth) %			30.03
Global=Average(Clouds & Weighted Earth)			0.3003

Table B2: Albedo=0.2975, 2019

Surface	Enter % of Earth Area	Enter Albedo (0-1)	Weighted Albedo in % Results
Water	68.593		
Sea Ice	14.493	0.66	9.57
Open Ocean	54.1	0.06	3.25
Land	31.399		
Roads (0.04)	0.09	0.04	0.00
Urban Cov (0.12)	3.68	0.12	0.44
Forest (0.17)	3.189	0.17	0.54
Forest (Snow)	4.83	0.81	3.91
Grass lands (0.26)	3.575	0.26	0.93
Grass Lands Snow	6.76	0.81	5.48
Desert (0.4)	9.275	0.4	3.71
Sum % of Earth Area	99.992		
Weighted Earth			27.83
Clouds (0.47)	60	0.472	31.68
			Global Weighted Albedo in
Global=Average(Clouds & Weighted Earth) %			29.75
Global=Average(Clouds & Weighted Earth)			0.2975

Equation B1 is the weighted albedo by area,

$$EWA = \sum_i \{\% \, Earth\ Area_i \ x \ Surface\ Item\ Albedo_i\} \tag{B1}$$

Here EWA is the Earth's Weighted Albedo. Equation B2 is the average weighted albedo with clouds.

$$Global\,Weighted\ Albedo = Average\{(Clouds\ Albedo)\,x\%\ Coverage) + (Earth\ Weighted\ Albedo)\} \tag{B2}$$

REST OF APPENDIX NEEDS UPDATES

Appendix E: Example of Hotspot Local Relative Humidity in Cities and Streets

Example: If the ambient temperature when it rains is 27°C and 98%RH and the HHS surface temperature is 87°C (black asphalt, see Table A1), then the local relative humidity at the hotspot surface is reduced from 98%RH to 5.6%RH [15].

Appendix C: Evaporation Rate of Cities Vs. Ocean Feedback

In Table 4 feasibility assessment, the 1% increase and ppm levels of moisture are important as they indicate the increase in greenhouse gases. One could argue that the increase in humidity from 1950 to 2019 is due primarily to the global warming ocean feedback mechanism and perhaps some contribution due to HHS. Here we investigated the possibility of humidity contributions from HHS in cities.

In this example, the evaporation rate increase of HHS simulated area in Cities (Ec) vs that of the Ocean (Eo), we make comparison between 1950 and 2019 relative to a possible average hydro-hotspot of 50°C (using average range from 25°-75°C) for simulated area growth via the final ratio. We find that the evaporation rate increase is dominated more by city area growth rather than ocean temperature change. In this assessment, we will first ignore the evaporation wind effect. The comparisons for the effects are:

$$HHS_{effect-o}(1950) = \frac{E_O}{E_C} = \frac{A_O}{A_C} R(T_O, T_{HHS}) \frac{E_{WO}}{E_{WC}} \frac{RH_C}{RH_O} = 40.8x\frac{1}{6.69}x100x0.5 = 304.9 \tag{C-1}$$

and

$$HHS_{effect-o}(2019) = \frac{E_O}{E_C} = \frac{A_O}{A_C} R(T_O, T_{HHS}) \frac{E_{WO}}{E_{WC}} \frac{RH_C}{RH_O} = 16.3x\frac{1}{6.28}x100x0.5 = 129.8 \tag{C-2}$$

where E_O,E_C=Evaporation Rate of Ocean, Evaporation Rate of Cities

AO, AC= Surface Area of Ocean, simulated proportional Area of City Surfaces growth rate (Ao/AC=49%/3%=16.3 in 2019, Ao/AC=49%/1.2%=40.8 in 1950)

$R(T_O$=16C,T_{HHS}=50C,1950) Temp. rate factor Ocean to City HHS ~6.69

$R(T_O$=17C,T_{HHS}=50C,2019) Temp. rate factor Ocean to City HHS ~6.28

$where\ R = \exp\{\frac{E_a}{K_B}(\frac{1}{T_{HHS}} - \frac{1}{T_O})\}$, Ea=0.45eV [24]

E_{WO}, E_{WC}= Percent of time surface exposed to water, E_{WO}=100%, E_{wc}=1% ~100

RH_C, RH_O=Local relative humidity of ocean and RH of city near surface ~40/80

From Eq. C-1 and C-2 we find the percent increase in evaporation rate from HHS relative to the ocean since 1950 (ignoring wind) as

$$\%2019\, Increase = \frac{304.9-129.8}{304.9} = 57.4\% \tag{C-3}$$

We now look at the wind effect. We will consider that the ocean wind evaporation factor has not changed much from 1950 to 2019. However, city growth increases friction near the ground level so the wind evaporation effect factor is diminished in cities by comparison to the ocean from 1950 compared to 2019. Then the results in Eq. C-3 is now modified by this factor

$$57.4\% x \frac{W_{O/C}(1950)}{W_{O/C}(2019)} = 57.4\% x \frac{W_C(1950)}{W_C(2019)} = 57.4\% x f_W \tag{C-4}$$

where f_W is an unknown factor between 0 and 1. If we take f_W as a median value of 0.5, for a rough wind reduction estimate in cities, this would yield a 29% growth rate in evaporation compared to the ocean effect.

C.1 Cities vs. Ocean Evaporation Growth Rate

Note that the ocean change since 1950 to 2019 is 1°C. The ocean evaporation rate increase is 6.4% $R(T_{1950}=16C, T_{2019}=17C, Ea=0.45eV)=1.064$ while cities evaporation rate area effect is 50% higher x wind factor or approximately 25% higher.

- Then cities evaporation rate has grown about a factor of 4 times faster than the ocean evaporation rate since 1950.

In summary, humidity forcing from HHS shows a strong evaporation growth rate compared to ocean changes in evaporation rate from 1950 to 2019. This supports reasonable strong feasibility that the 1% increase in moisture greenhouse gas (Table 4) can have high contributions from an urban humidity forcing/feedback effect.

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