

# Impacts of SLCF and Co-benefits of Mitigation: Crop production and Regional Ecosystems



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# Impacts of SLCF and Co-benefits of Mitigation: Crop production and Regional Ecosystems

- Which SLCFs are causing ecosystem damage?
- What are their current impacts?
- How might these impacts change in the future?
- What benefits might be achieved through SLCF mitigation?
- What knowledge gaps exist in our understanding of impacts?

# Which SLCFs are causing ecosystem damage?

Methane  
(CH<sub>4</sub>)



warming

Tropospheric Ozone (O<sub>3</sub>)

Direct effects leading to crop yield loss; forest biomass loss and changes in species composition of grasslands

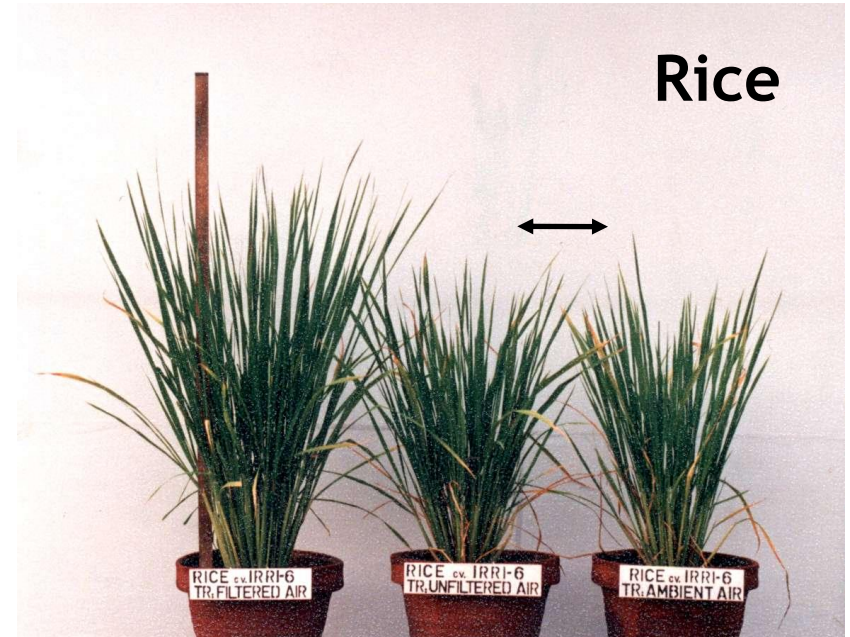
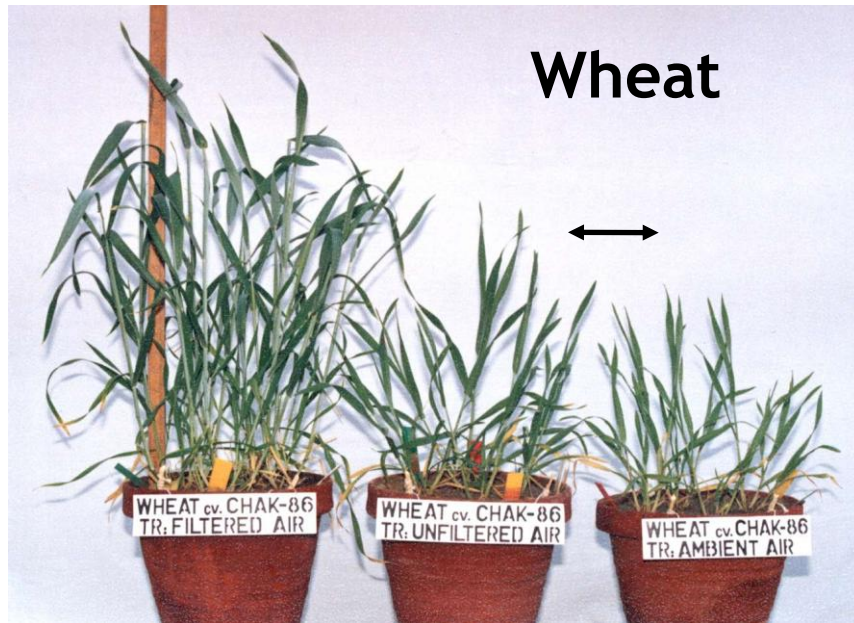
warming & cooling

Aerosols (nitrates, sulphates, BC, OC etc...)

Indirect effects acidification, eutrophication, and alteration to quality of incoming solar radiation affecting photosynthesis

