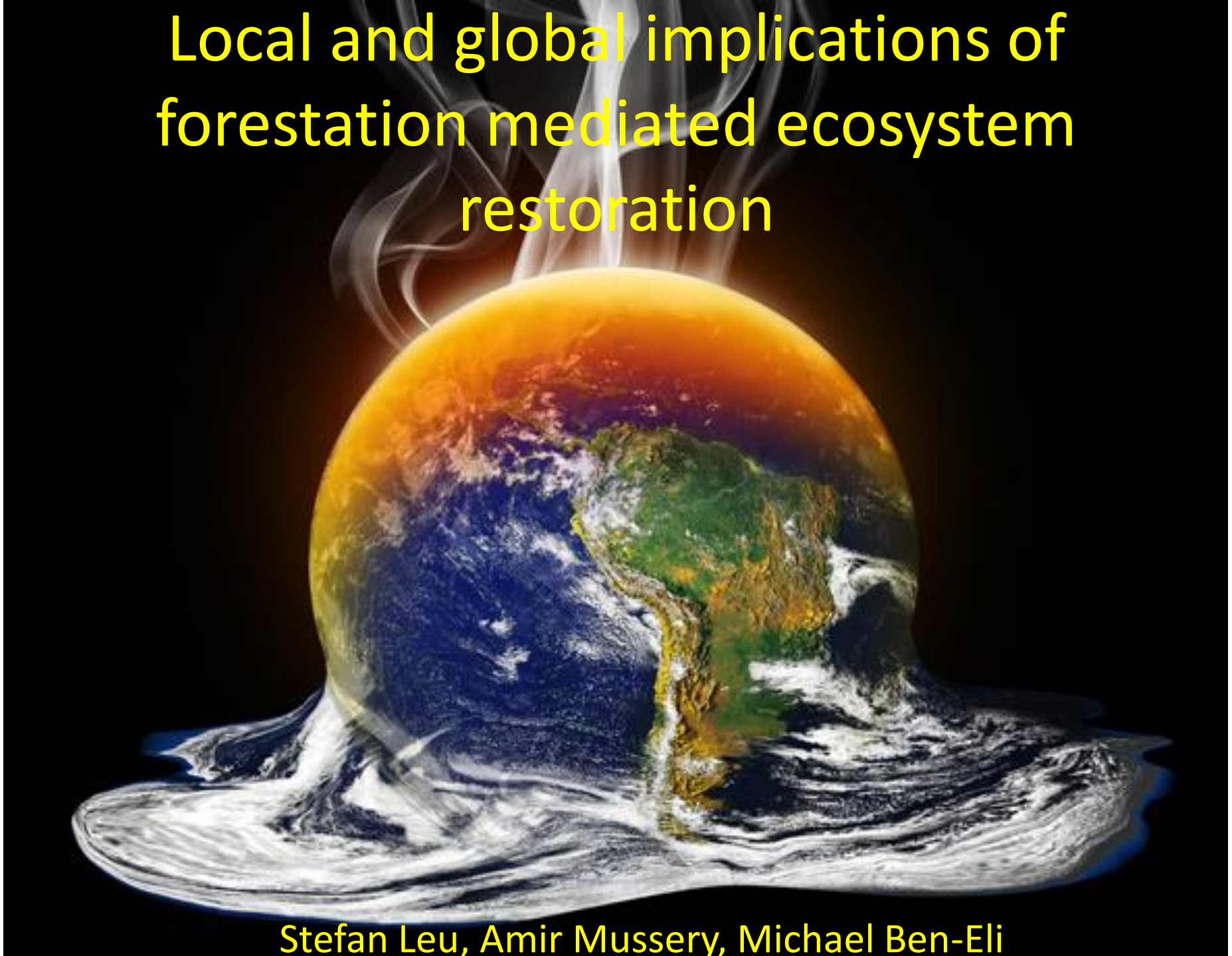
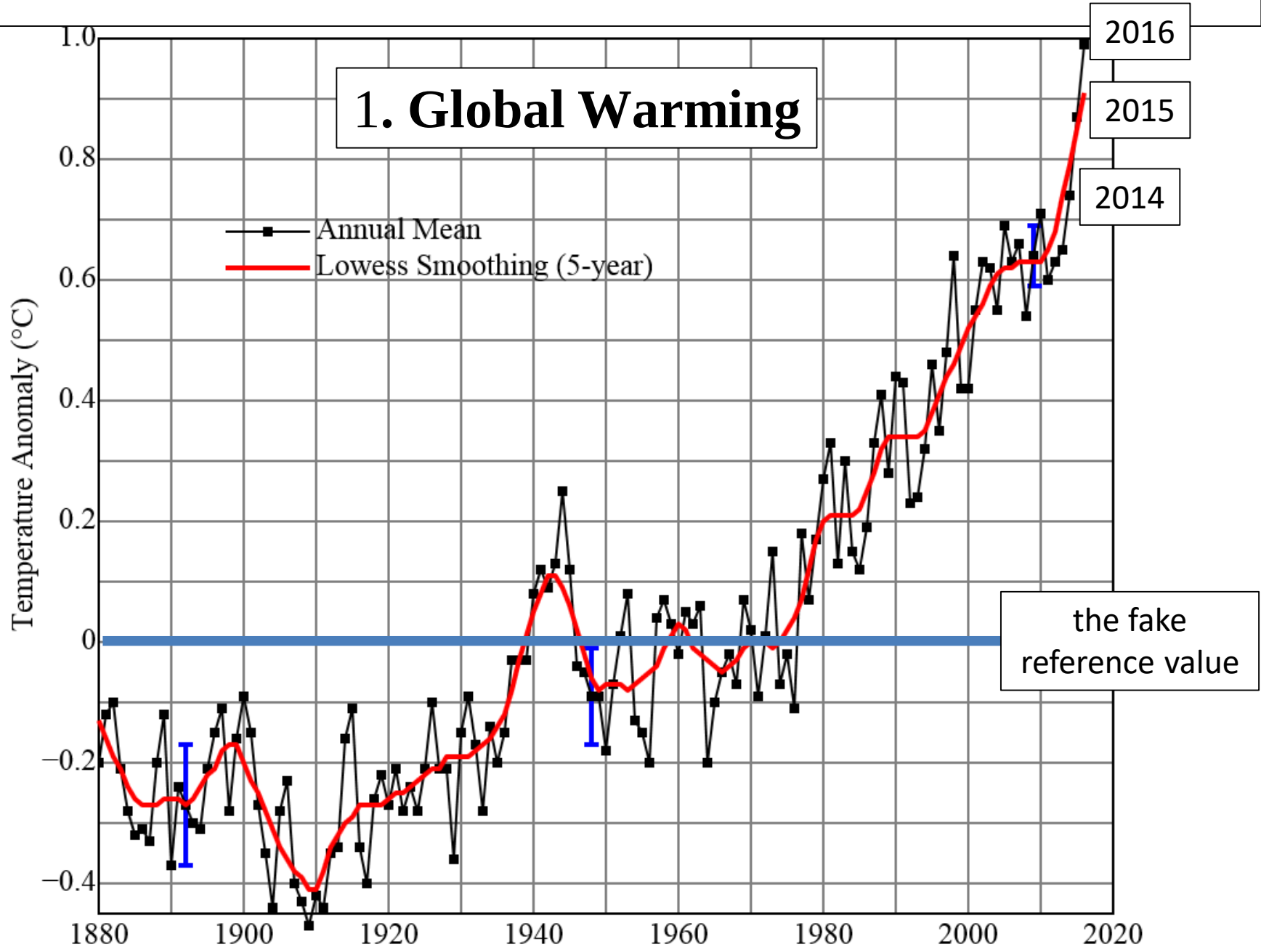
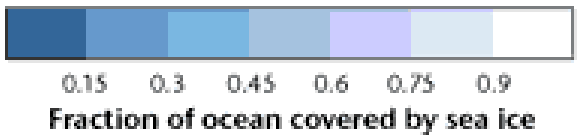
Local and global implications of forestation mediated ecosystem restoration



Stefan Leu, Amir Mussery, Michael Ben-Eli

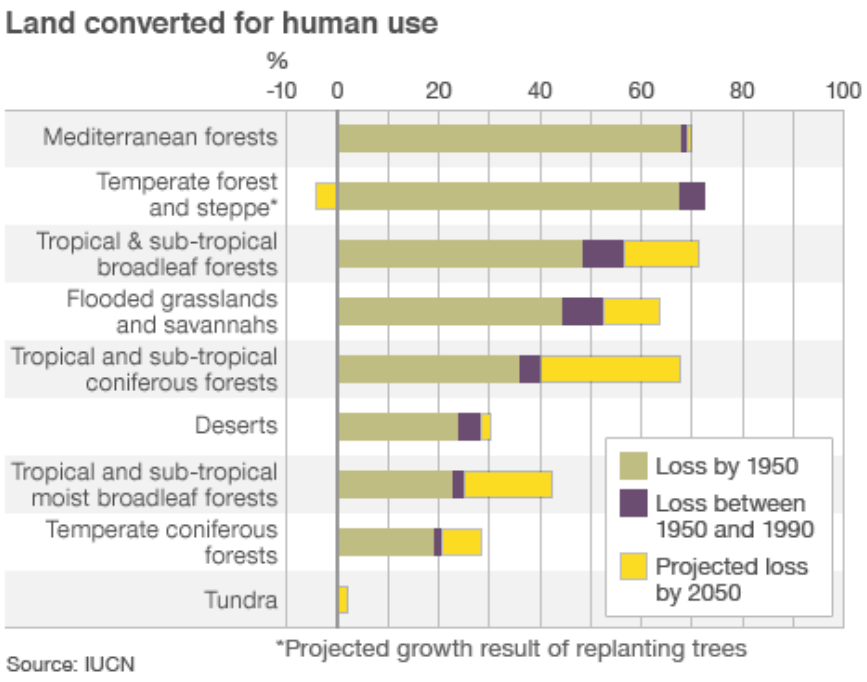
The world is facing two remaining key challenges:

