Modelling Changes in Climate and Land Use in 2100.
Importance of climate for business and policy

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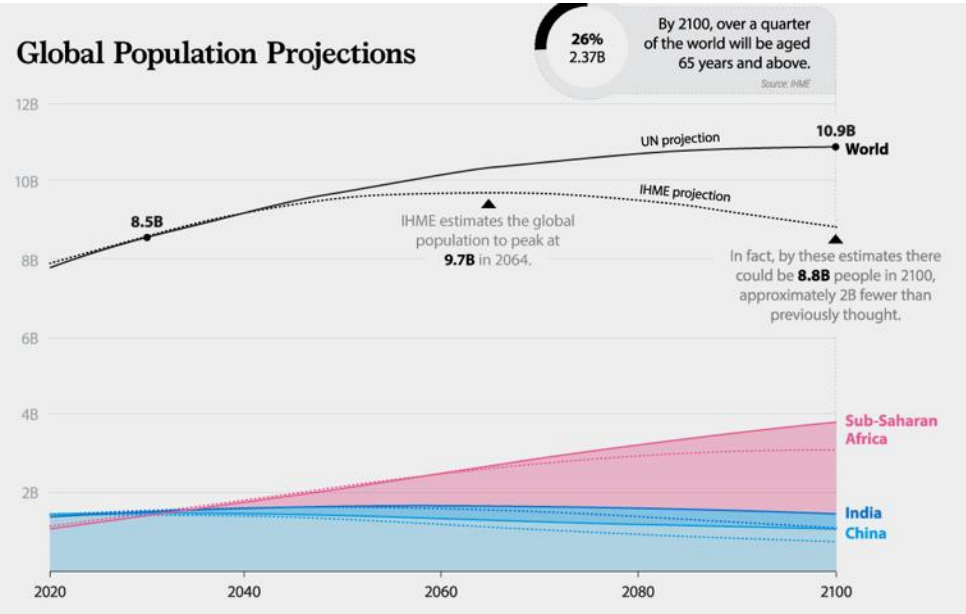
Session “Public-Academic-Private Collaboration to Support Climate Neutrality Goals”
EMS, 2024-09-03 09:00-10:30

Changes in Climate and Land Use in 2100 - Agenda

1. Key drivers of change
2. Land use scenarios
3. Climate change scenarios
4. Impact on food supply
5. Climate and industry considerations
6. Conclusions

1. Key drivers of change: population



Source: https://www.weforum.org/agenda/2020/09/the-world-population-in-2100-by-country/ (20240401)