# What are the ecosystems impacts caused by O<sub>3</sub>?

Reduced growth

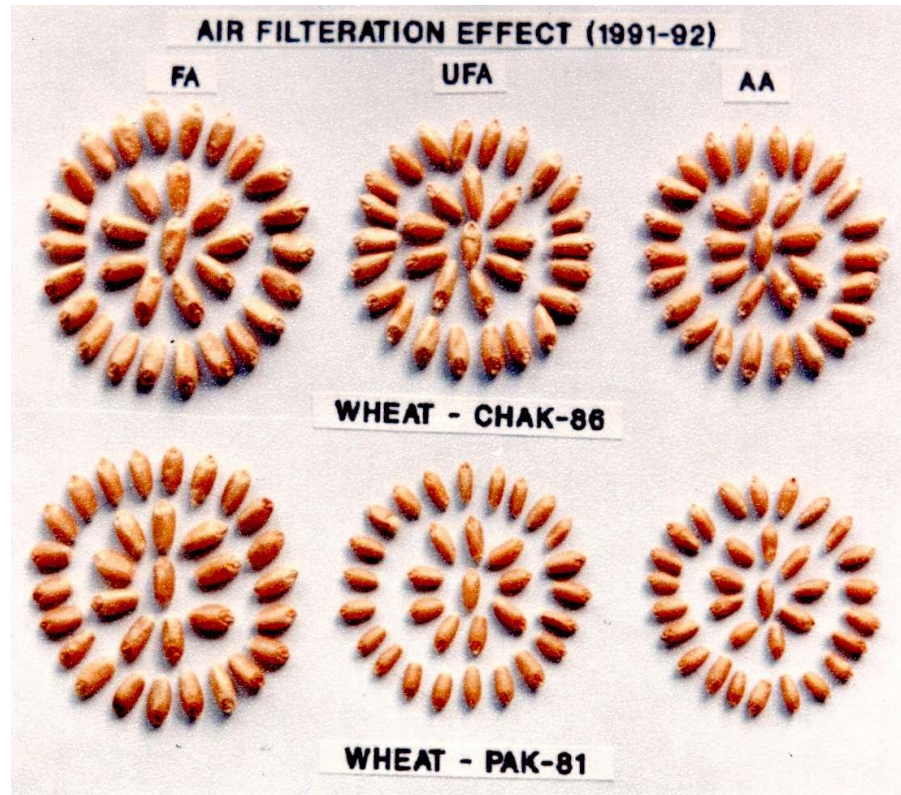


Plants grown in ambient air with high levels of O<sub>3</sub> pollution

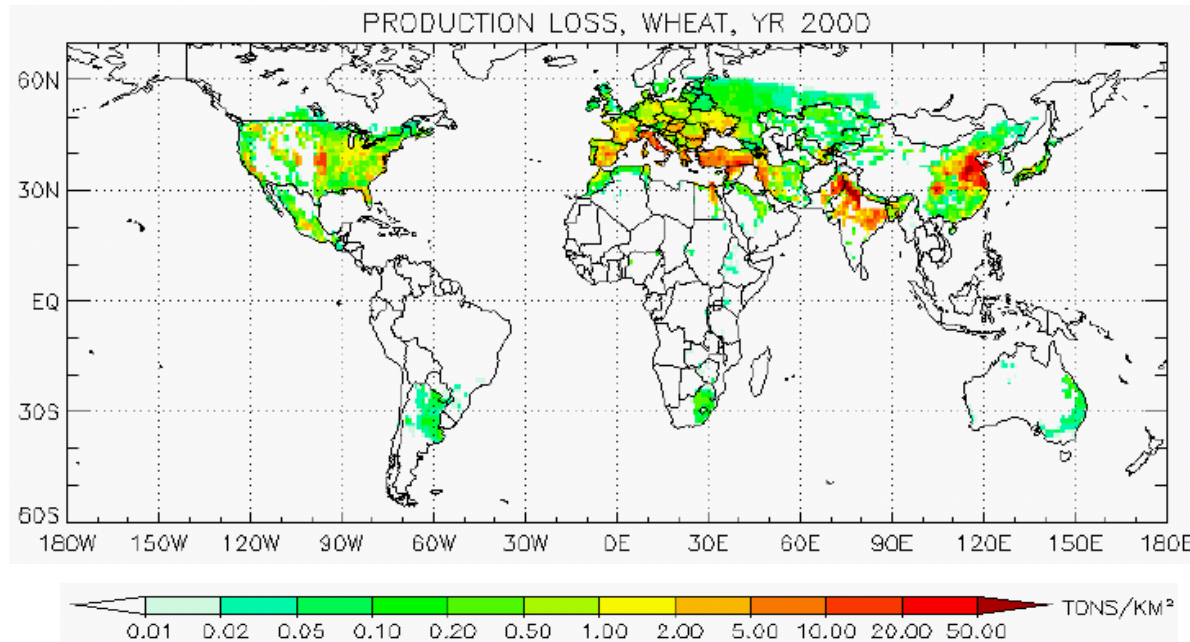
Plants grown in filtered air (pollutant free), Lahore, Pakistan

