1. Introduction

Unifying Fields has worked together with a great number of scientists all over the world to develop an integral vision of the role forests play in the dynamics of climate change. These scientists worked in the following fields of biophysics:

- **Bio-Precipitation**[1]: forests create bacteria which increase the probability of rain.

- **Bio-Cooling**[2]: forests cool the landmass through the evaporation of water on the surface of the tree leaves. Forests also make clouds which play an important role in the thermal regulation of the earth.

- **Bio-Regulation**[3]: forests transport water vapour from the seas to the landmass.

By working with these scientists over the last 7 years the founders of UFF were able to create an integral view of the role forests play in global climate change dynamics. Based on this assessment integral solutions were developed to address climate change in the optimal way.

2. Deforestation

Scientists have determined that in recent history about 45% of the original forest cover on earth was removed. This was mainly done to create agricultural land for industrial farming. The total deforested area is about 3 billion hectares of land. This is about 20 % of the landmass of the earth. And this land is now moderately degraded.

Scientists have found that this land change affected the proper functioning of the carbon cycle, the hydrological cycle and the thermal cycle of our planet. The imbalances in these cycles that grew over time in line with the growth of the world population are probably the most probable cause of the change in climate on earth.

3. Bio-Cooling: Forest are Miracle Air Conditioners

The image below is the summary of very important work performed by a group of scientists the Czech Republic[2].