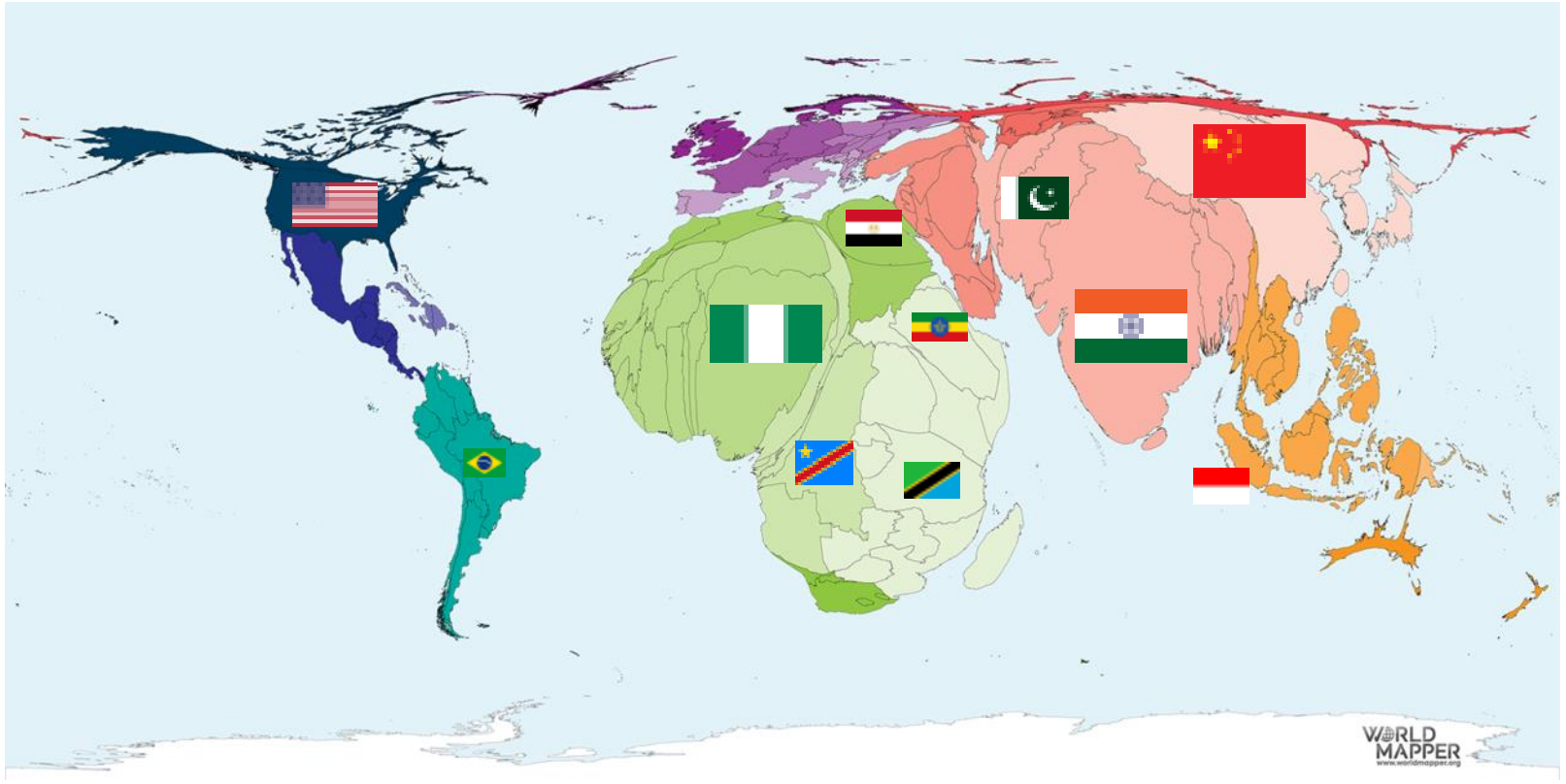
From now 8 to 11 billion people in 2100

Influencing (changing) factors:

- Birth rate
- Age
- Migration
- Catastrophes (pandemic, war, famine...)

Population growth is certain, the extent not…

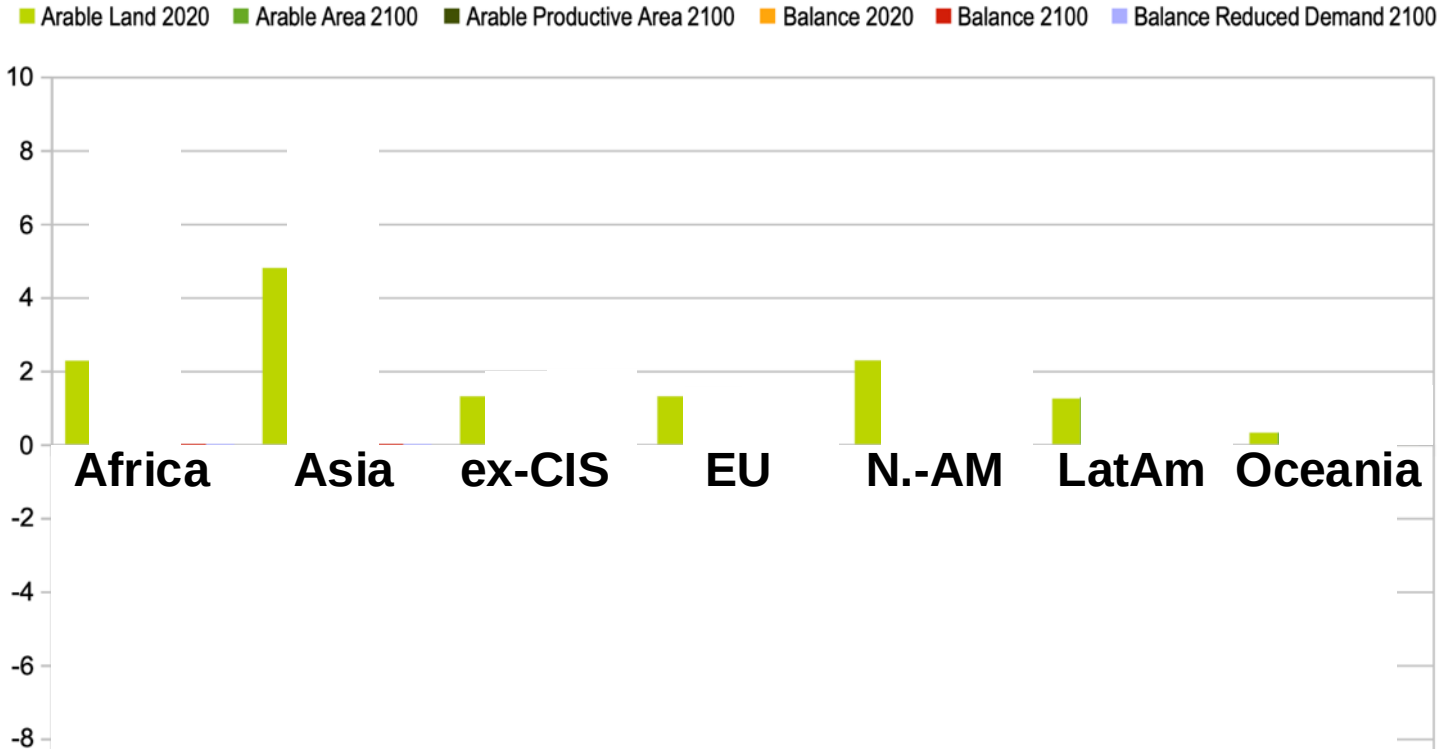
1. Key drivers of change: population distribution in 2100