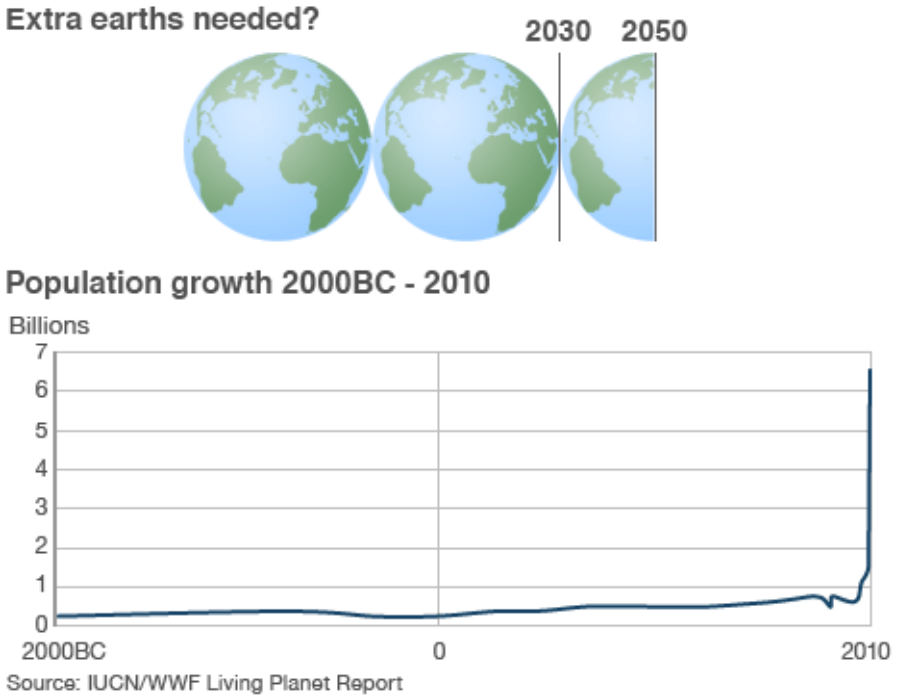




Various positive feedback mechanisms

2. **Ecosystem degradation and biodiversity loss**

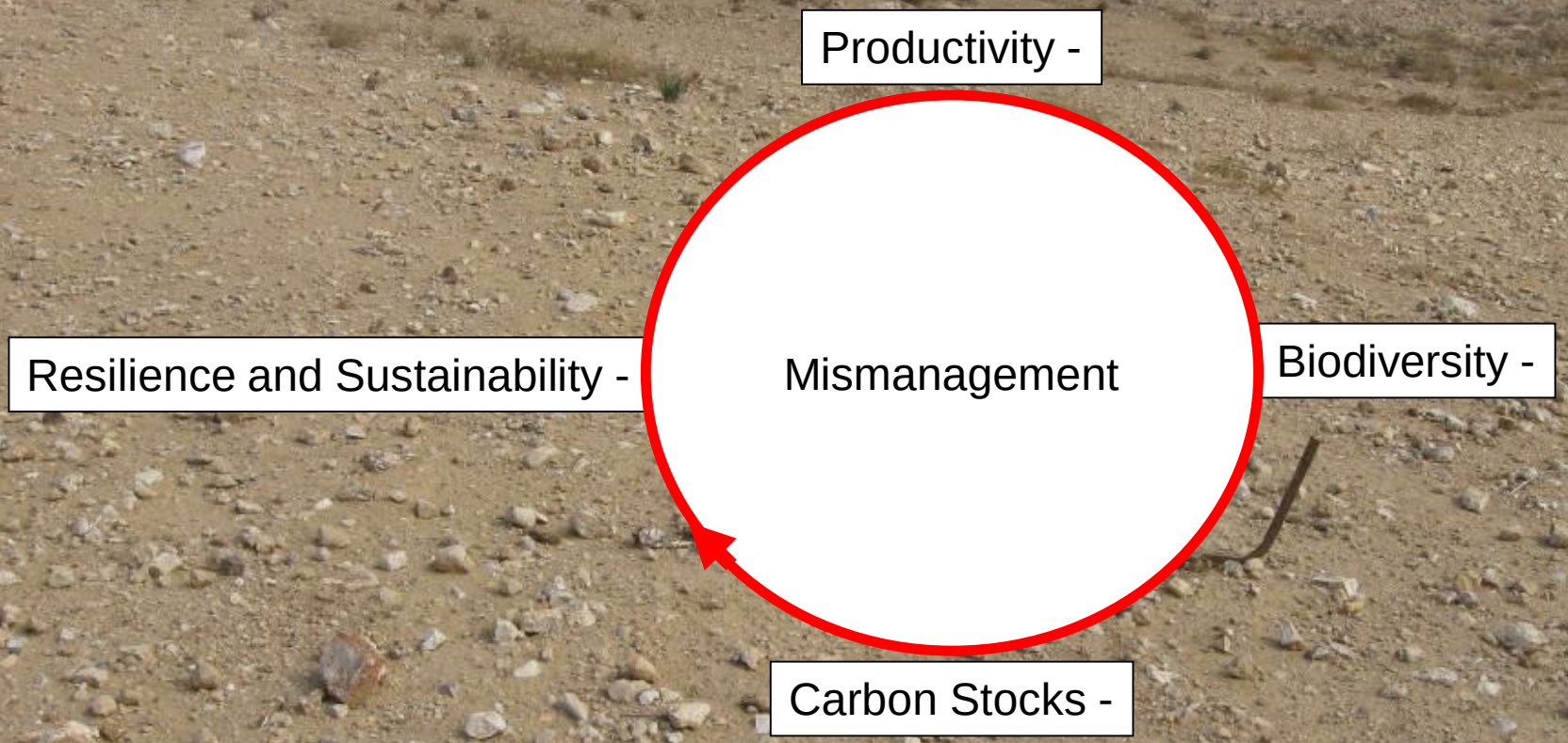




Both challenges are tightly linked:

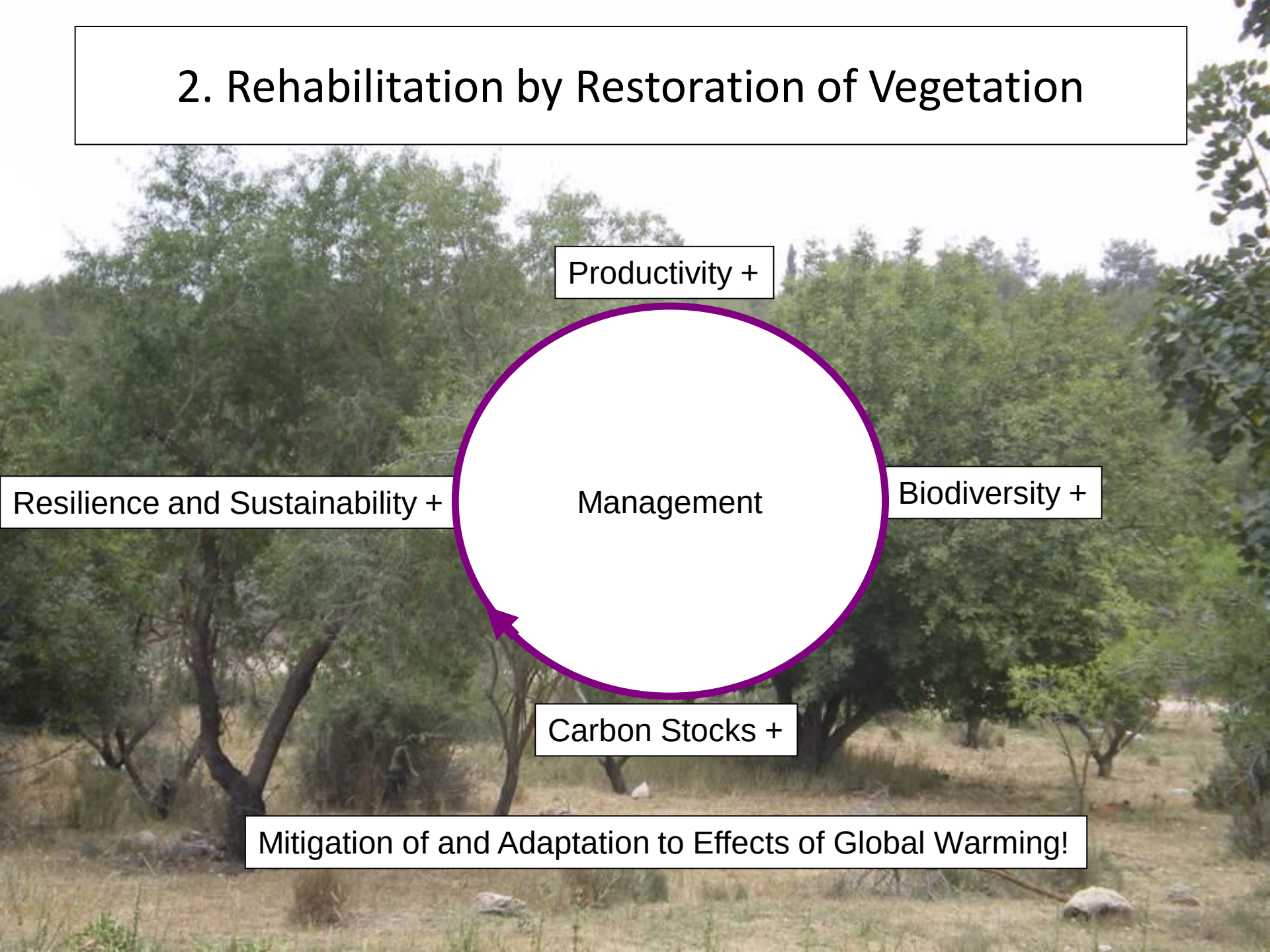
- Degradation increases GHG emissions and reduces ecosystem resilience;
- Restoration sequesters GHG, increases ecosystem resilience and ecosystem services!

1. Land Degradation by Overexploitation



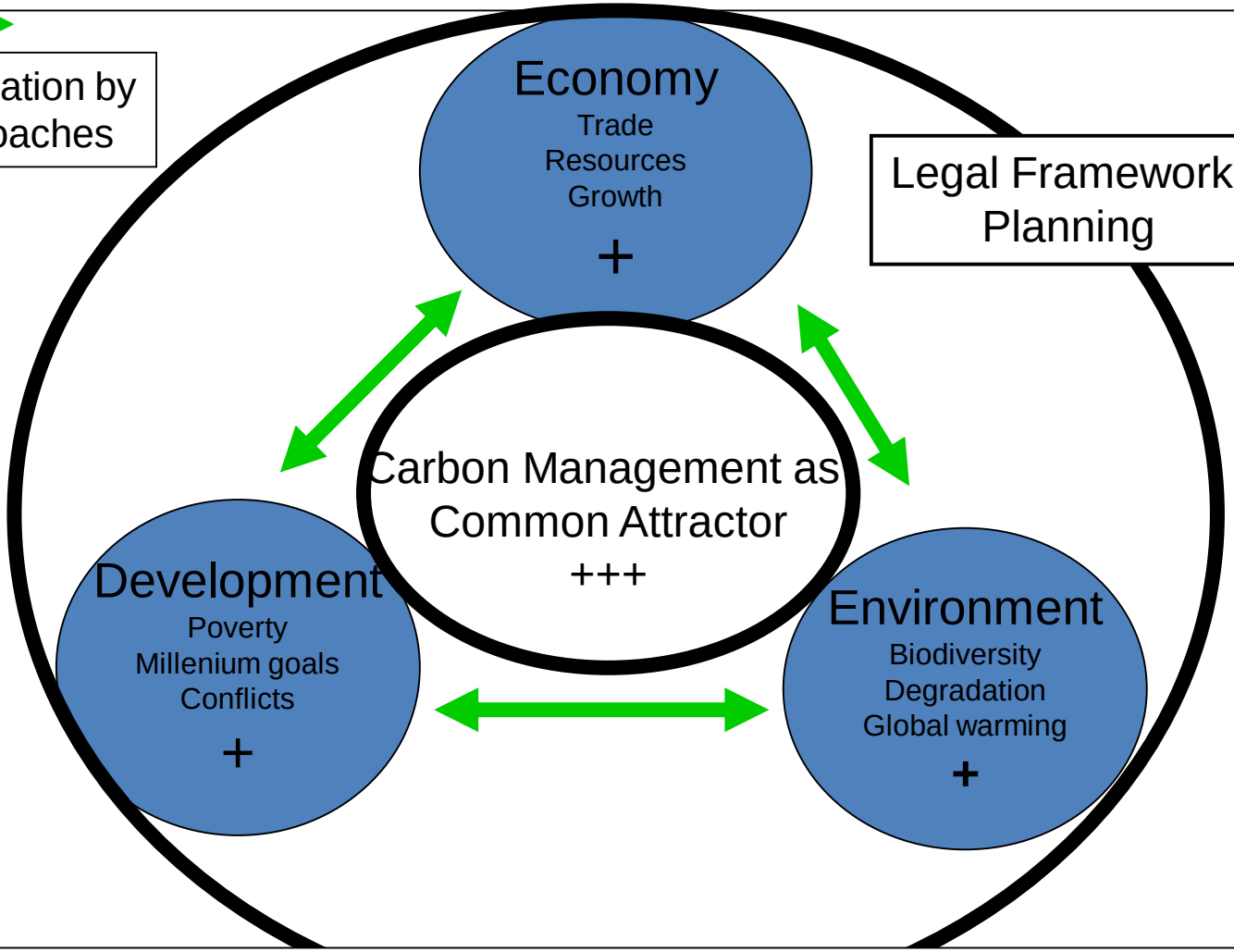
Acceleration of and Sensitization to Effects of Global Warming

2. Rehabilitation by Restoration of Vegetation



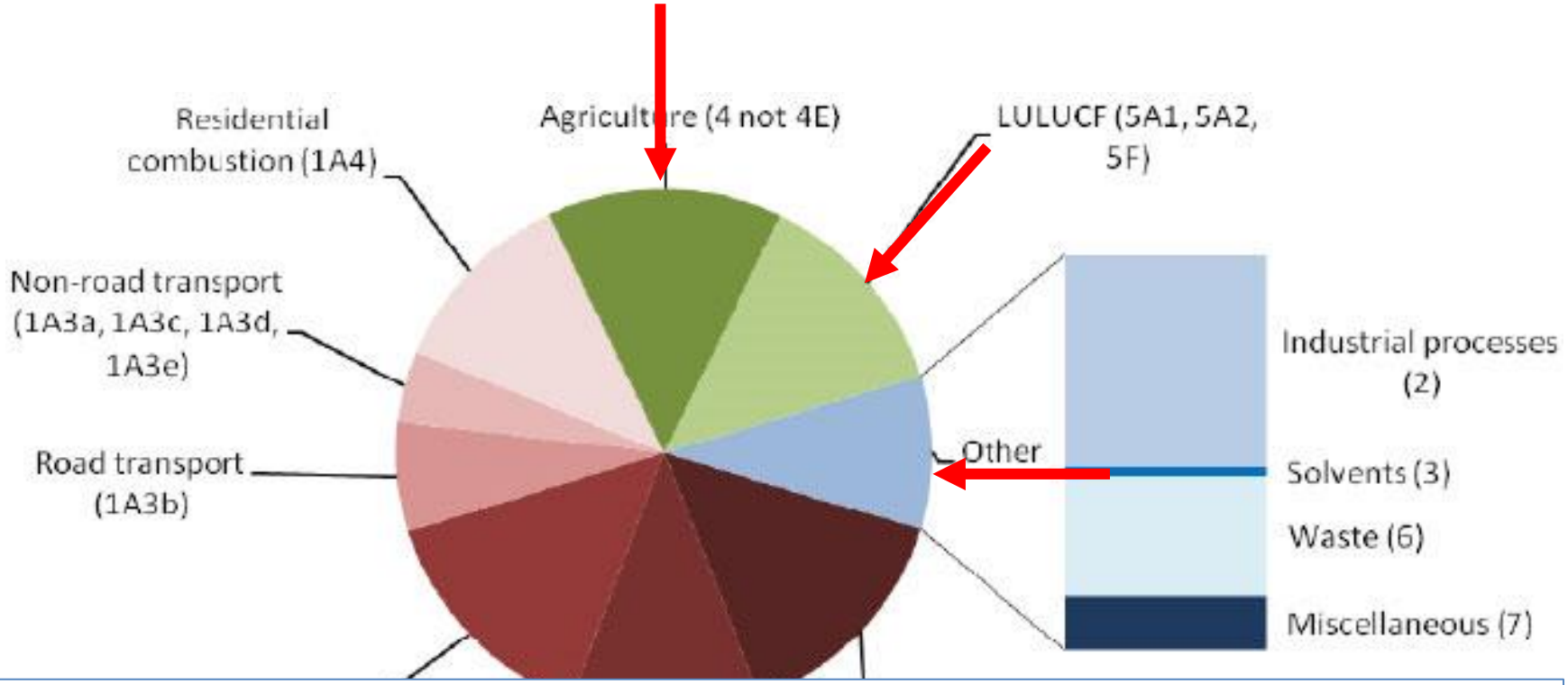
Controlled Market Economy and Carbon Management can Overcome the Incompatibility

Mutual stimulation by win-win approaches



Carbon Emissions Pay for Sustainable Development and Biosphere Conservation or Restoration!!