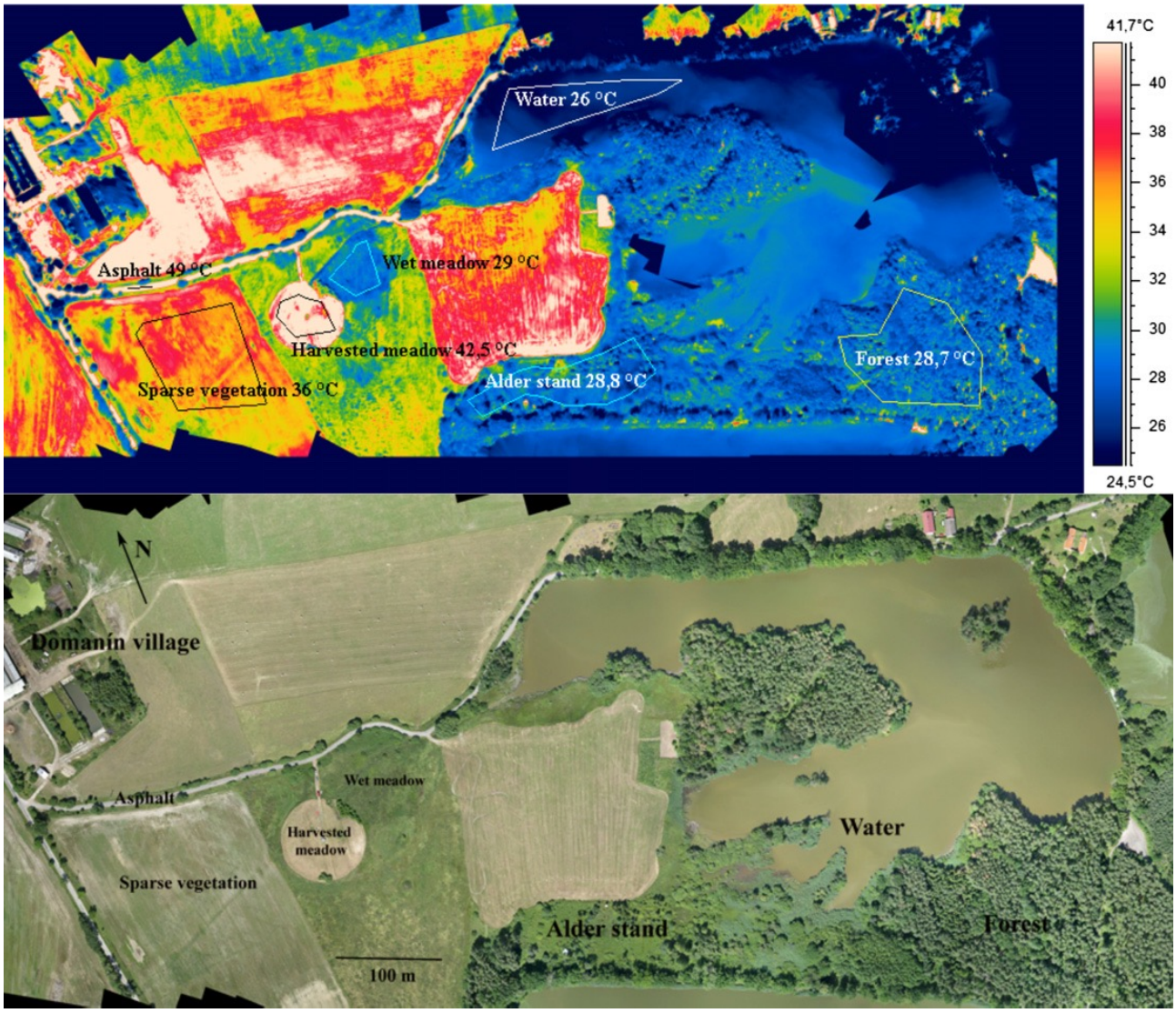

Fig. 1. Surface temperature of a landscape on a summer sunny day in the Trebon Biosphere Reserve (Czech Republic) taken by thermographic and visible cameras.

From the above thermographic image of the same landscape it can be seen that water and forested surfaces have a temperature of 26.0-28.8 ºC and the adjacent agricultural land areas (for instance a harvested meadow) have a temperature of 36.0-42.5 ºC. The difference in temperature originates from the presence or absence of plants and trees that cool the local environment by the evaporation of water[4]. Trees cool the local environment very efficiently because they evaporate water at the surface of the leaves. Because trees have a large surface area (Leaf Area Index: LAI) they have an even more significant cooling effect. One tree could cool as much as 10 room size air conditioners operating 20 hrs pr day[5,6].

4. Thermodynamics of the Hydrological Cycle

In close collaboration with the above referenced groups of bio-physicists we have developed a graphic, which reflects the integral dynamic relationship between forests and the many aspects of the local and global hydrological cycle[7,8,9,].

The hydrological cycle and the thermal cycle of the atmosphere is characterised by: 1) evaporative cooling on the surface of the leaves, 2) the thermal regulation of low and high clouds, 3) bacteria induced bio-precipitation and 4) the transport of water vapour from the oceans to the landmass (biotic pump)·