Losers (billion)	
1. China	-0.7
2. India	-0.3
3. EU	**-0.1**
4. Bangladesh	-0.07
5. Japan	-0.06
6. Brazil	-0.06
7. Russia	-0.04

What is certain: the balance will change - massively

Agricultural land area in production 2020



2020 = 13.5 mio km^2 → 2100:

- Asia largest producer
- Africa, North America 2nd.
- Ex-CIS EU LatAm 3rd
- Others insignificant

- Strong differences with continents (not relevant for this analysis)

Major production centres: Asia, Africa, North-America

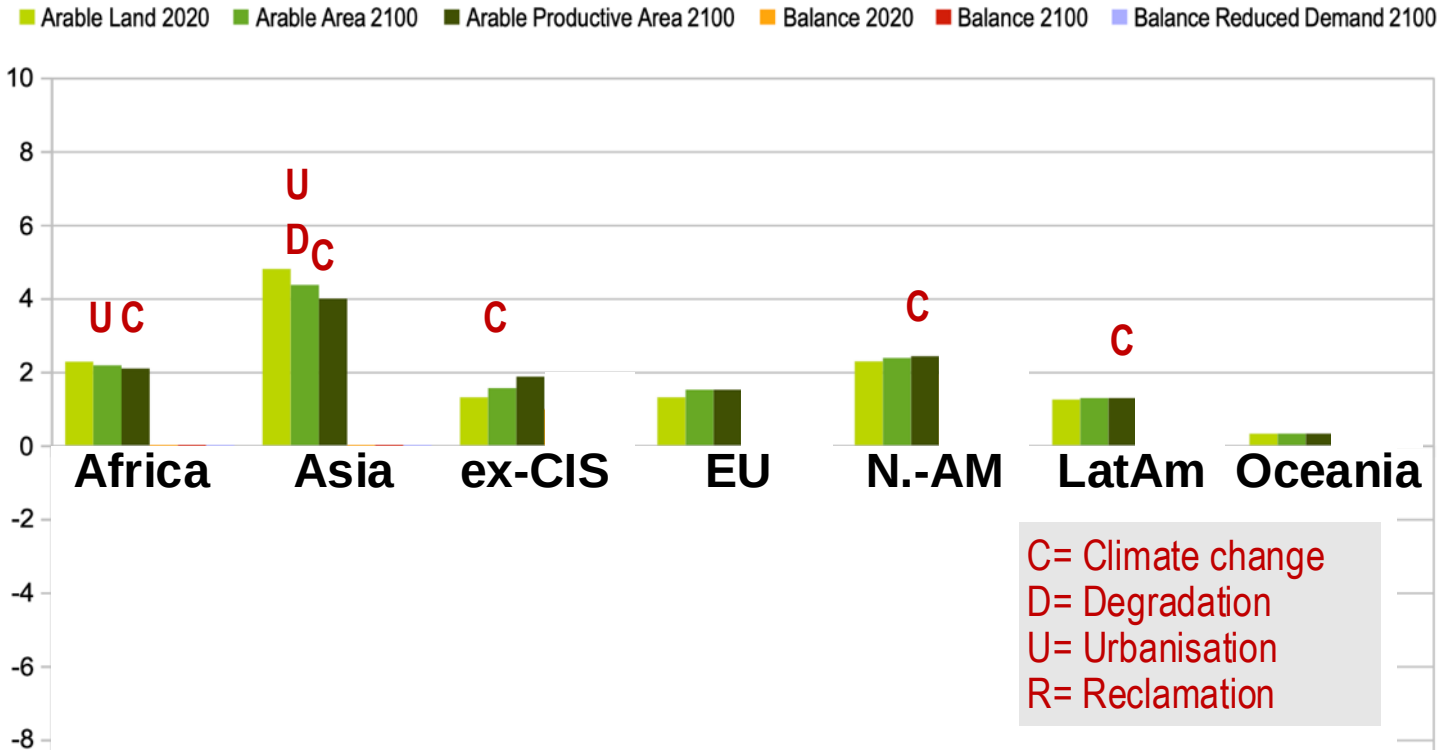
Calculation process for land requirements