GHG Emissions by Sector

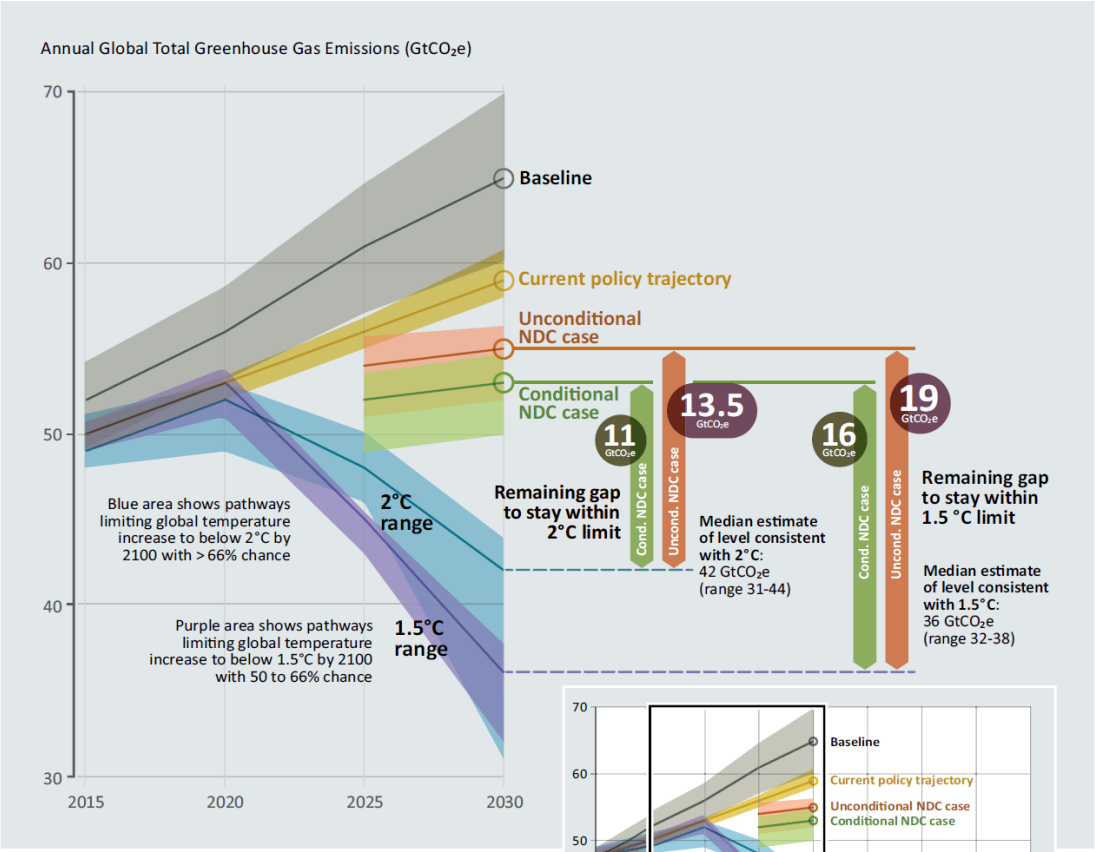


To remember:

Not only fuel burning causes global warming, agriculture and food production are as important;

The “Emissions Gap” and agriculture

Figure ES.2: Global greenhouse gas emissions under different scenarios and the emissions gap in 2030 (median estimate and 10th to 90th percentile range).



Note: the emissions range for 1.5°C is smaller than for 2°C, as a smaller number of studies for 1.5°C are available. For current policy, the minimum–maximum across all assessed studies are provided.

The situation is grave: another 16 – 19 tons of CO2eq emissions per year need to be saved to keep warming at an acceptable 1.5 °C

Carbon sequestration into soils and biomass-the only option!

- 3 bln hectares degraded drylands times 5 tons per ha year;
- 2 bln ha degraded farmlands times 2.5 tons per ha year;
- 2 bln ha degraded forests times 5 tons per ha year;

at least 25 bln tons per year achievable!

That's as clear today

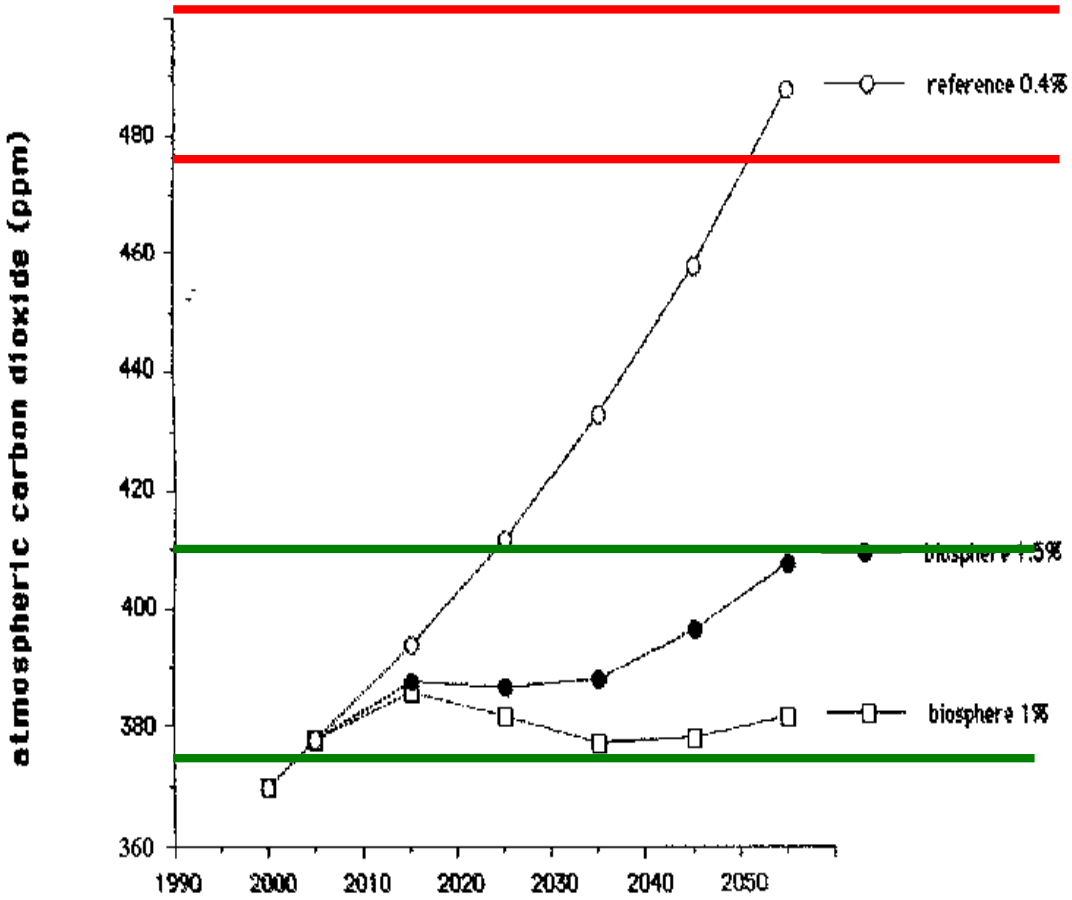
13. Carbon dioxide removal from the atmosphere can provide an additional mitigation element to conventional emission abatement strategies. Biological CO_2 removal through afforestation, reforestation, forest management, restoration of degraded lands, soil carbon enhancement and biochar application in agriculture can play an immediate role, and can also significantly contribute to achieving several other Sustainable Development Goals.

Forests and Carbon Dioxide

Stefan Leu

As it was 30 years ago
(Leu 1987)

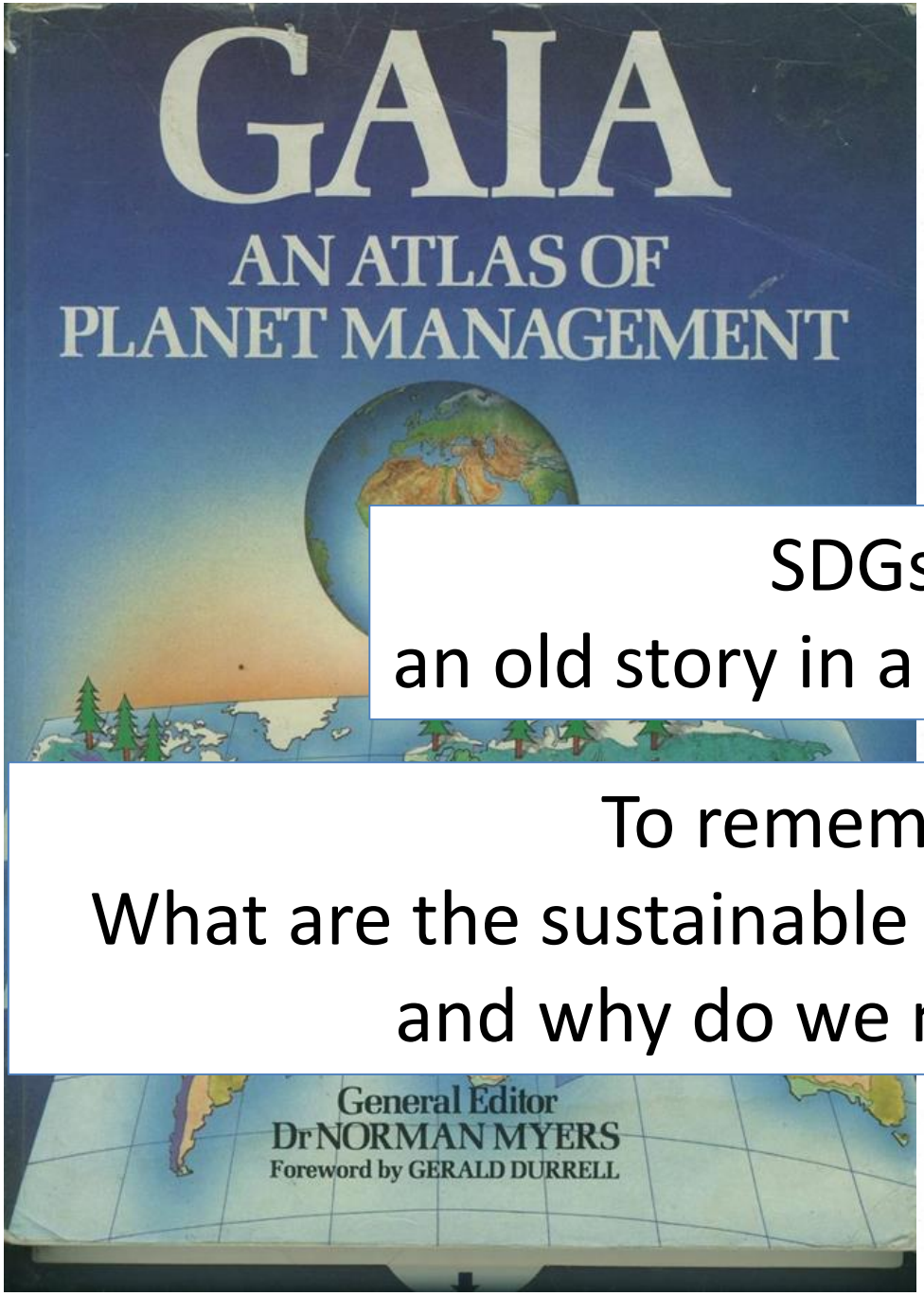
THE SOLUTION: Carbon sequestration into biomass and soil!