# What are the ecosystems impacts caused by O<sub>3</sub>?

Reduced crop yield....and also quality



# What are the ecosystems impacts caused by O<sub>3</sub>?

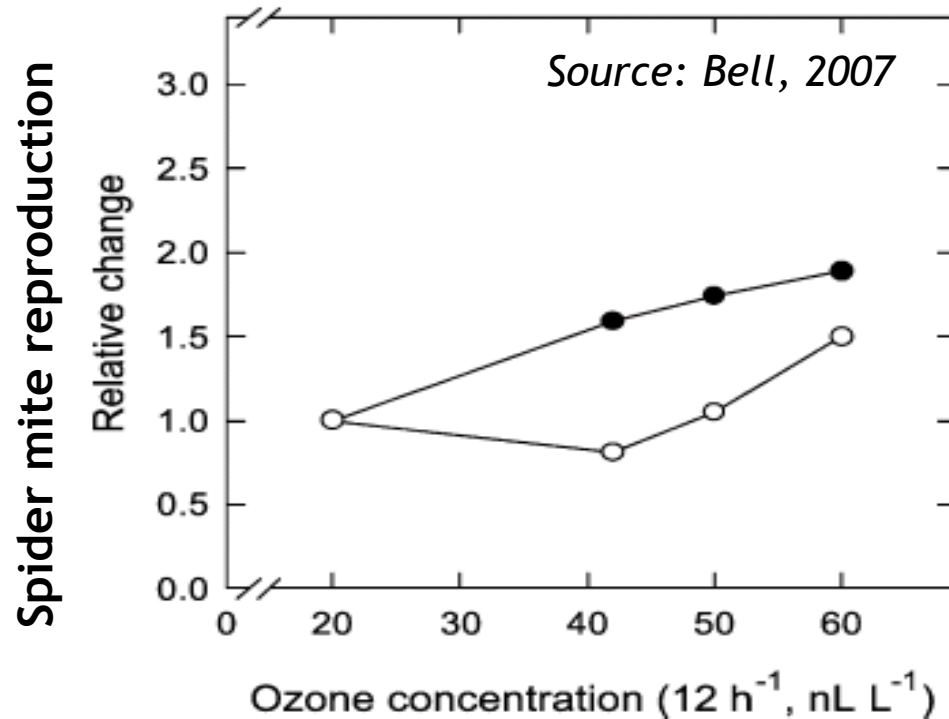


For countries with an economy largely based on agricultural production, O<sub>3</sub> induced damage is estimated to offset a significant portion (20 - 80%) of the year 2000 GDP growth rate.

*Van Dingenen et al, in press*

# What are the ecosystems impacts caused by O<sub>3</sub>?

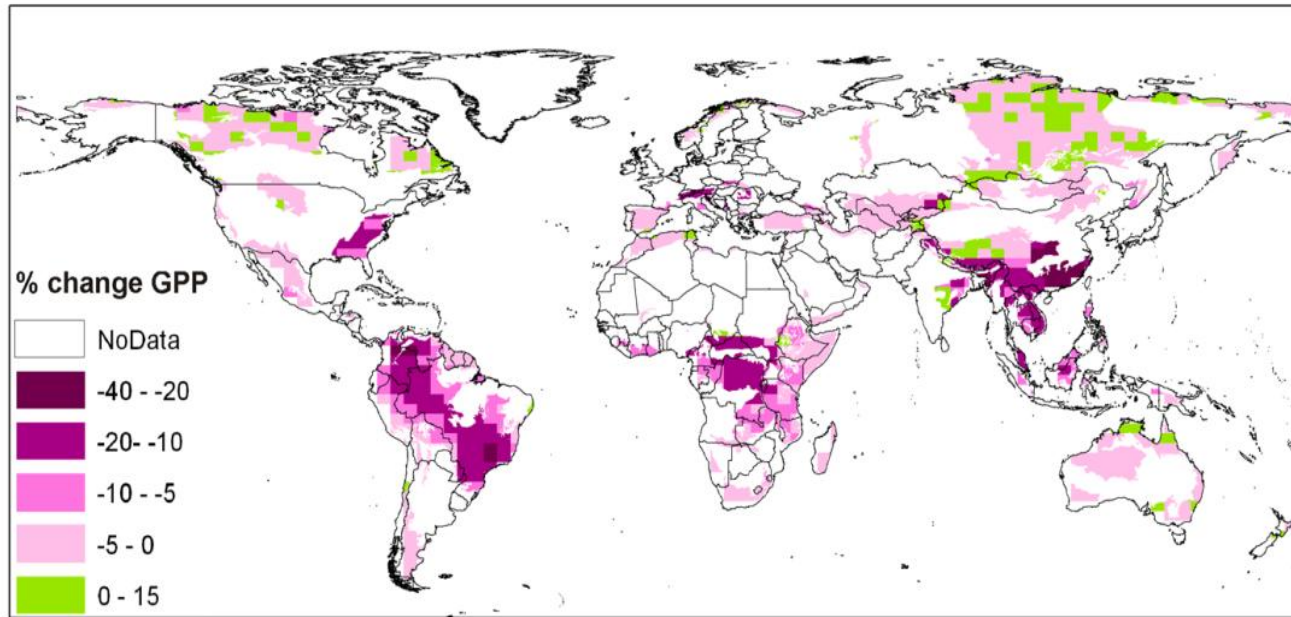
Alters resistance to pests and diseases



- O<sub>3</sub> sensitive plant
- O<sub>3</sub> resistant plant

Accelerated reproductive rate may allow mites to adapt quickly to resist pesticides