STEPS (Assumptions)

1. Land use by country 2020.
2. Percent of self-sufficiency in 2012-2020: (optimal nutrition = optimal consumption)
3. Population change 2020-2100
4. Expected food and fibre demand in 2100 (calculated with optimal consumption)
5. Change in land availability 2020-2100 (urbanisation, degradation, cultivation)
6. Expected self-sufficiency in 2100 (optimal consumption)

Uncertainties possible, but orders of magnitude won‘t change

Agricultural land area needs 2020-2100



2020 = 13.5 mio km^2 → 2100:

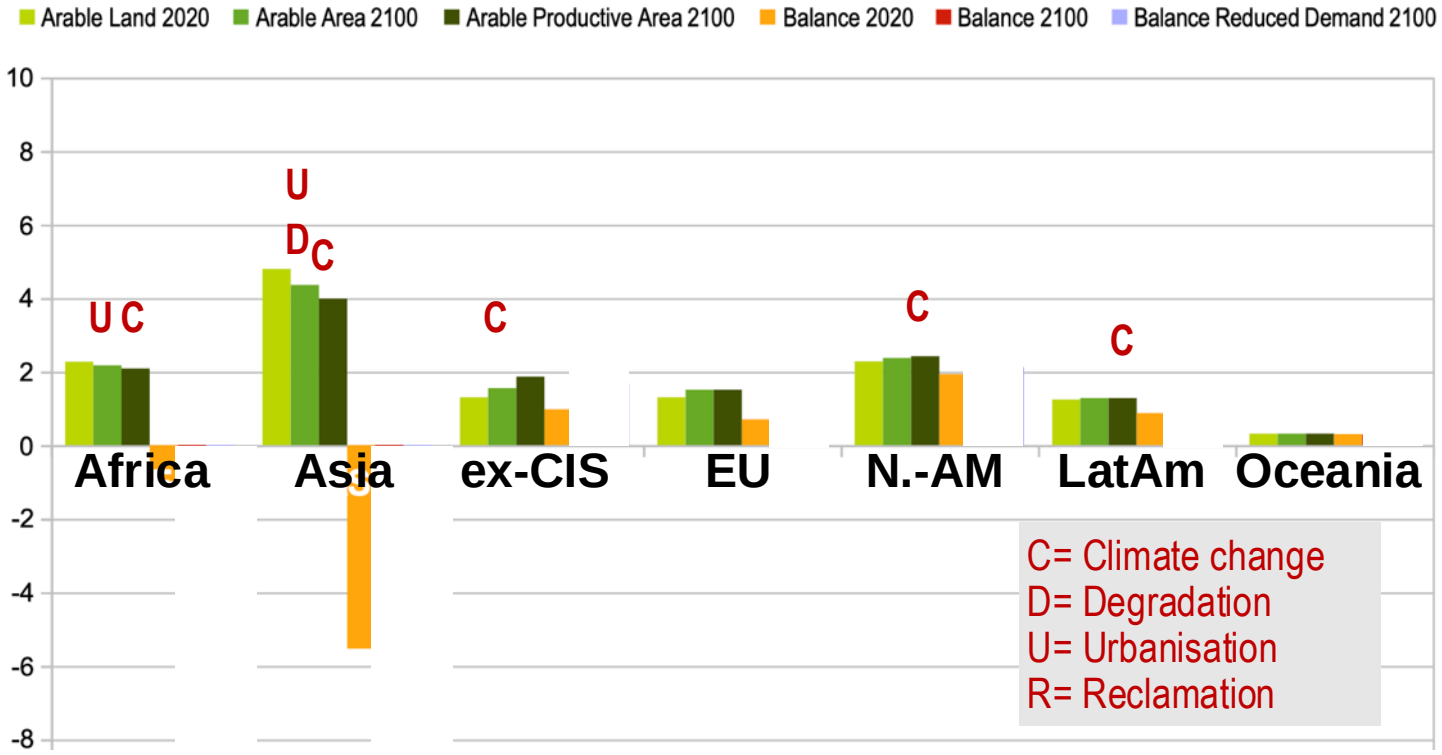
- Decrease in Africa, Asia
- Increase in ex-CIS, N-Am
- Others not changed

Key assumptions

- Population projections valid
- No further loss of biotopes
- Current technologies
- Productivity not considered