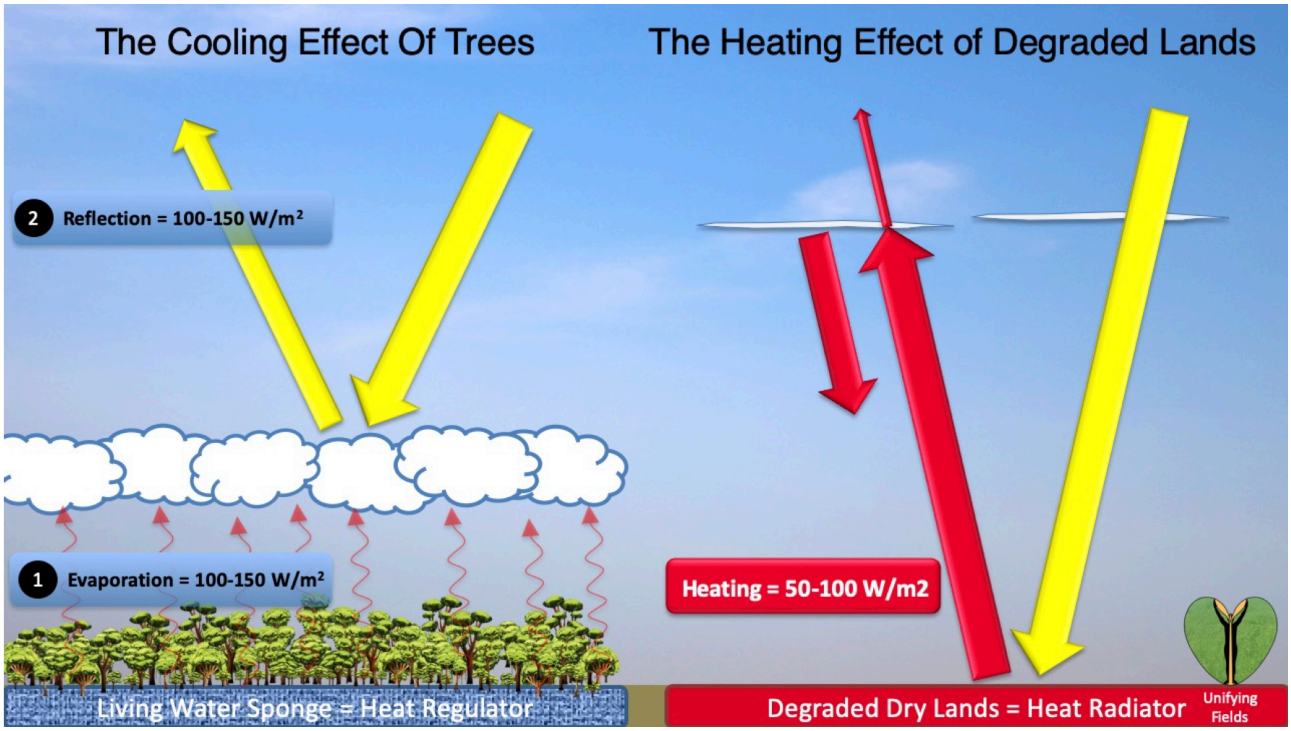

Fig.2. Cooling effect of forests and heating effect of degraded land

On average individual trees evaporate 100-150 litres of water per day. The energy for evaporation is mostly provided by the local environment. It has been determined by bio-physicists that the local cooling effect of trees/forests is about 100-200 W/m² of forest.

Water vapour rises naturally because it is lighter than air. When water vapour rises to higher atmospheric regions it naturally condenses into low clouds which under the right circumstances create rain.

The water vapour condenses at the top of the clouds. The heat of condensation is then released to the atmosphere above the clouds and subsequently radiated into space.

Therefore this local evaporation and condensation cycle effectively transports heat from the local environment to outer space. Thus this heat is **not trapped** in the atmosphere.

Trees can evaporate significant amounts of water because they have a leaf surface area of about 4-5 m^2/m^2 ground surface. This also enables trees to capture a lot of sunlight.

A secondary cooling effect of forests is that the low clouds above the forest block the incoming solar radiation. Therefore bio-physicist have determined that the ***total net cooling effect of forests is in the range of 200-300 W/m².***

However if the land is deforested solar radiation heats the bare surface of the soil. In this case no low level clouds are created. Often one finds high level clouds above warm and dry land.

These high clouds do not block the solar radiation. At the same time these high clouds prevent infrared radiation, emitted by the warm soil surface, to escape to outer space.

Therefore degraded lands **trap** heat in the atmosphere. Thus bare soils and the resulting high clouds have a double warming effect. Biophysicists have estimated that the ***total net heating effect of degraded lands*** is about 50-100 W/m2

Thus, if forests are cut and eventually transformed into degraded lands this creates a total heating effect of 250-400 W/m2.

Therefore the group of biophysicists who studied the physics of trees for many years have found that global deforestation is the main reason for global warming and that appropriately designed reforestation is the solution.

5. Forests are Miracle Rainmakers

Scientists all over the world have found that intact biodiverse forests emit specific bacteria (Pseudomonas Syringa) into the atmosphere in the process of evapotranspiration of water at the surface of leaves. These bacteria increase the probability of rain. In the scientific literature this is called bio-precipitation[10,11,12].