Atmospheric Carbon Dioxide Concentration under Current Trends

Atmospheric Carbon Dioxide Concentration with Biosphere Rehabilitation Program

As it was 30 years ago (Leu 1987)



SUSTAINABLE DEVELOPMENT GOALS

1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
16 PEACE AND JUSTICE
17 PARTNERSHIPS FOR THE GOALS

SDGs:
an old story in a new disguise

To remember:
What are the sustainable development goals'
and why do we need them

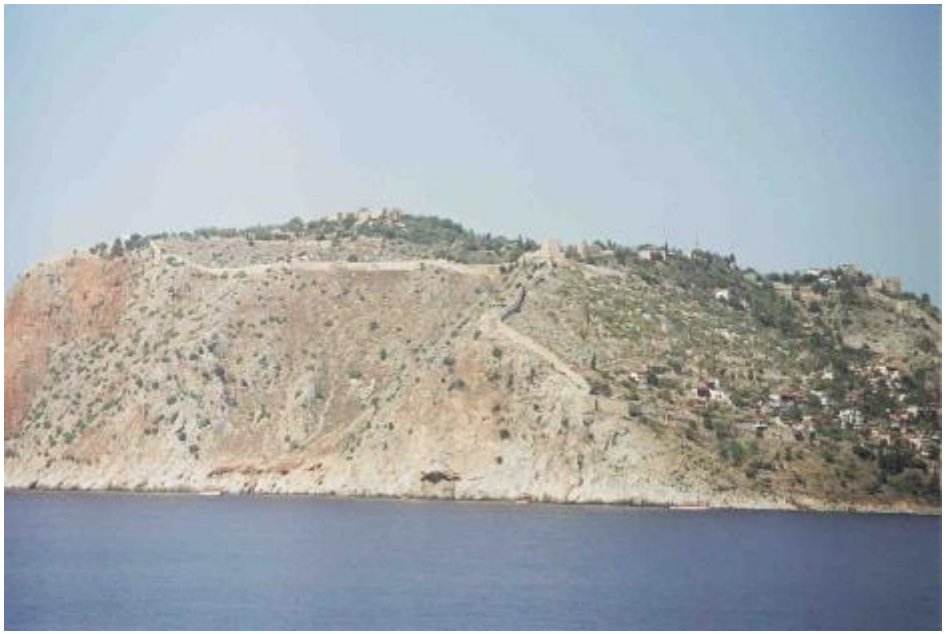
Desertification control in Israel: We live in the most degraded location on earth

Degree and extend of degradation are much more dramatic than we are willing to recognize

Critias: «Soil has been carried to the bottom of the sea.. Earthy high mountains, that in the past carried tall forest and large pastures, have become rocky lands and look like the bones of a sick body... In the past rain water was utilized and did not run on the barren land to the sea as it does now. It infiltrated and stored into the soil and it was distributed in springs, fountains and river streams .«

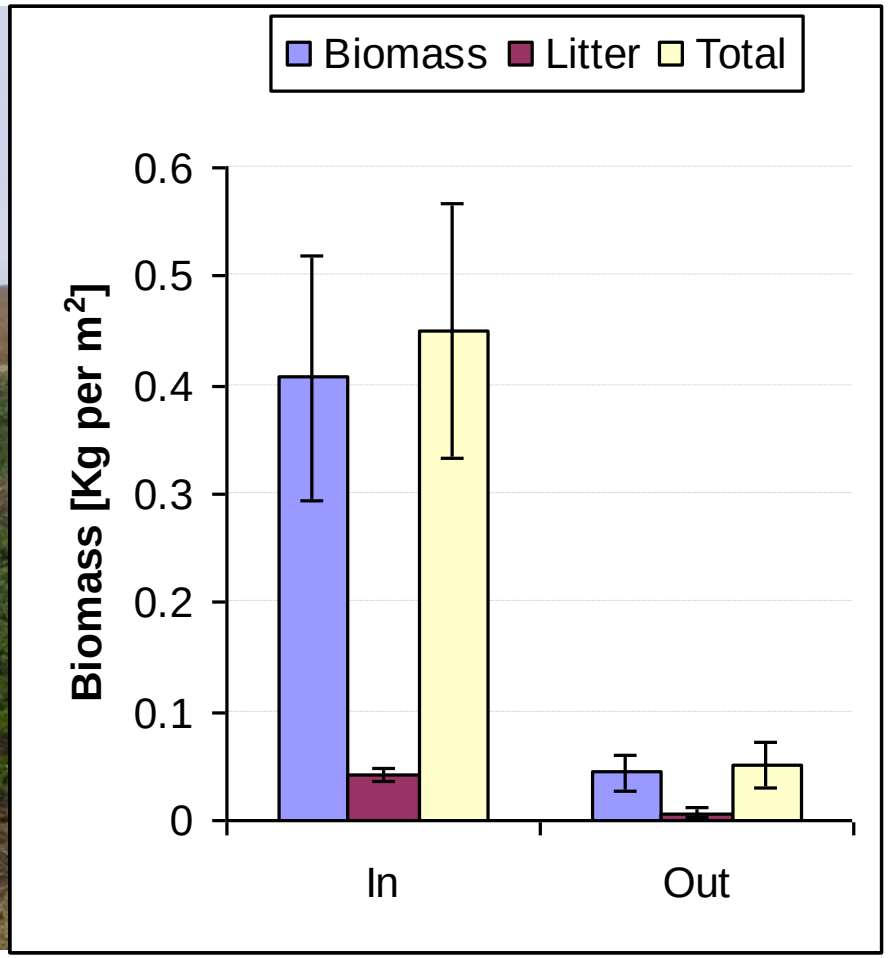
Plato

(427-347 BCE)



Historic Degradation: Mediterranean Coast: 90% degraded

First you need to know the true rain-fed productivity; 10 fold higher productivity in restored plot



An area covered by manure (right) displayed maximum productivity, in contrast to the exposed soil to the left, 200 mm pa precipitation.

Naturally restored litter layer (15 years without grazing)

Decomposing Litter – Compost – Soil - Continuum:
automatic precipitation controlled slow release fertilizer!!

Much higher carbon sequestration, biomass productivity, and carbon sequestration in *Acacia* woodland

24 years old *Acacia victoria* woodland near Yattir farm (22. 3. 2016):

~ 2-10 t per ha and year annual vegetation;
~ 2 tons per ha and year tree litter (edible);
~ 1 ton per ha and year woody biomass;
~ 4 tons per ha and year CO_2 sequestration;
Supports 2 goats per ha sustainably;

RICH ANIMAL AND PLANT LIFE!

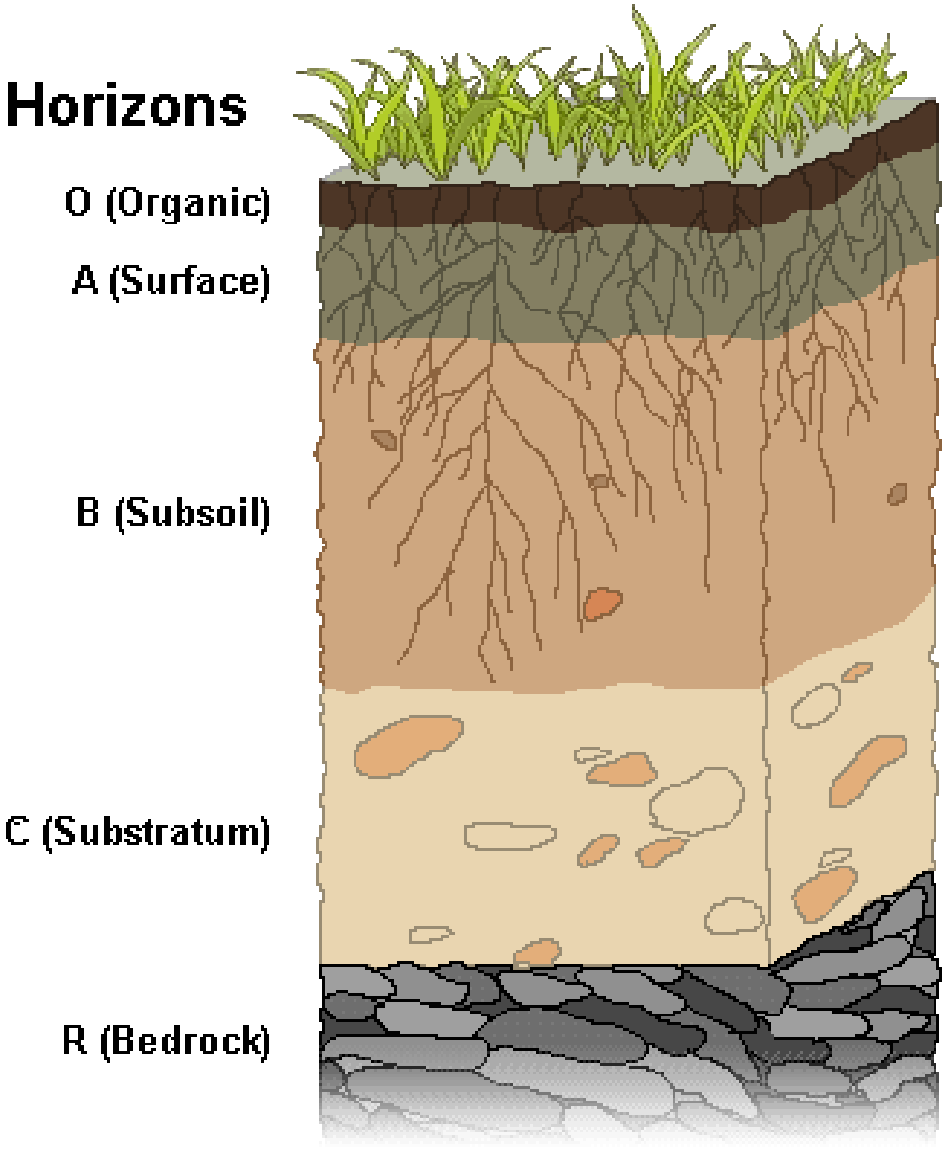
At 220 mm mean Annual Precipitation

Degraded land nearby (23.3.2016):

~ 0.5 -1t per ha and year annual vegetation
No plant litter!
No woody biomass!
No CO_2 sequestration!
Supports 0.2 goats per ha

NEGLIGIBLE ANIMAL LIFE!