Major production centres: Asia, Africa, N.-America + ex-CIS

Agricultural land area needs 2020-2100



2020 = 13.5 mio km^2 → 2100

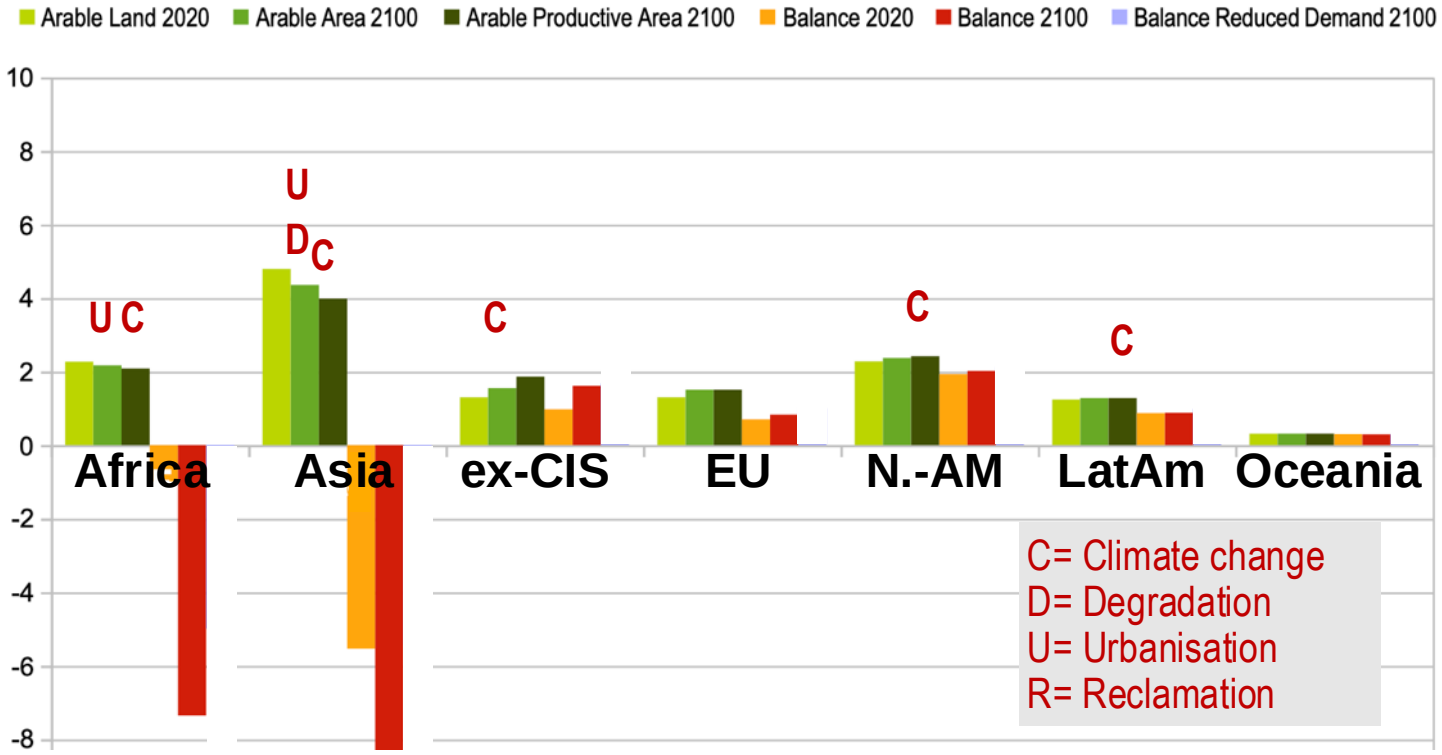
- Decrease in Africa, Asia
- Increase in ex-CIS, N-Am
- Others not changed

Today

- Importers: Asia >> Africa
- Exporters: NA>LA>CIS>EU

2020: Major importer= Asia; Major exporter= N.America

Agricultural land area needs 2020-2100



2020 = 13.5 mio km^2 → 2100:

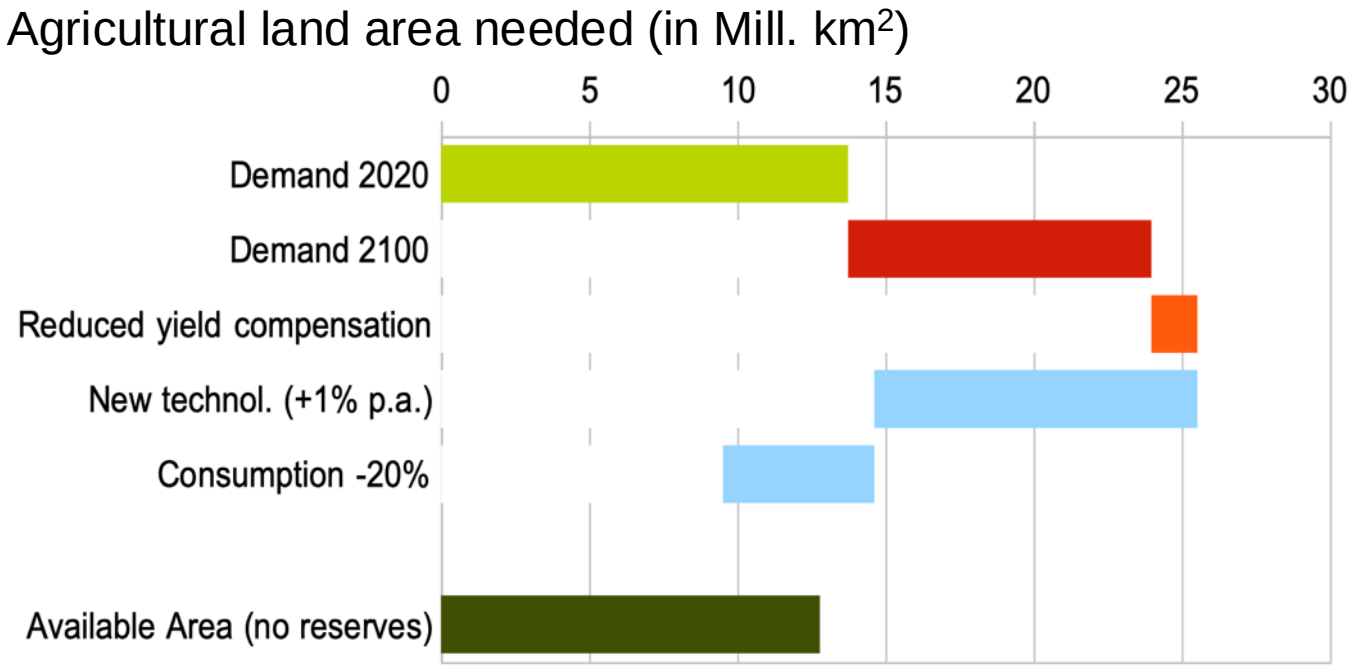
- Decrease in Africa, Asia
- Increase in ex-CIS, N-Am
- Others not changed

In 2100…

- Deficit explodes in Africa
- Exporting capacity does not increase (at current status)

Not enough land = Major aggregate food deficit in 2100

Agricultural land area needs 2020-2100



Key assumptions

✓ Population projections valid

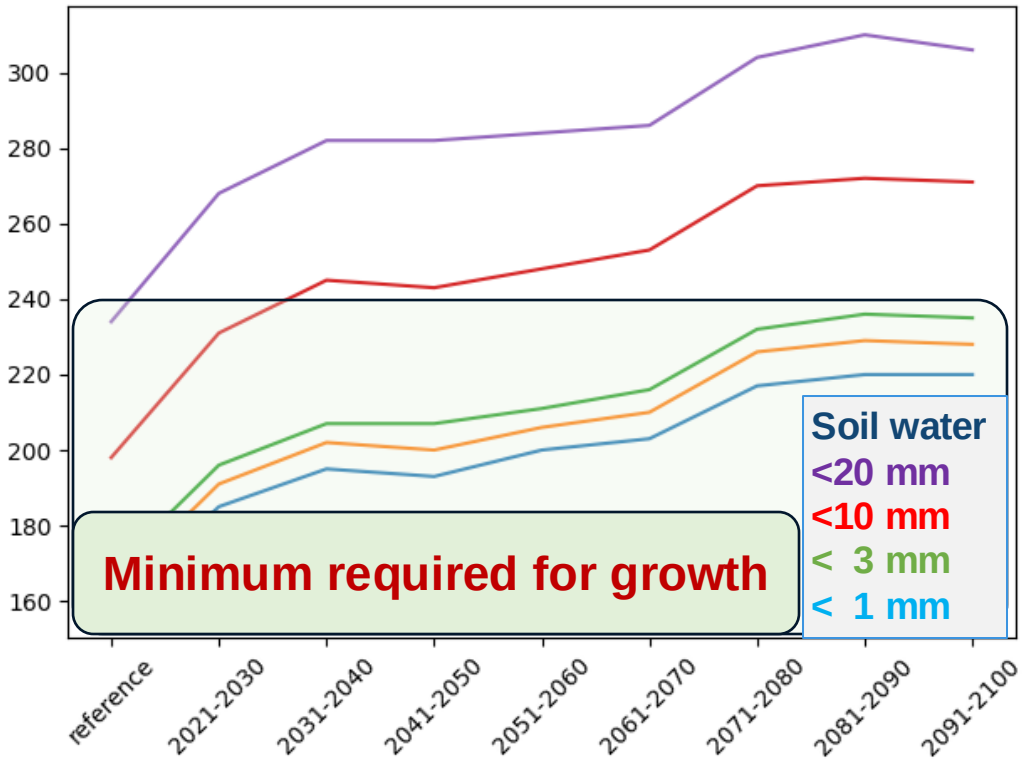
✓ No further loss of biotopes

➢ Technology yield increases of the past 50 years continue

[1])