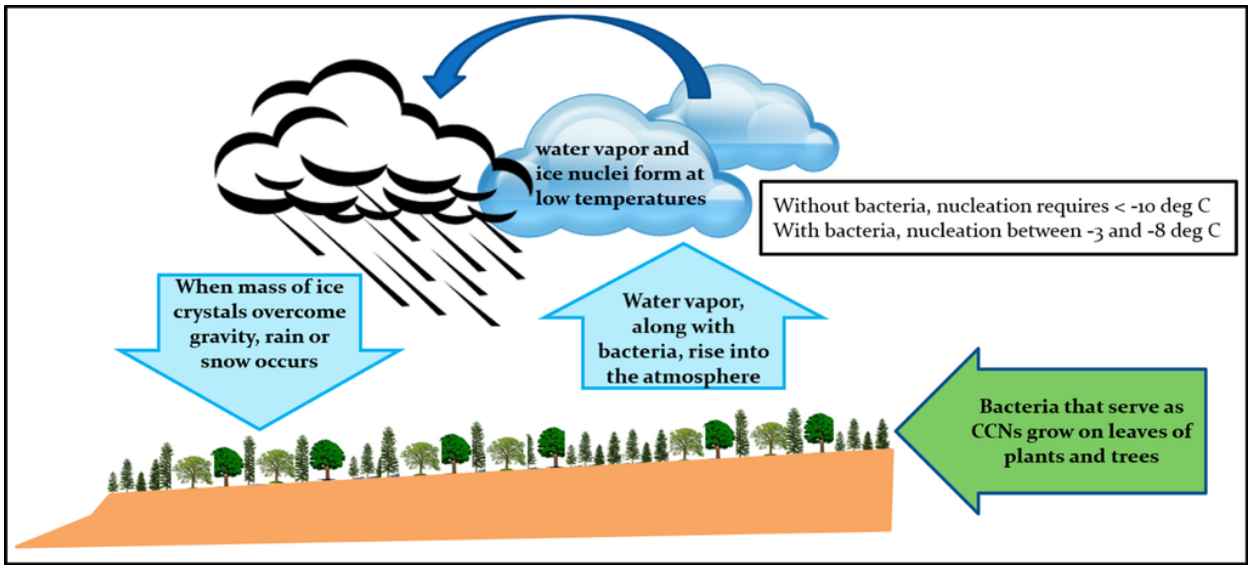

Fig.3. Bio-condensation and bio-precipitation Source: https://www.manzanitasolutions.org/supporting-research

The formation of ice crystals precedes rainfall. When there are no ice nucleation bacteria in the local atmosphere ice crystals are formed at a temperature of -10 degrees C. Bacteria promote the formation of ice crystals at higher temperatures, - 3 to -8 degrees or sometimes even up to 0 degrees C. This greatly enhances the probability of rain. This makes forests miracle rainmakers. This is why forests play a very important role in the hydrological cycle.

6. The Biotic Pump: Forests are Hydrological Powerhouses

There is another profound effect when trees create clouds and rain. Water vapour rises in air because it is lighter than air. The water vapour condenses into clouds at higher altitudes (assisted by micro-organisms) and transforms into rain.

Upon condensation the local pressure reduces relative to areas where there is no condensation. This then affects the local circulation of air.

Areas of relative low pressure suck moist air in from nearby locations. This is how trees and forests draw in moisture from the seas and oceans and transport it further inland[13,14,15,]. This process is continuous as long as there is forest on the land.

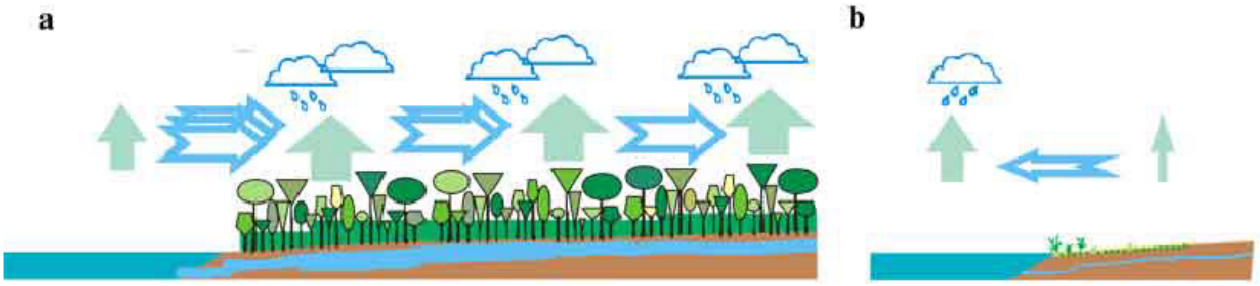

Fig.4. Source Image: https://www.bioticregulation.ru/pump/pump.php

When the forests are removed to make way for local agriculture there is no driving force for condensation and less rain is produced, although the surrounding air contains plenty of moisture. It is the ability of the trees to evaporate water and create condensation which is the key to local and global cooling over the landmass.