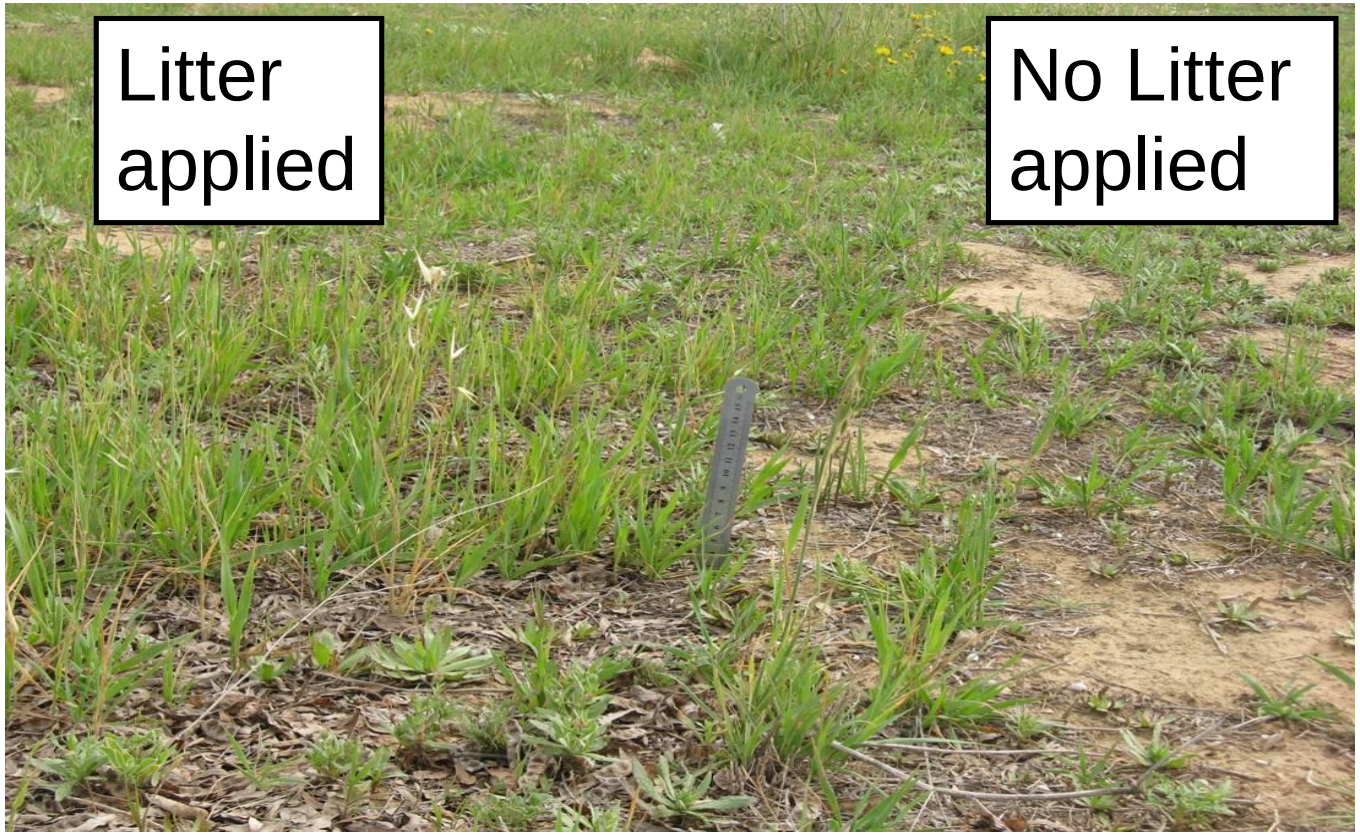
It’s all well known



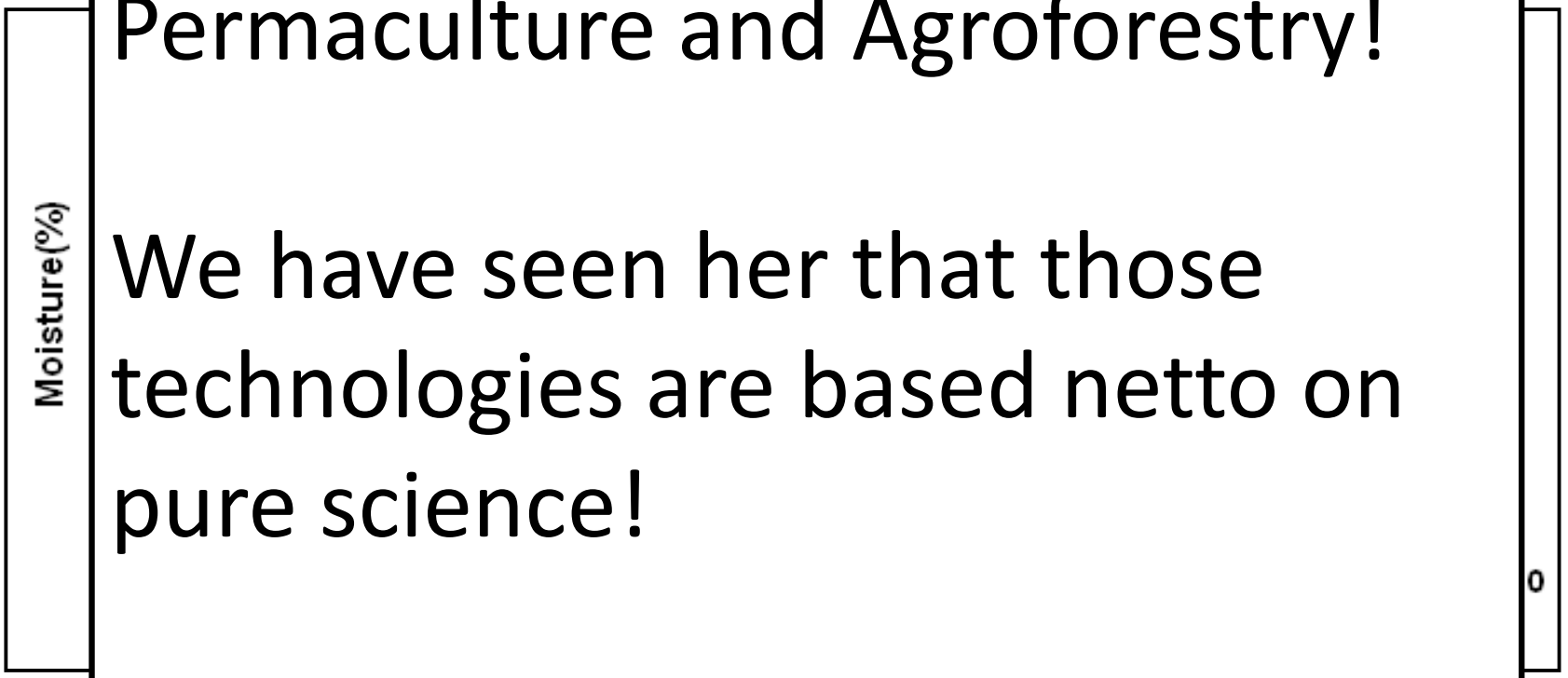
Main conclusion:
Semi-arid/arid soil without O-Horizon is degraded; restoring O-horizon restores productivity

Fig. 1: Express soil and productivity restoration at Project Wadi Attir: the green, highly productive area in the middle was created by over-laying of excess compost in 2013. The good 2014/15 winter rains transformed this area into a highly productive mixed grass-land, while the control areas in front and in the back remain essentially unproductive

Restoration of Degraded Grassland by Litter Application at Moshav Maslul



Much better water conservation!

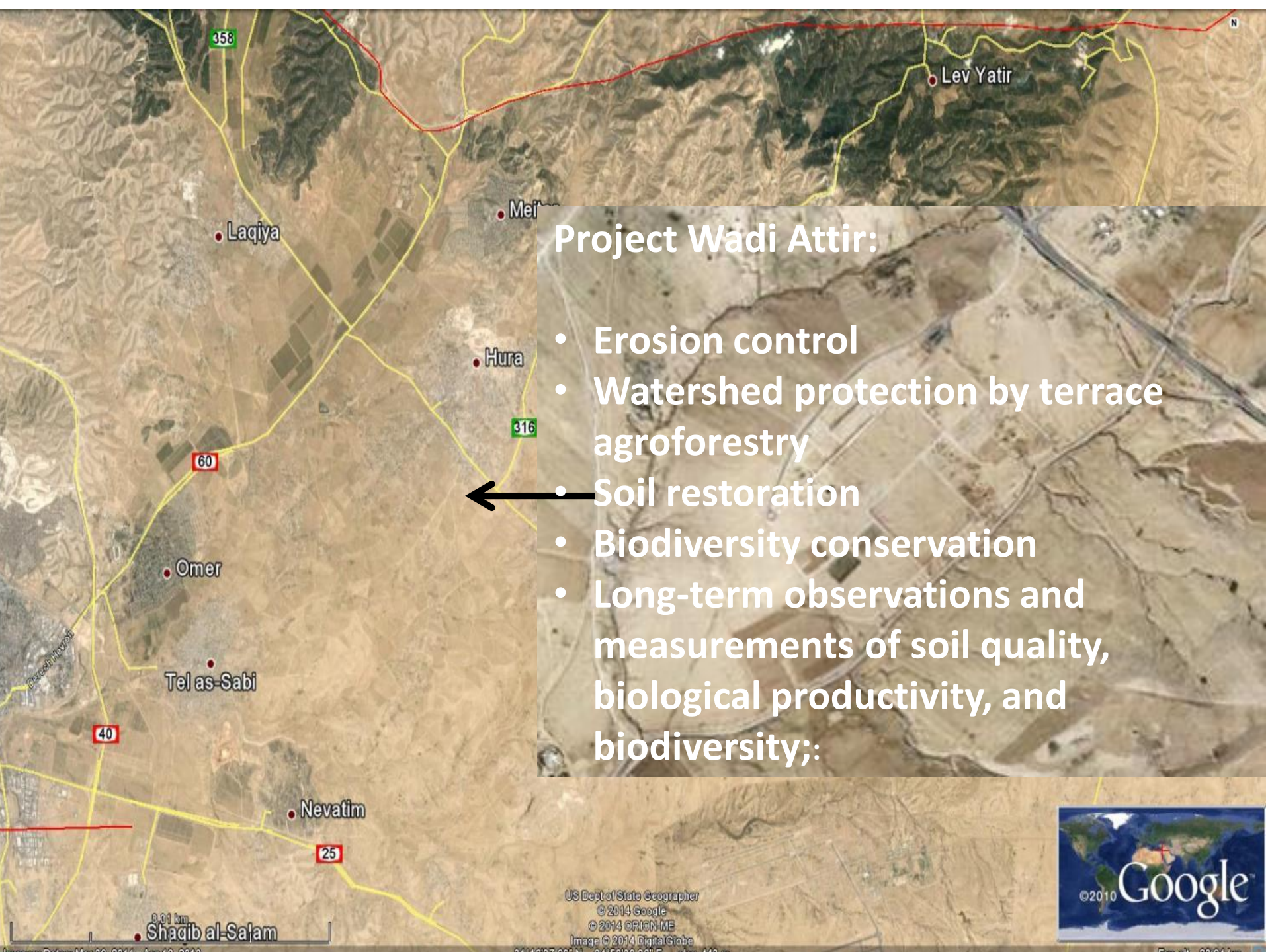


Those are exactly the principles of Permaculture and Agroforestry!

We have seen her that those technologies are based netto on pure science!

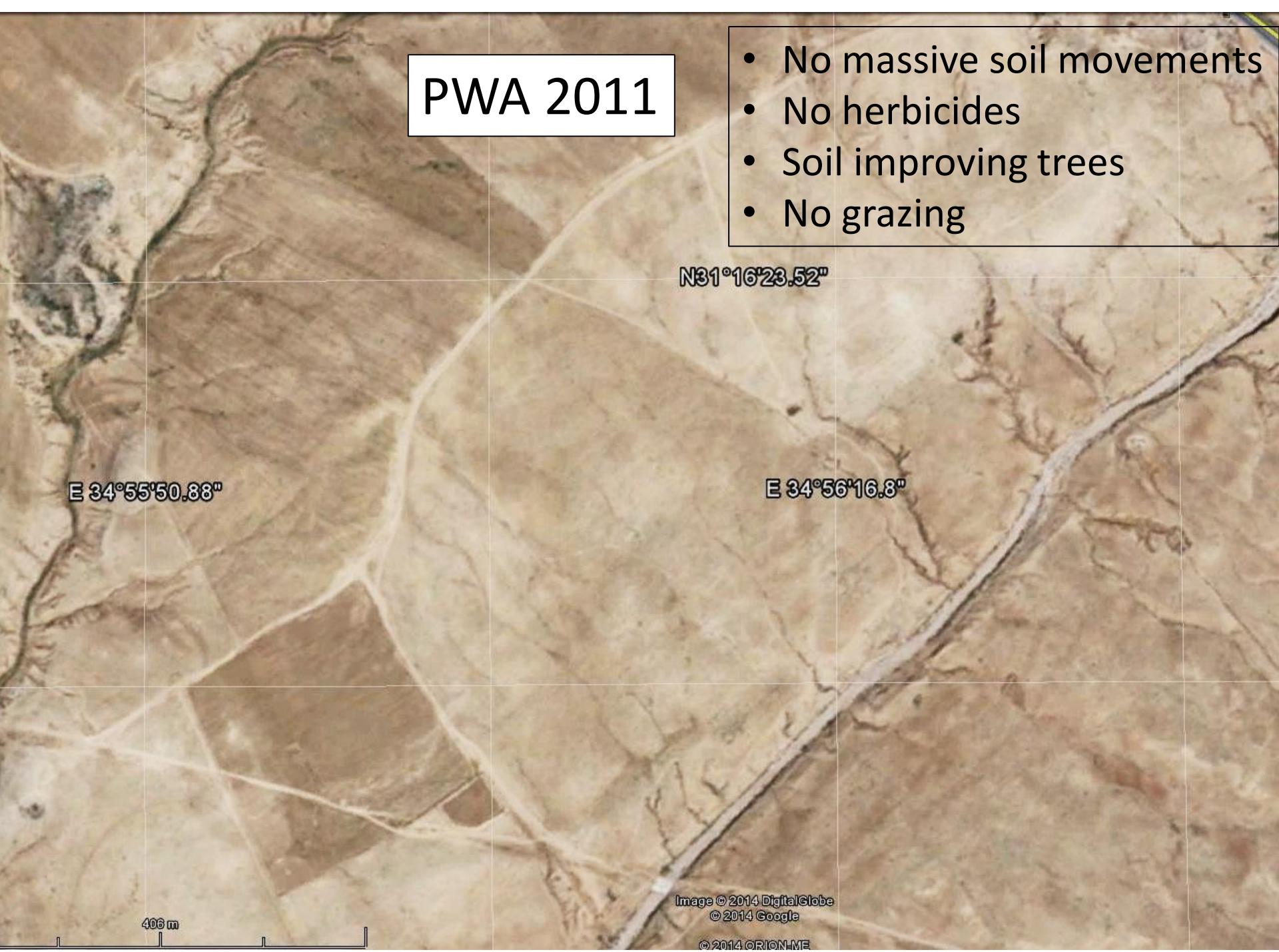
Everybody can measure and confirm that

- *Ac* nt of
- Pa r water infiltration reduce transpiration losses.