# What are the ecosystems impacts caused by O<sub>3</sub>?



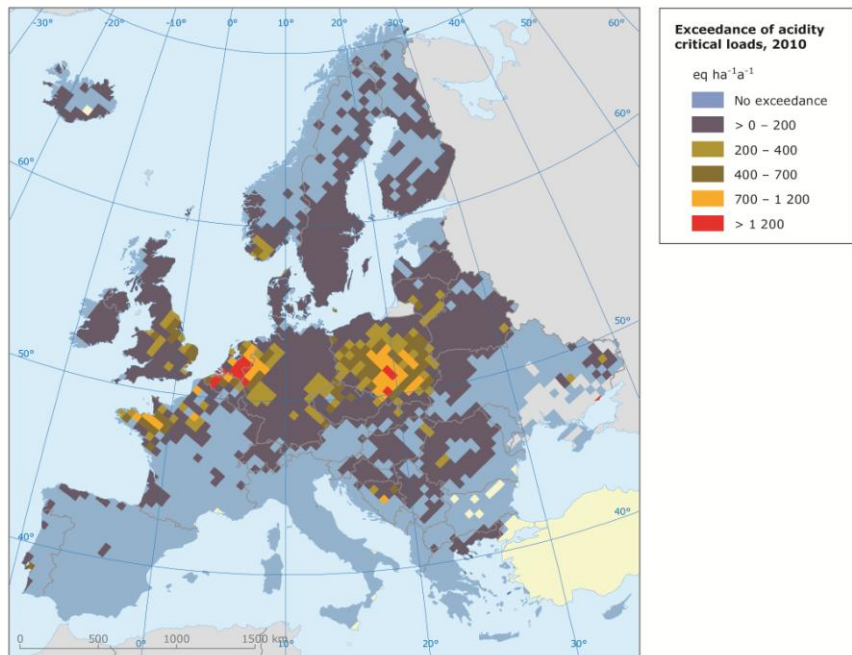
O<sub>3</sub> doesn't only impact on crops.....map shows key biodiversity areas at high risk from O<sub>3</sub> impacts.