The <u>main</u> hope to fill the gap is technology

3.Dry day trend in major food production areas 2020-2100

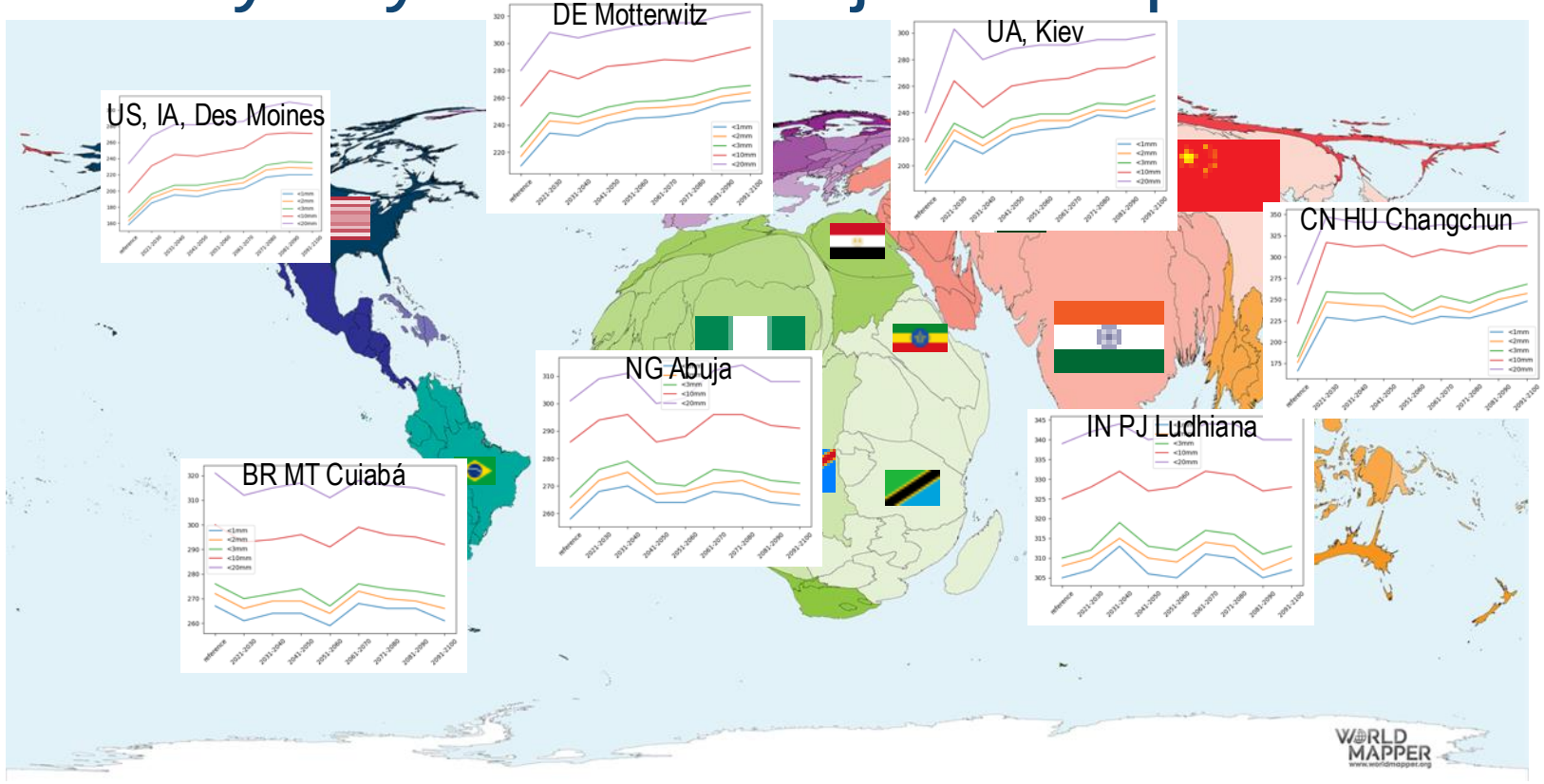


Number of days per year with less than X mm of water in the soil

- **20 mm = 1 week of growth**
- **10 mm = 0.5 week of growth**
- **3 mm = 1 day of growth**
- **<1 mm = crop death**

To increase production, drought should not increase

3.Dry day trend in major food production areas 2020-2100



Climate predictions: CSM4 model (spatial resolution 100 km) downscaled to 30 km spatial resolution (ERA5 grid)