Project Wadi Attir:

- Erosion control
- Watershed protection by terrace agroforestry
- Soil restoration
- Biodiversity conservation
- Long-term observations and measurements of soil quality, biological productivity, and biodiversity;:


PWA 2011
No massive soil movements
No herbicides
Soil improving trees
No grazing
N31°16'23.52"
E 34°55'50.88"
E 34°56'16.8"
406 m
Image © 2014 DigitalGlobe
© 2014 Google
© 2014 ORION-ME

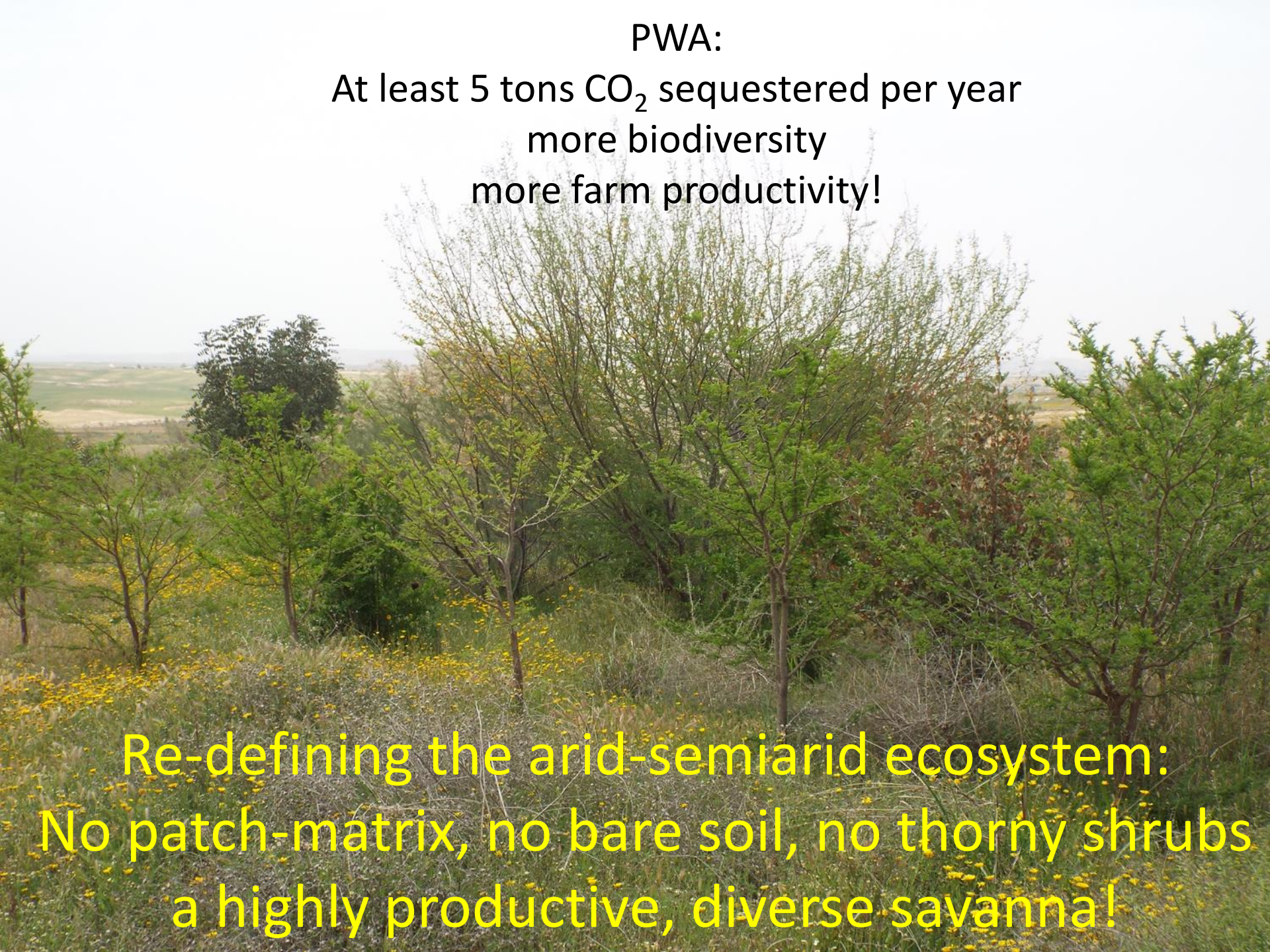

March 2012

Watershed protection and ecosystem restoration for rehabilitation of degraded arid agro-ecosystems, using savanna trees

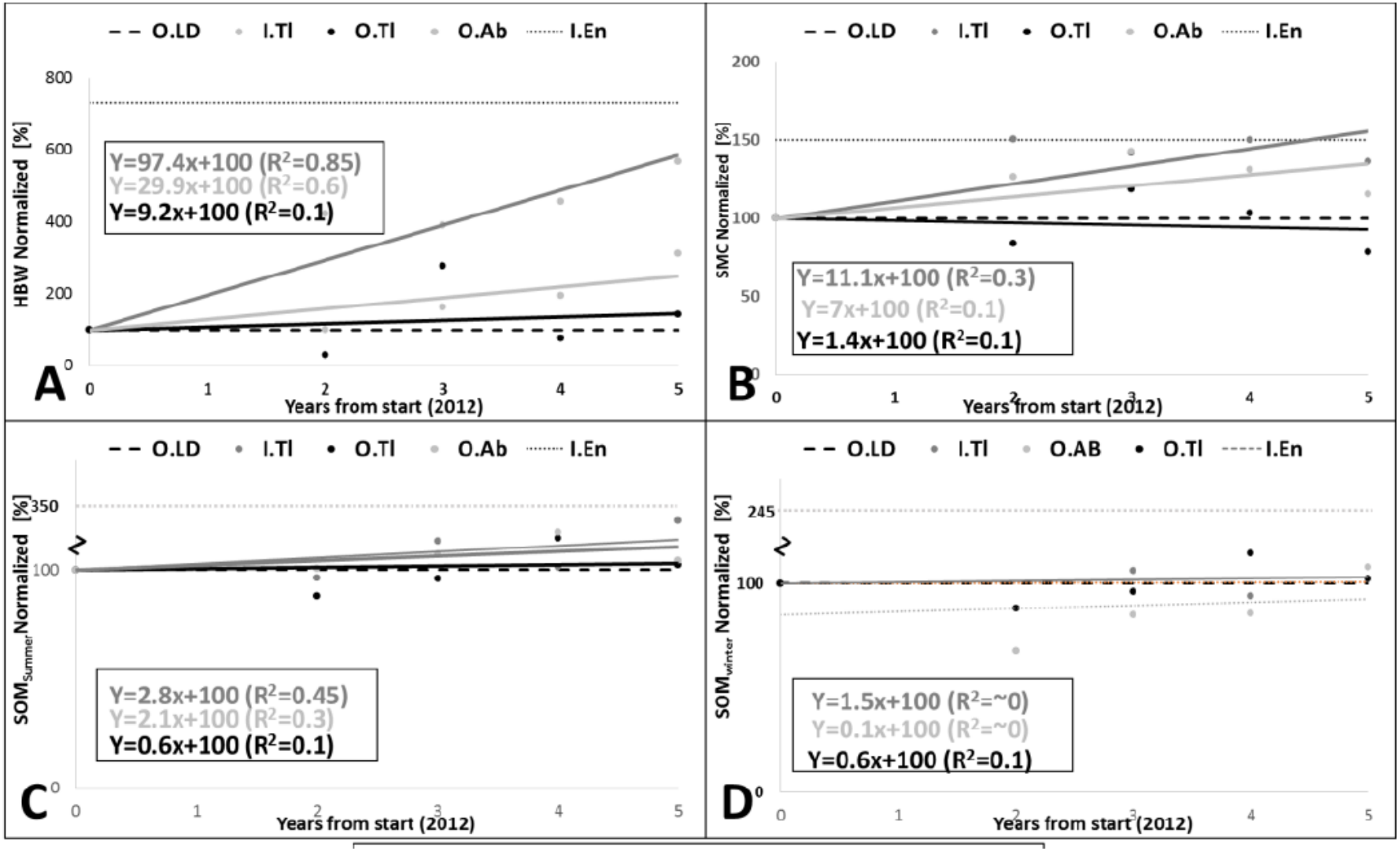
E 34°56'16.8"

A degraded eroding waste land

Transformed into a productive diverse agroforestry woodland within 4 years.


PWA:
At least 5 tons CO_2 sequestered per year
more biodiversity
more farm productivity!
Re-defining the arid-semiarid ecosystem:
No patch-matrix, no bare soil, no thorny shrubs
a highly productive, diverse savanna!

Impact of conservation on key soil properties



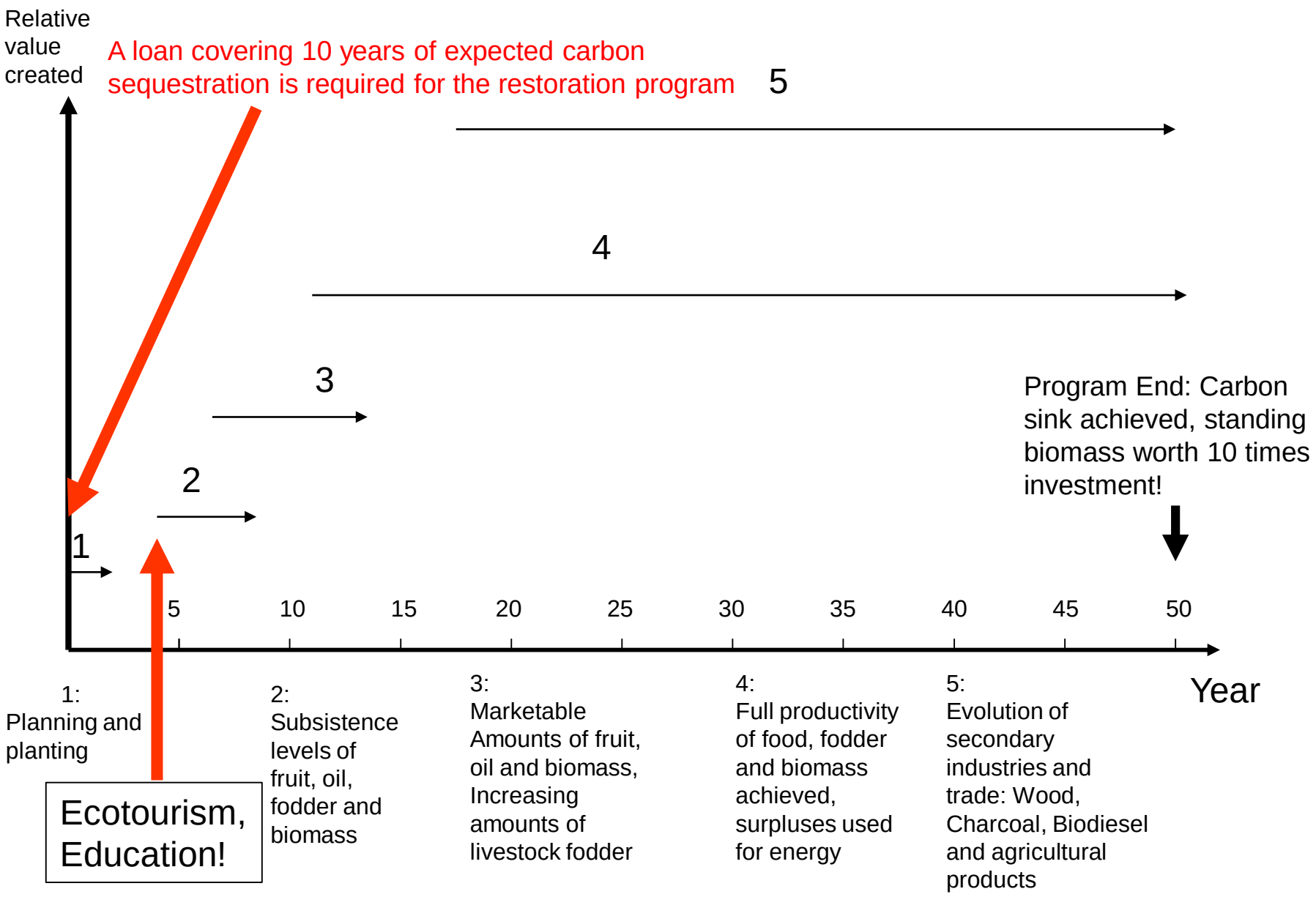
Scientific Conclusions

1. Five years of conservation from grazing increased the pasture amounts of PWA lands by 3-5 folds compared to the common cultivation.
2. The use of reference plots for monitoring rehabilitation changes is adequate for long time monitoring of cultivated arid areas
3. The harvester ants' activity has highly positive influence on cultivated areas rehabilitation state.
4. Adequate cultivated and planted limans can increase the areas fertility fivefold compared to the common use, stabilized and rehabilitate the whole landform fertility and geomorphology.
5. Five years of conservation also enriched dramatically the vegetal and faunal biodiversity (www.sustainabilitylabs.org/ecosystem-restoration/biodiversity/?lang=en).
6. Five years of conservation enriched the nutrients content of the root zone layer.
7. Five years of conservation induced massive sequestration of the greenhouse gas CO_2 into SOM, at a rate of around 5 tons per hectare and year, not counting growth of trees and other perennial vegetation.