*Royal Society, 2008*

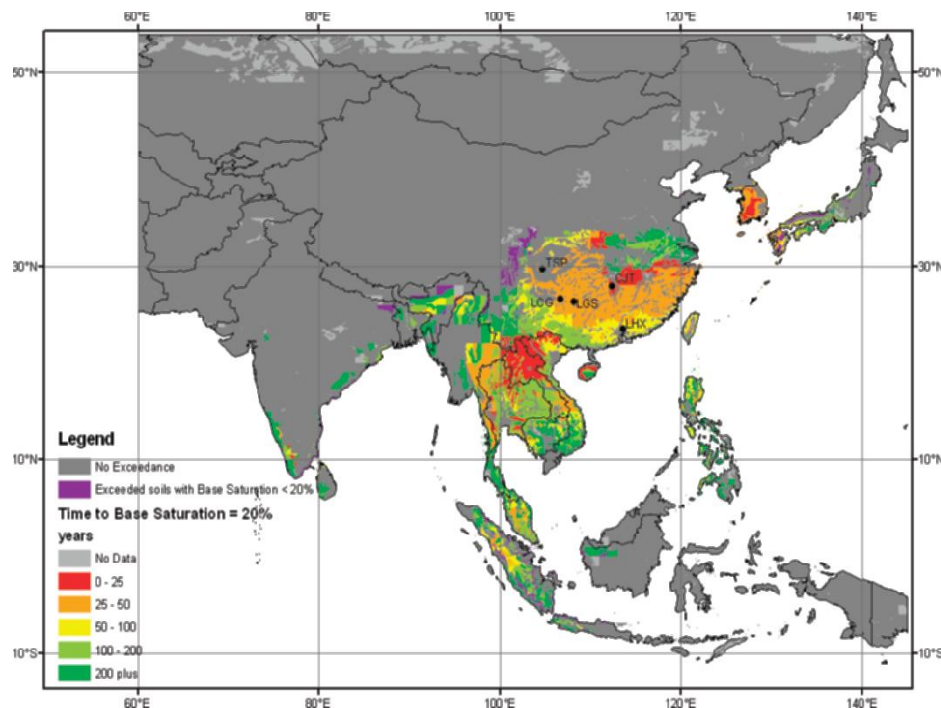


# What are the ecosystems impacts caused by aerosols?

## Soil (and surface water) acidification



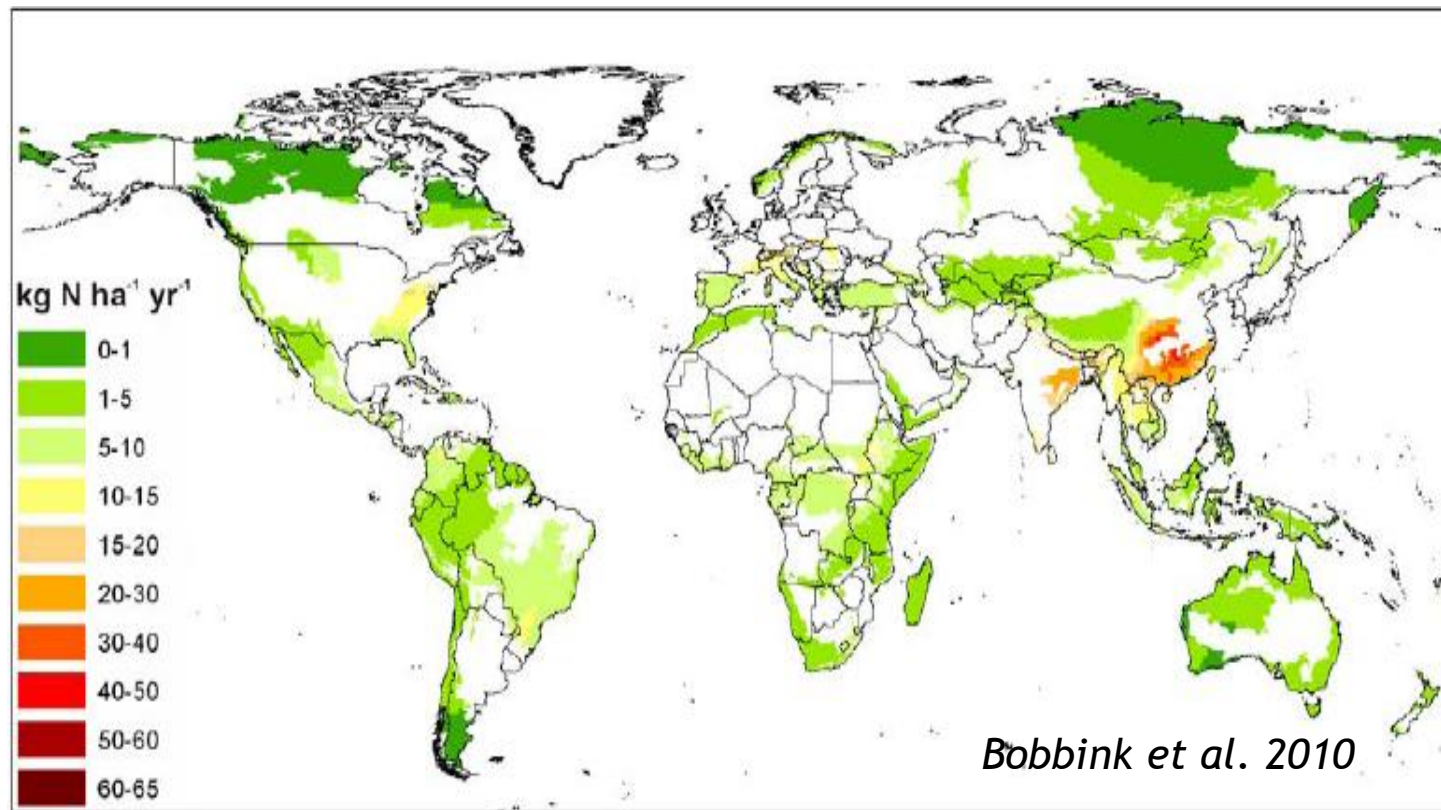
Critical load exceedance decline in Europe



Areas at risk from acidification in the next 50 years limited in Asia

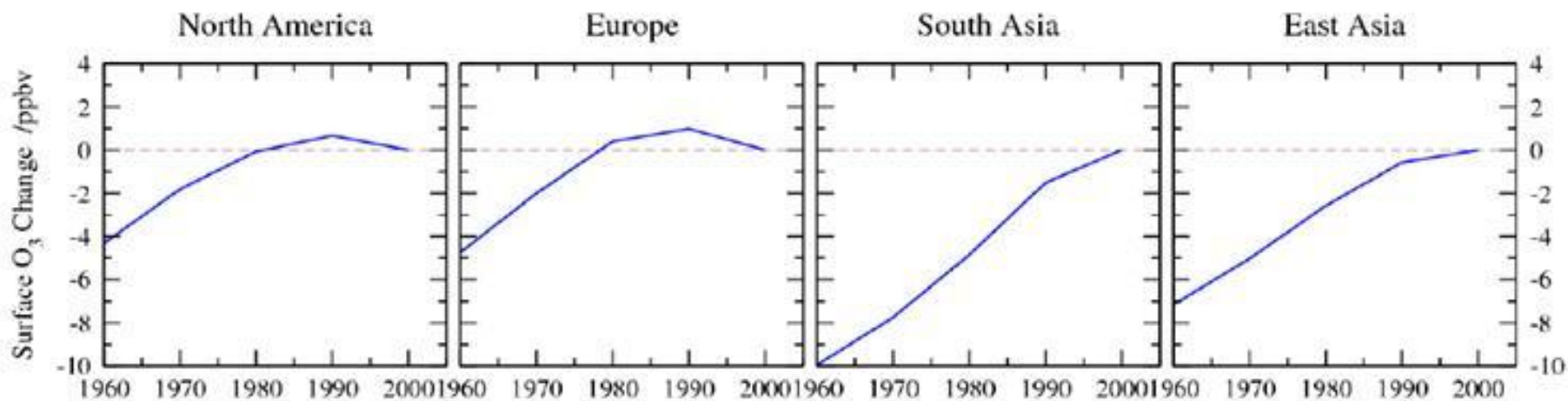
# What are the ecosystems impacts caused by aerosols?