7. Reforestation: Agroforestry Systems

As indicated in section 2 of this document, the main driver for deforestation is the creation of agricultural land to conduct large scale industrial dairy and meat farming. This practice has degraded about 3-4 billion hectares of the landmass of the earth. This land used to be primeval forest. Primeval forests are highly biodiverse, have abundant plant and soil life and emits the rainmaking bacteria. Primeval forests function very well in the context of the carbon cycle, the hydrological cycle and the thermal cycle of the planet.

All-around the world agroforestry systems are being created which restore biodiversity, produce healthy and affordable plant-based-food for local communities. Scientists of a number of highly credible organisations[16,17] have determined that agroforestry practices require 4 times less agricultural land. This leads to the conclusion that there will be enough land to feed 10 billion people when the switch to agroforestry is made.

8. Agroforestry: Plant Based Food.

The World Data[16] organisation has done numerous studies as to the future of our food producing systems, the health of agriculture and and how a growing world population has local and affordable access to **plant-based-food** on land which grows more biodiverse over time. These studies lead to the following conclusion:

"Whereas industrial farming is degenerative in nature and occupies 77% of the available agricultural land it produces only 18% of the world's calories and 37% of the world's proteins".

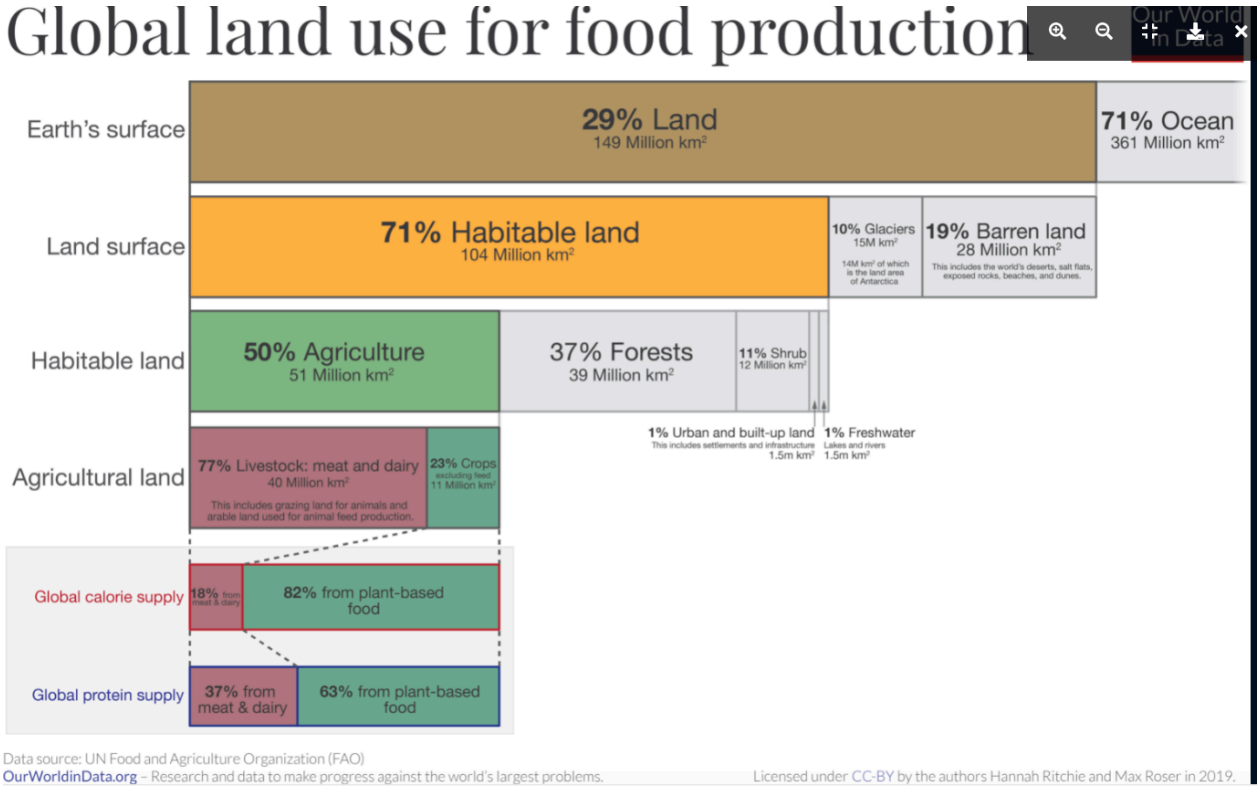

Fig.5: Global land-use for food production

In UFF's many years of research we have found that the methodology of Syntropic Agroforestry is probably the most integral way of conducting food-forestry. Syntropic Agroforestry is a natural way of producing food by small-hold family farmers for local communities.