Reference period: 1991-2020

Future: RCP 8.5

➢decades 2021- 2100

➢Hourly simulations : climate+®

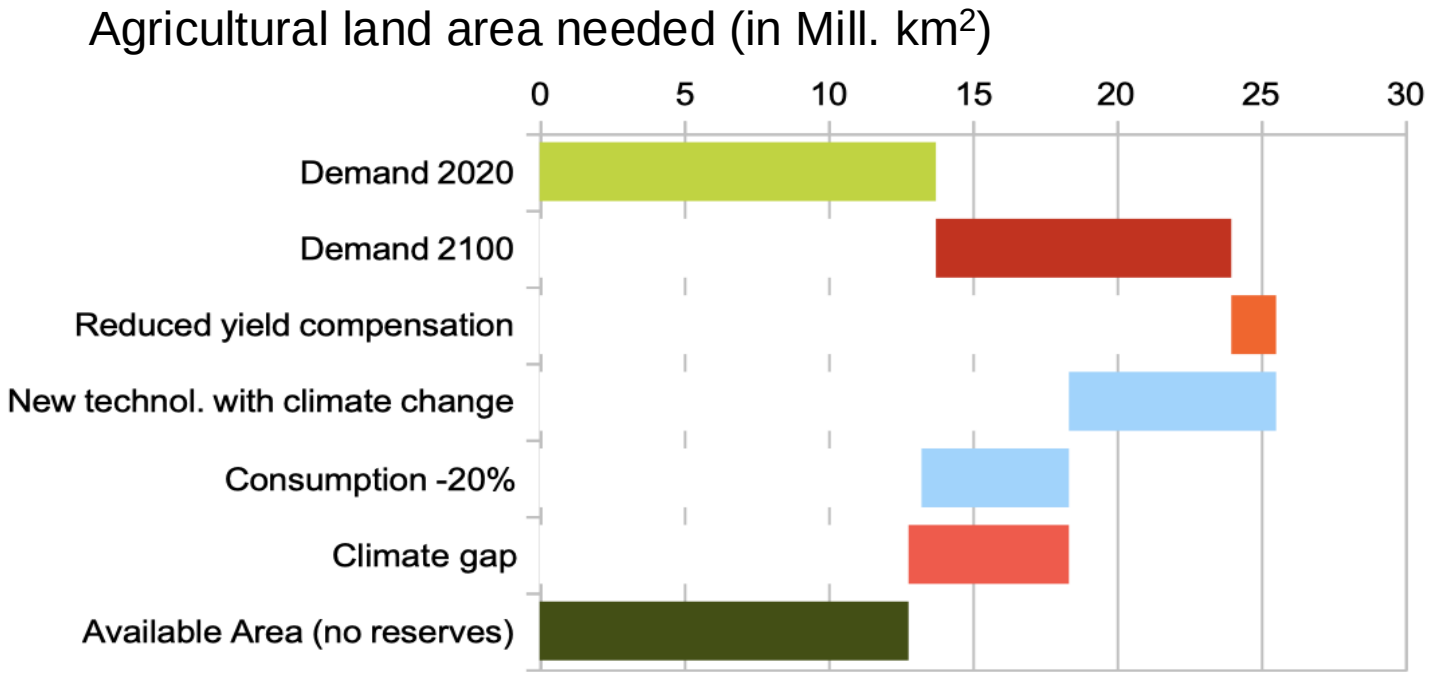
Drought: simplified version of single-layer soil water balance bucket model (Laio, 2001)

* drought events calculated for thresholds (< 1, 2, 3, 10, 20 mm)
* soil capacity: 100 mm
*

US, IA, Des Moines
US, IA, Des Moines

Tropics = stable - Key production areas = more drought

Agricultural land area needs 2020-2100: the climate gap



Key assumptions

✓ Population projections valid

✓ No further loss of biotopes

➢ Technology yield increases of the past 50 years will be hampered by climate change

[1])

Climate change will make the technology insufficient

5. Climate and industry considerations

1. Climate change will impact agricultural areas
2. Regional differences will be dignificant
3. Water availability will lead to competition between agriculture, households and industry
4. Other factors affecting population well being (health) not considered here
5. We need a more impact oriented assessment of climate change
6. Approaches to speed up technology transfer are needed to avoid calamities.

Climate change knowledge will be the key determinant of human well being

6. Conclusions

1. Population growth is certain, the extent not…
2. Regional balance will change – massively
3. Major production centres (Asia, Africa) will become heavy food importers
4. Major aggregate food deficit expected in 2100
5. The gap should be filled with technology, but climate change not permit that
6. Other factors affecting population well being (water, health) must also be considered
7. **We need a more impact oriented assessment of climate change**
8. **Approaches to speed up technology transfer are needed to avoid calamities**.

Our industry must translate the Climate Change impact into economic and social terms