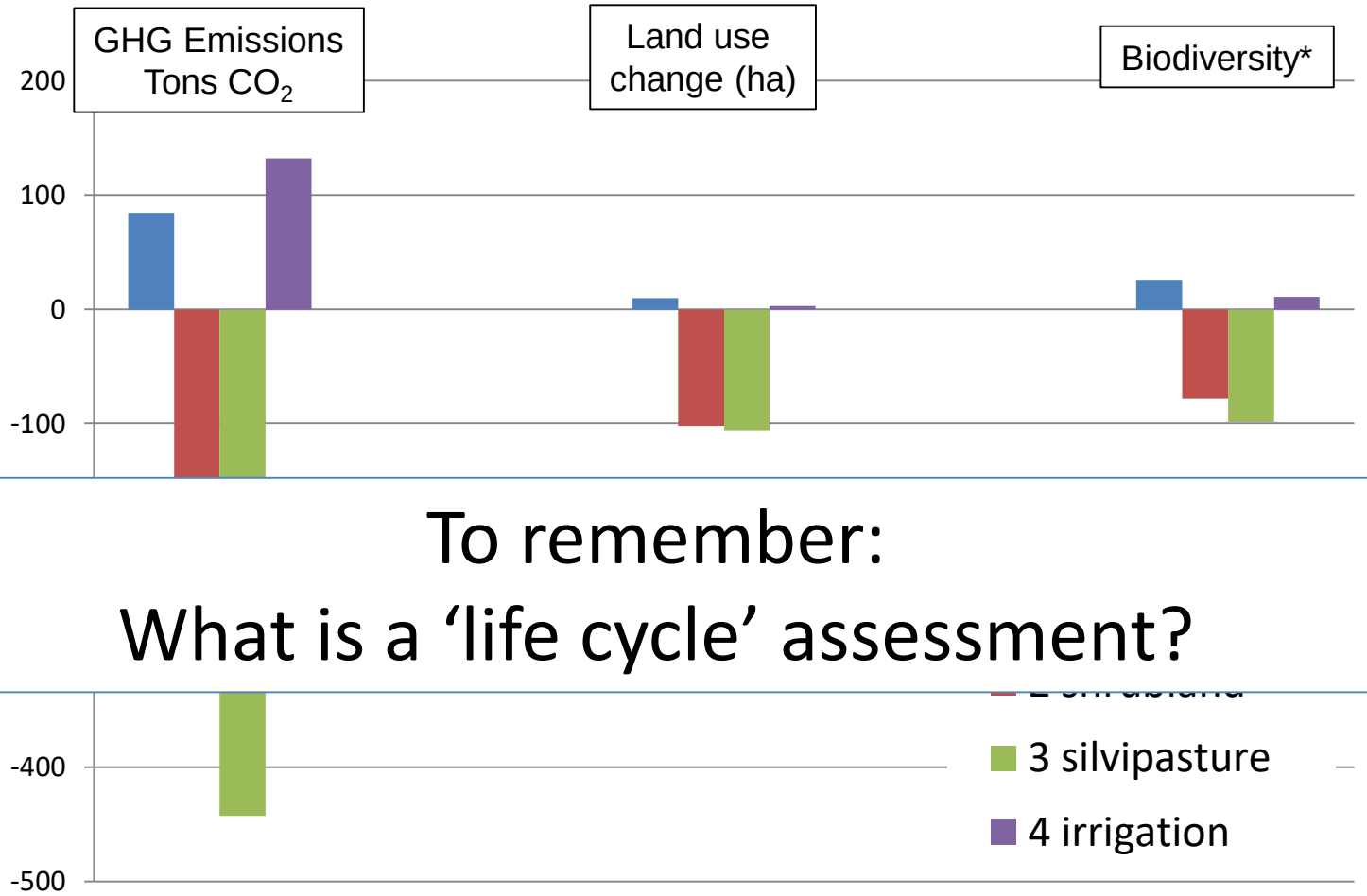
All Sustainable Development Goals addressed!

All Environmental UN Conventions satisfied!

Business development according to plan



LCA Impact of four Farming Approaches

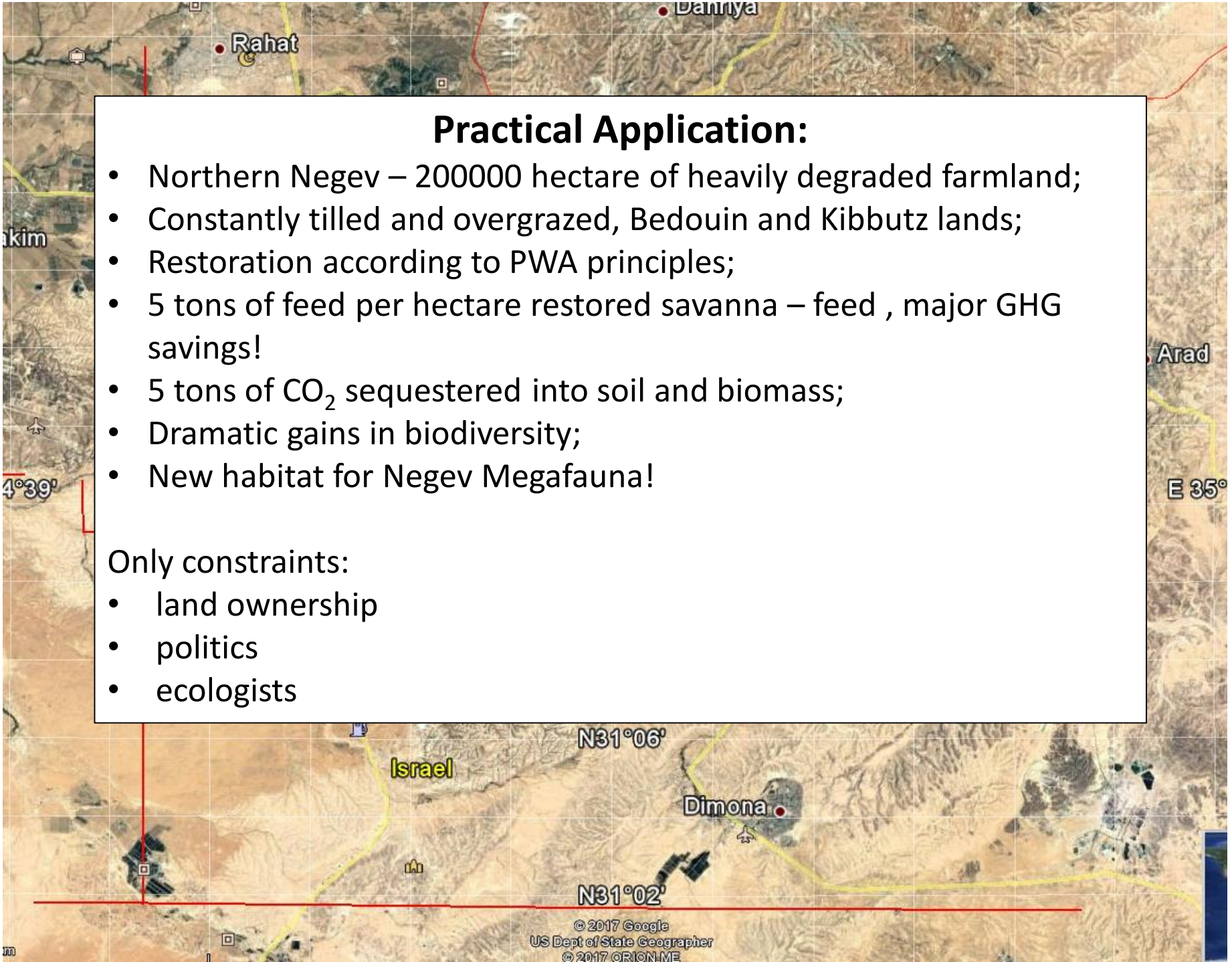


To remember:

What is a 'life cycle' assessment?

By Convention: Positive means a negative environmental impact

Thus negative numbers mean a positive environmental impact



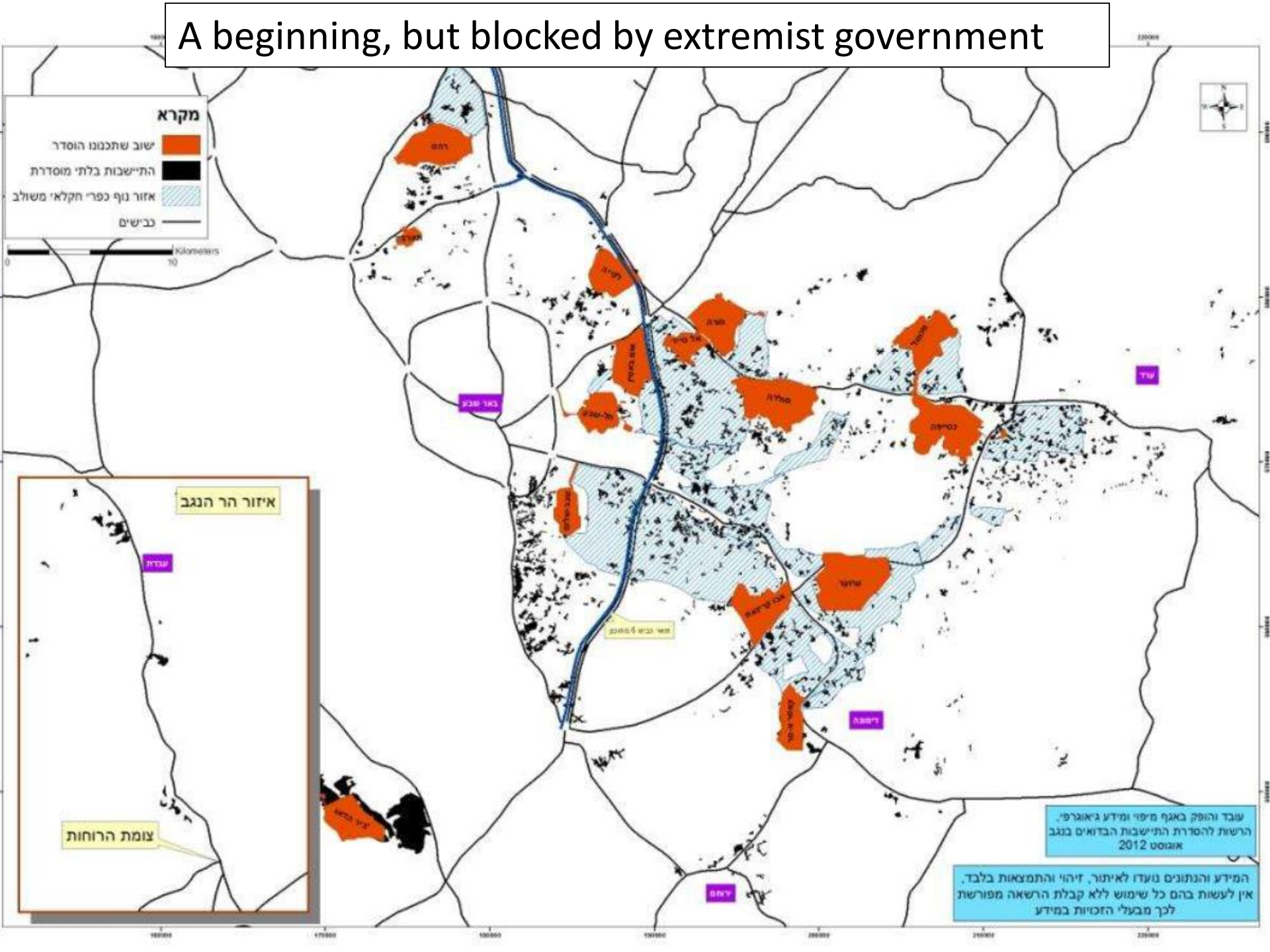
Practical Application:

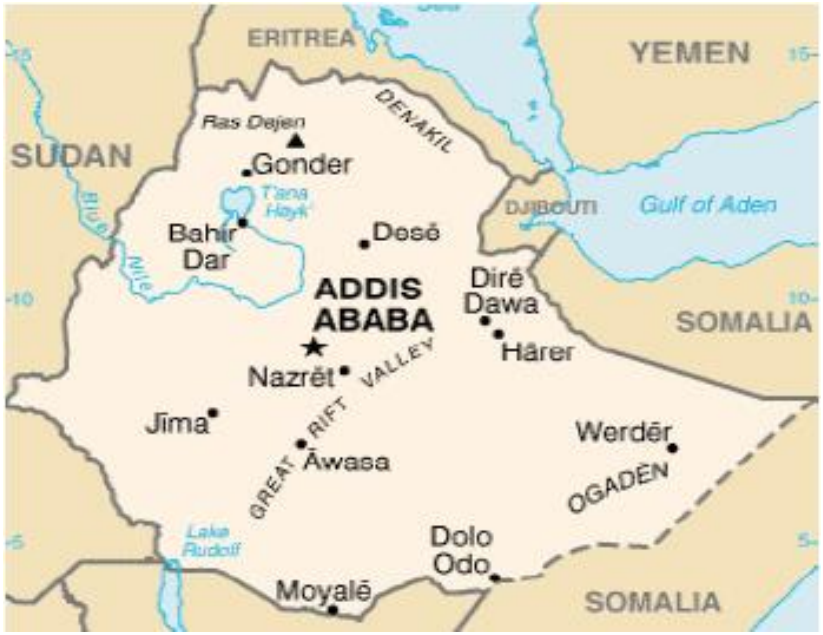
- Northern Negev – 200000 hectare of heavily degraded farmland;
- Constantly tilled and overgrazed, Bedouin and Kibbutz lands;
- Restoration according to PWA principles;
- 5 tons of feed per hectare restored savanna – feed , major GHG savings!
- 5 tons of CO_2 sequestered into soil and biomass;
- Dramatic gains in biodiversity;
- New habitat for Negev Megafauna!