## Eutrophication



N deposition rates to WWF G200 defined biodiversity hotspots in 2000

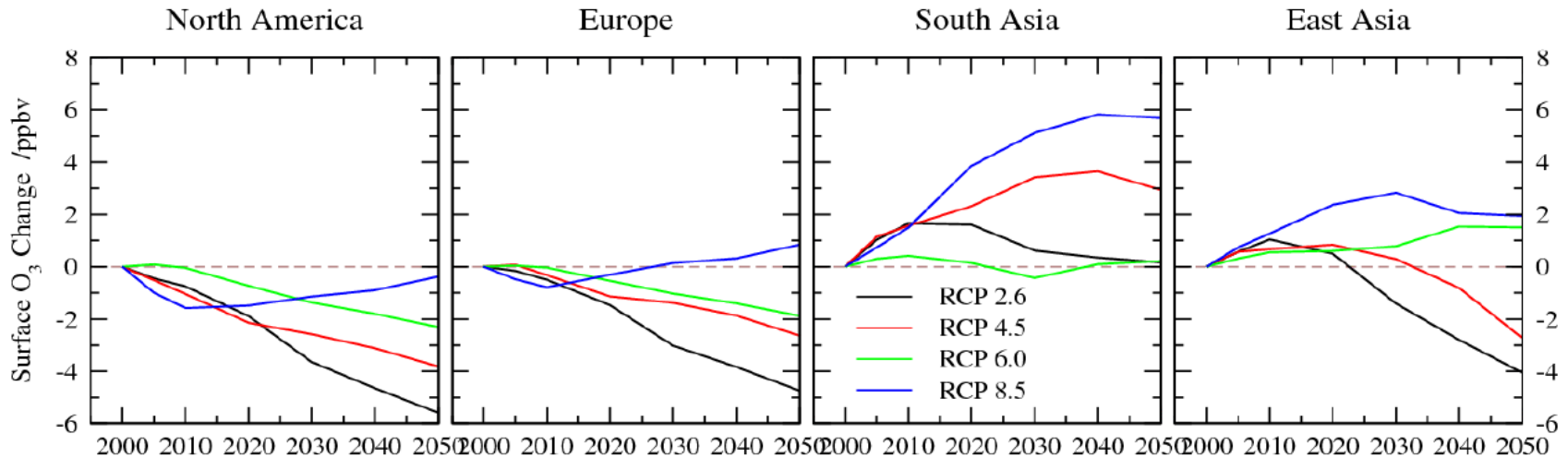
## How might O<sub>3</sub> related impacts change in the future?



*HTAP, 2010*

Changes relative to 2000 in annual mean surface O<sub>3</sub> over specific global regions between 1960 and 2000 based on modelling.

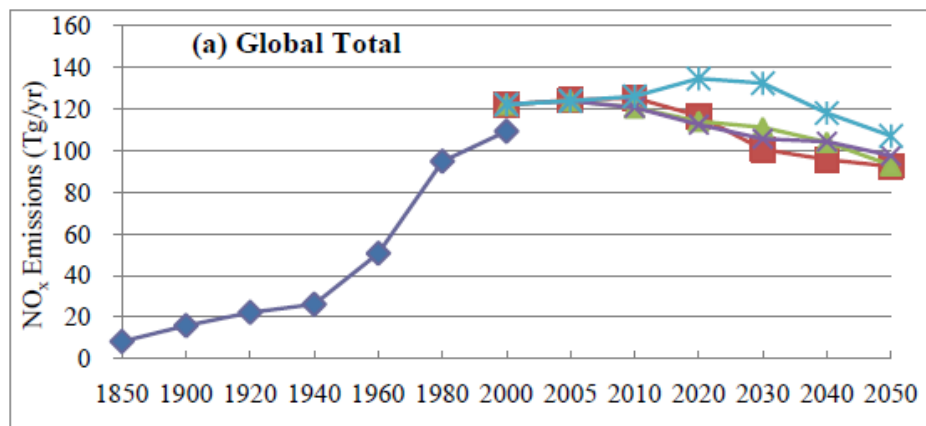
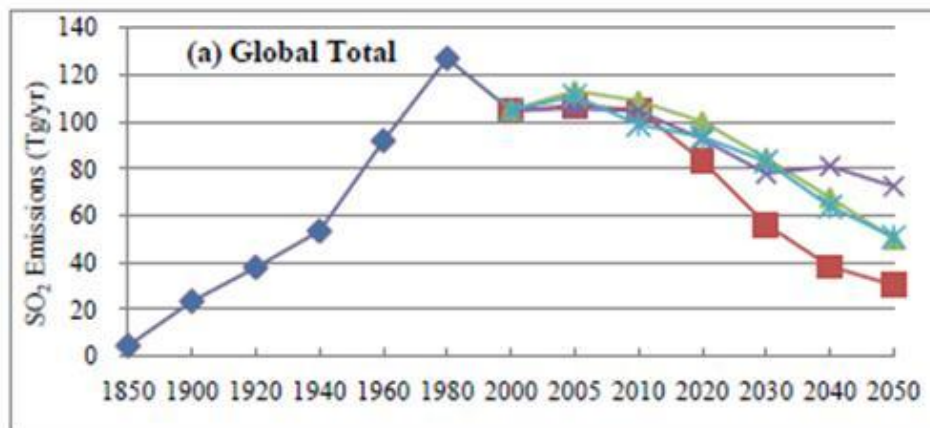
# How might O<sub>3</sub> related impacts change in the future?