This change in farming methodology reverses the environmental load on agricultural land and reduces the land required to produce agricultural products by a factor of 4. It also allows for reforestation of the land which was degraded by industrial farming and is no longer required to produce food.

9. Climate Change Solutions

The Greenhouse Gas (GHG) hypothesis of global warming indicates that the increased warming that has been found is the result of an increased concentration of GHG in the atmosphere. This additional GHG induced net cumulative heating effect (radiative forcing)[19,20] is currently estimated at 1.5 W/m².

The total area of deforested and degraded lands is 3 billion hectares or 5.8 % of the total surface of the planet. Taking the above calculated heating effect of deforestation at a conservative estimate of on average 250 W/m², it means that the cumulative net heating effect of deforestation is in the order of 14,5 W/m².

This an order of magnitude larger than the estimated heating effect of emissions. This is not to say that GHG's are not a contributor to global warming, but indicates that properly designed reforestation and agroforestry programs are the most effective solution.

Agroforestry systems absorb CO2, cool the local climate, increase biodiversity, produce healthy and affordable local food and restore degraded lands.

10. Conclusions

From the above studies about climate change dynamics, the bio-physics of trees and forests, the functioning of the hydrological cycle and the the removal of forests to create land for industrial agricultural practices it is evident that an integral solution is now emerging. Well designed reforestation, the production of healthy locally produced plants based in agroforestry systems restores the degraded lands, produces enough food for a growing world population while this also addresses climate change at affordable cost.

The Founders of Unifying Fields, Baarn, the Netherlands, March 2023

Unifying Fields

Restoration Power

References

1. https://soilcarboncoalition.org/walter-jehne-water/

2. http://www.waterparadigm.org/download/Water_for_the_Recovery_of_the_Climate_A_New_Water_Paradigm.pdf

3. https://www.bioticregulation.ru/contacts.php

4. https://books.google.nl/books?id=x1h7DwAAQBAJ&pg=RA1-PA292&lpg=RA1-PA292&dq=pokorny+trebon+evapotranspiration+elsevier+2019&source=bl&ots=cq-0yKy9Dh&sig=ACfU3U0b478EChCExN2i5PTHTDOtDPRayA&hl=nl&sa=X&ved=2ahUKEwjywPPs3-PiAhUDDewKHaeACtAQ6AEwCHoECAkQAQ#v=onepage&q=pokorny%20trebon%20evapotranspiration%20elsevier%202019&f=false

5. https://www.fs.usda.gov/detail/r9/home/?cid=stelprd3832558

6. https://www.fs.usda.gov/openspace/fote/reports/nrs-62_sustaining_americas_urban.pdf

7. https://www.youtube.com/watch?v=Gd6TFhTWYYo

8. https://soilcarboncoalition.org/bioprecipitation/

9. https://www.youtube.com/watch?v=kKL40aBg-7E

10. https://onlinelibrary.wiley.com/doi/full/10.1111/gcb.12447

11. https://portal.research.lu.se/en/publications/bioprecipitation-a-feedback-cycle-linking-earth-history-ecosystem

12. https://cv.hal.science/cindy-e-morris

13. https://www.bioticregulation.ru/

14. https://www.bioticregulation.ru/pump/pump2.php

15. https://www.bioticregulation.ru/pump/pump.phphttps://www.researchgate.net/publication/261133718_How_plants_water_our_planet_Advances_and_imperatives

16. https://ourworldindata.org/land-use-diets

17. https://ourworldindata.org/agricultural-land-by-global-diets

18. https://www.wur.nl/en/newsarticle/the-world-can-be-fed-with-only-plant-based-food.htm

19. https://en.wikipedia.org/wiki/Greenhouse_gas

20. https://en.wikipedia.org/wiki/Radiative_forcing