Only constraints:

- land ownership
- politics
- ecologists

A beginning, but blocked by extremist government





GDP (US$ billion; 2005)[1]:	US$11.2
Population (million; 2005):	71.3
Population living on less than $2/day (%)[2]	77.8
Land Area (1,000 sq km)	1.000
Agricultural land (percentage of total land area, 2005):	32

<u>Afforestation Plan</u>:

20 mio ha times 10 t CO_2 per ha per year = 200 mio tons per year.

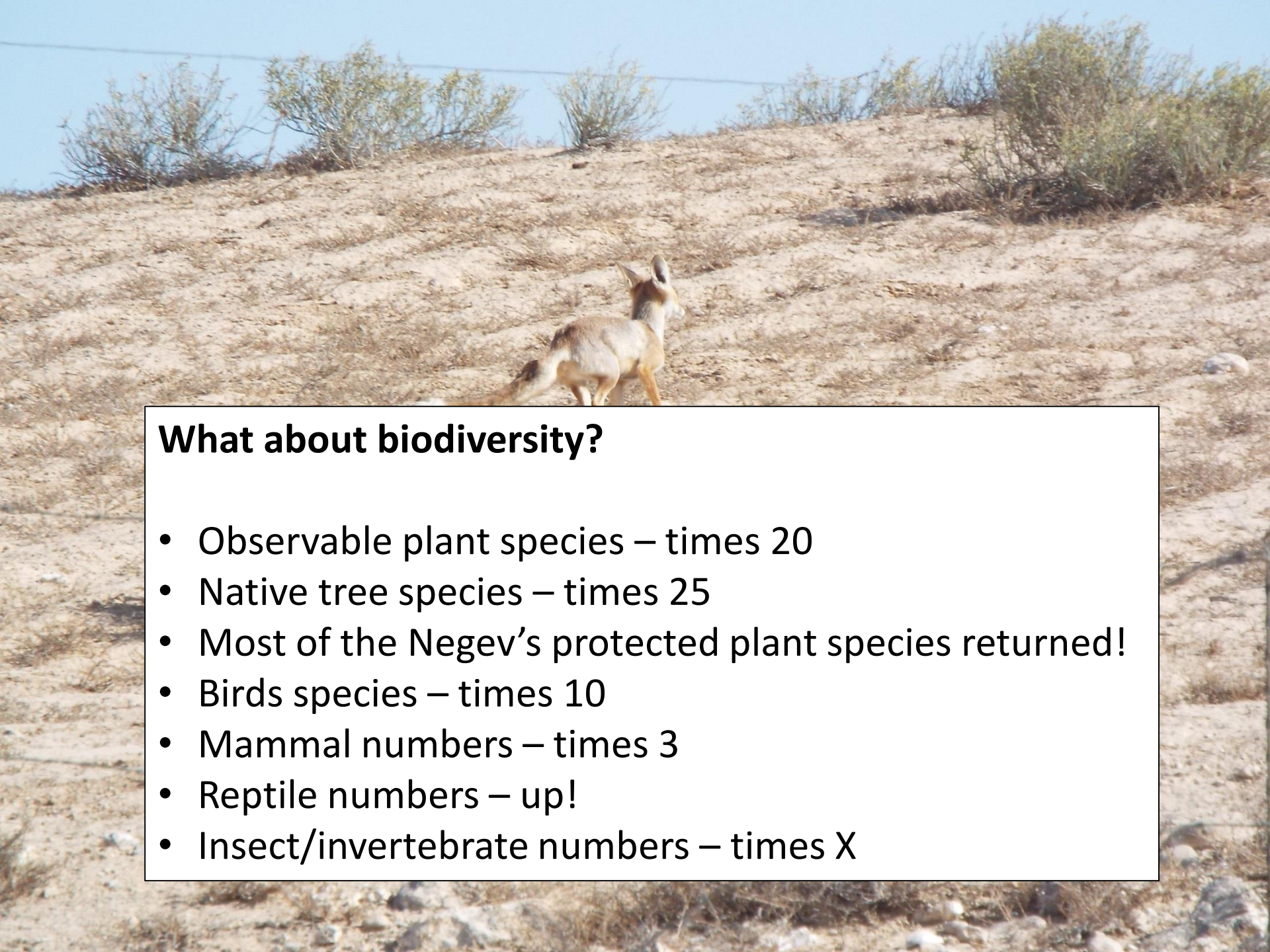
Times $ 15 per ton = 3 bln $ per year;

30 % of GNP

AND:
Flood and drought control;
Sustainable Renewable Energy;
Food and Fodder;
Restoration of Biodiversity (African Megafauna)
Ecotourism

<u>Management Demands:</u>

1. Land Management
2. Restoration of native vegetation;
3. High value wood, food and energy plants;
4. High value agroforestry;



What about biodiversity?

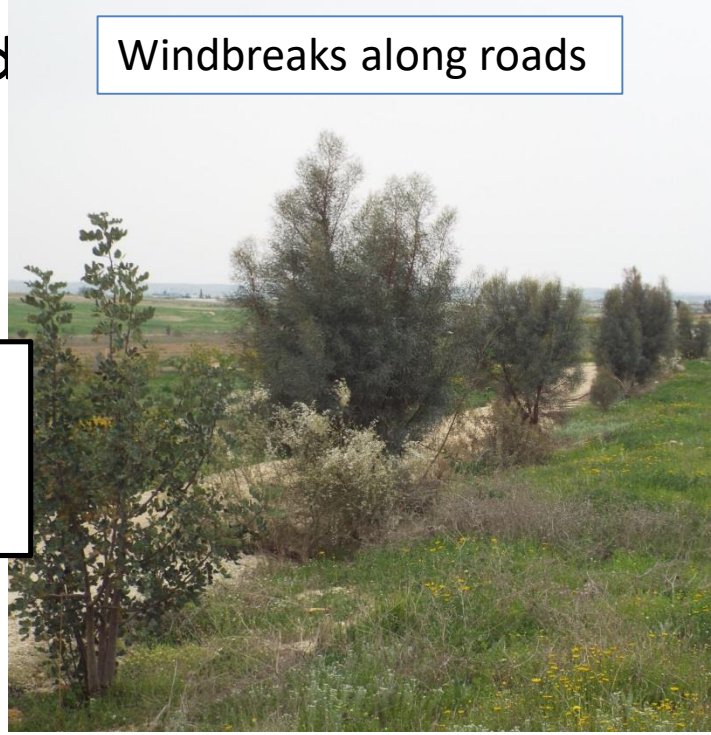
- Observable plant species – times 20
- Native tree species – times 25
- Most of the Negev's protected plant species returned!
- Birds species – times 10
- Mammal numbers – times 3
- Reptile numbers – up!
- Insect/invertebrate numbers – times X

At least 40 species useful at the arid-semiarid interface

Species statistics PWA (200 mm p/a):

34 species
23 native
16 Agroforestry species
8 nitrogen fixing species
5 reintroduction to the Negev
3 first attempted high value species in limans

Trees



More tree species tested at Moshav Maslul (200 mm p/a)

At least 5 tons CO_2 sequestered per year
more biodiversity
more farm productivity!

CONCLUSION

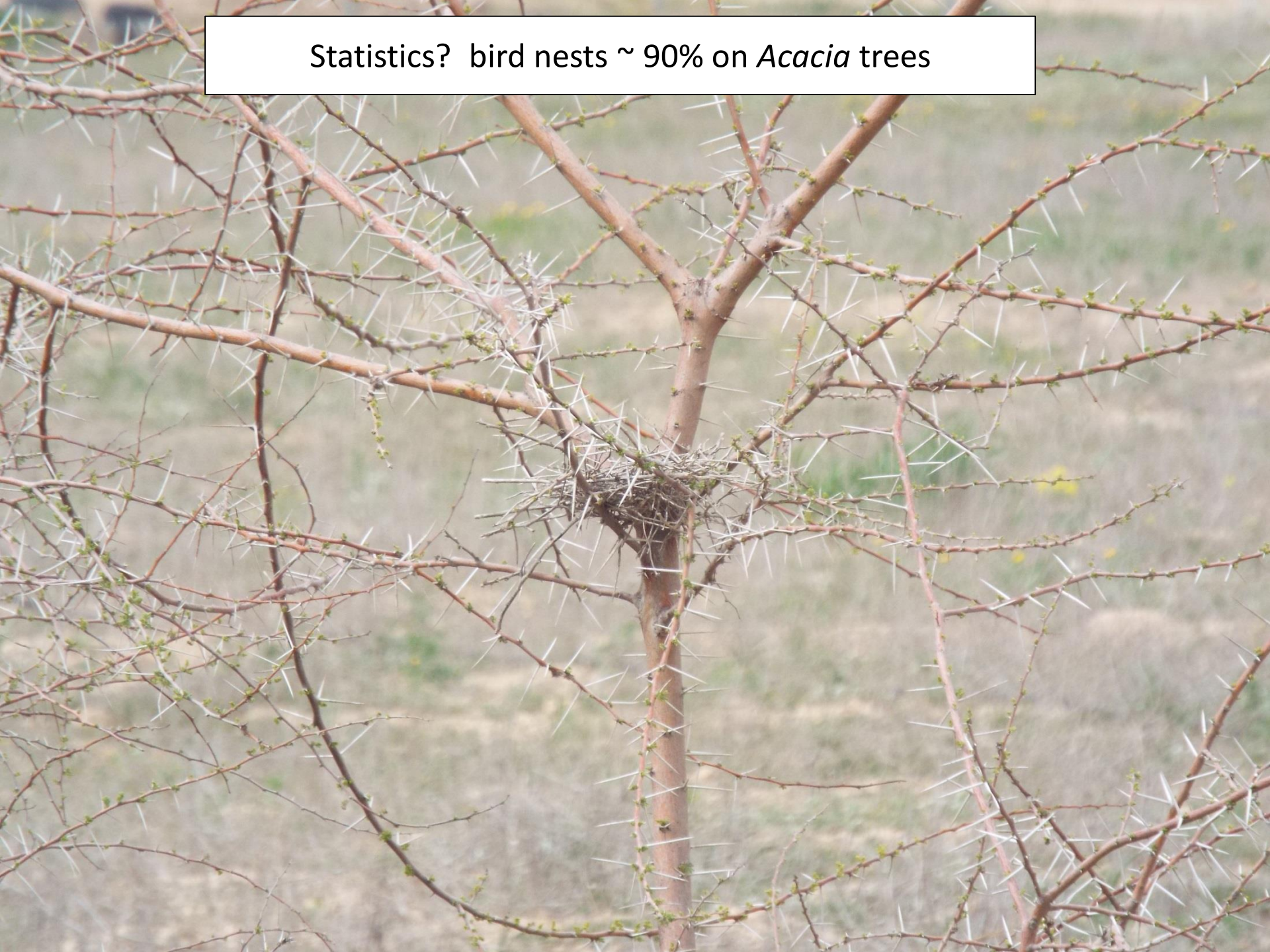
- **S.B ecologist's models are two climate zones off target!**
- **patch – matrix crusted shrub steppe is a good model in hyper arid ecosystems,**
- **but completely inadequate in semi arid ones!**
- **arid to semi arid ecosystems should be savanna, grasslands, or woodlands, dependent of topography**


Are lizards threatened by ecosystem restoration?


Doesn’t need trees
כוס החורבות - *Athene noctua*

Rhodospiza obsoletus

back from extinction in the Negev due to tree planting


Statistics? bird nests ~ 90% on *Acacia* trees

Education and ecotourism:
Bird diversity comparison with Bedouin school project

Insects – an extinction story!

Biological Conservation 232 (2019) 8–27

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journal homepage: www.elsevier.com/locate/biocon

Review

Worldwide decline of the entomofauna: A review of its drivers

Francisco Sánchez-Bayo[a,*], Kris A.G. Wyckhuys[b,c,d]

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[b] School of Biological Sciences, University of Queensland, Brisbane, Australia
[c] Chrysalis, Hanoi, Viet Nam
[d] Institute of Plant Protection, China Academy of Agricultural Sciences, Beijing, China


Restoring insect and pollinator populations!

4. The harvester ant *Messor sp.* as key engineer for restoring degraded dry ecosystems


Plant biodiversity:
a few of the returning iconic species


and so on
Thank you very much

Conclusions:

global dryland restoration will successfully address:

- **The UN Convention to Combat Desertification;**
- **The UN Convention on Biological Diversity**
- **The UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE;**
- **contribute to food and water security, socioeconomic development, economic growth, resilience and diversification (as predicted)!**
- **In short: address all SDGs!**
- **will provide 5 BILLION TONS of additional biomaterials annually (wood, food, fiber or feed above current) in a GHG NEGATIVE APPROACH!**

“Economic viability”:

what are your systems boundaries?