*HTAP, 2010*

The future is much more uncertain...essentially O<sub>3</sub> concentrations will depend on whether O<sub>3</sub> precursor control options are implemented

# How might aerosol related impacts change in the future?



HTAP, 2010

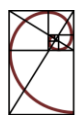
# What benefits might be achieved through SLCF mitigation?

- Review scientific literature on BC and O<sub>3</sub>
- Focus on small number of carefully identified measures
- Assess the extent of near-term global and regional climate protection
- Estimate co-benefits on health and O<sub>3</sub> induced **crop yield loss**
- Examine how the measures can be widely implemented

Two groups of measures - CH<sub>4</sub> and BC measures

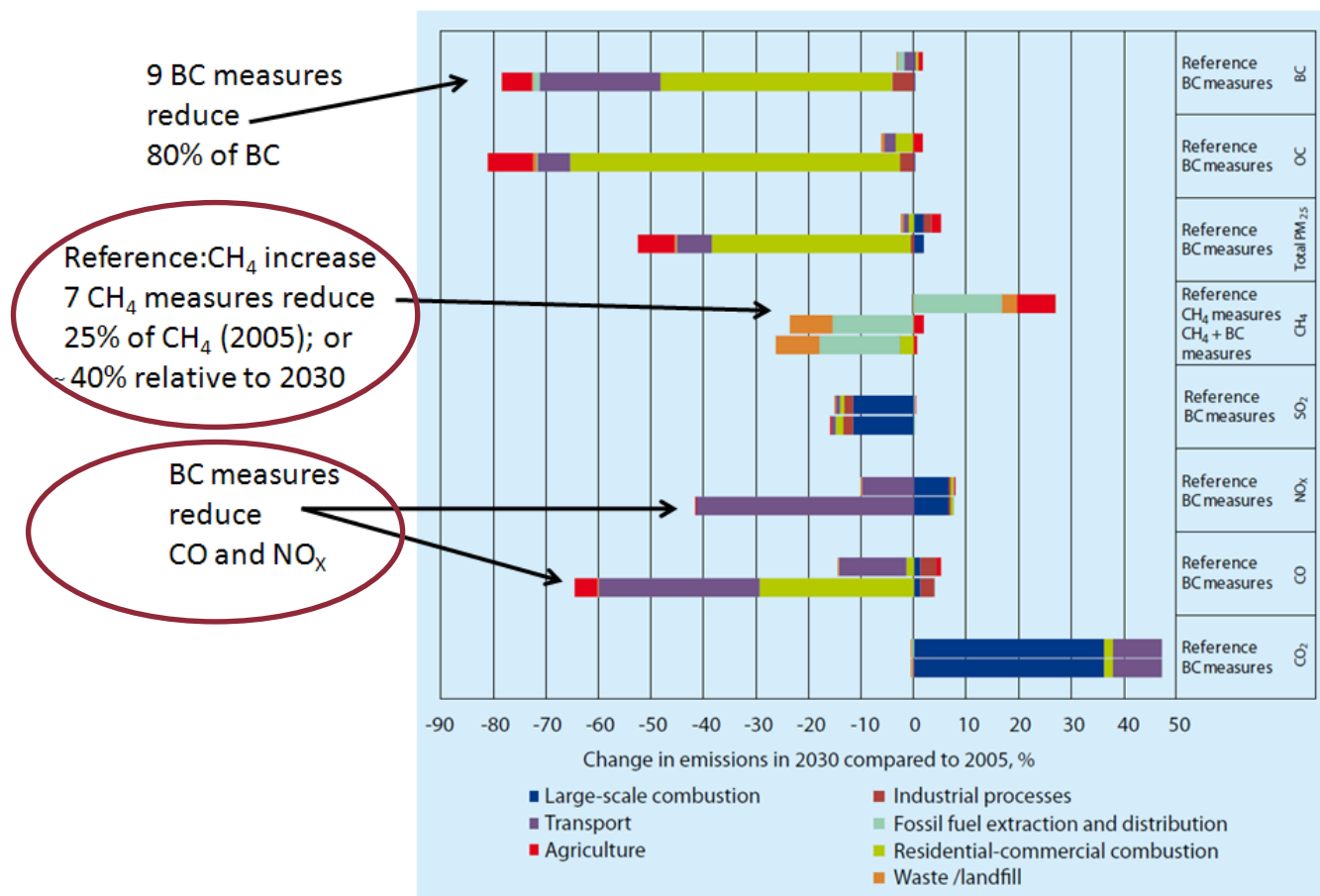


**Integrated Assessment  
of Black Carbon  
and Tropospheric Ozone**  
Summary for Decision Makers

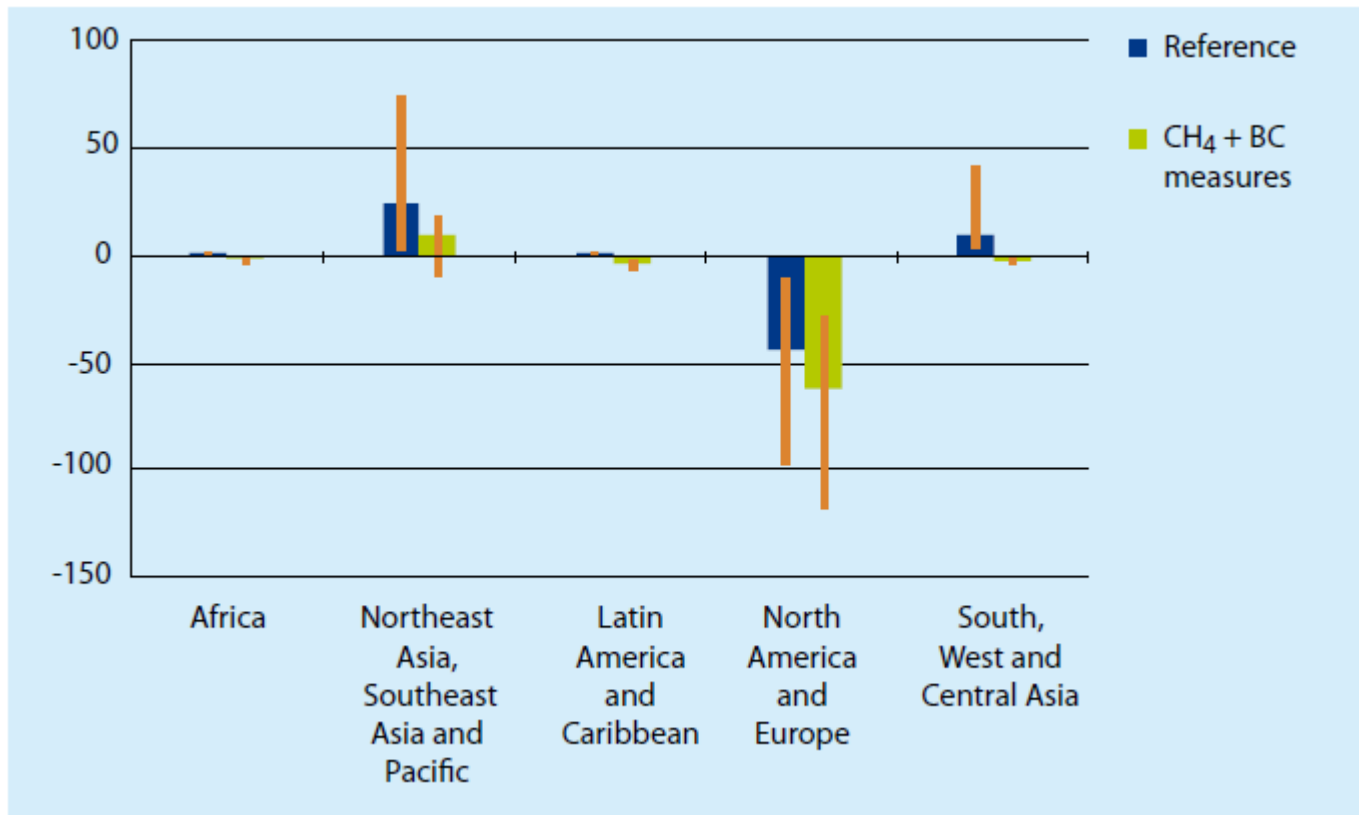


# UNEP Integrated Assessment of Black Carbon (BC) and Ozone (O<sub>3</sub>)

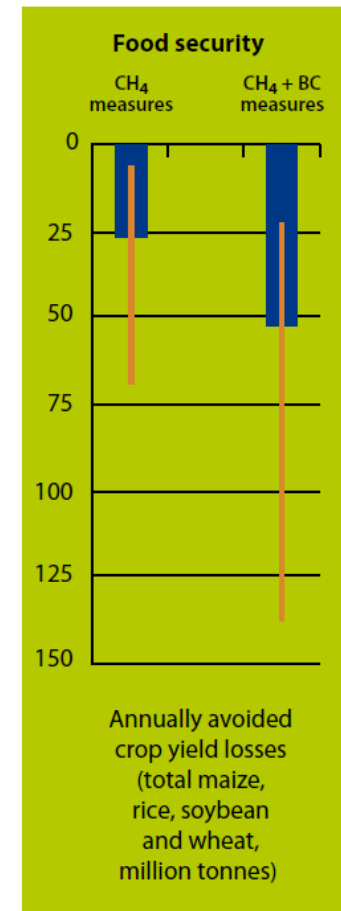
## Effect of measures on emissions projected in 2030 relative to 2005



# UNEP Integrated Assessment of Black Carbon (BC) and Ozone (O<sub>3</sub>)



Comparison of crop yield losses (million tonnes annually) by region, showing the change in 2030 compared with 2005 for the reference emission trends (blue) and after methane + BC measures (green).





# What knowledge gaps exist in our understanding of impacts?

- ❖ Crop & ecosystem responses to direct effects of O<sub>3</sub> and aerosols, especially in tropical regions with limited empirical evidence.
- ❖ Knowledge of surface global O<sub>3</sub> concentrations...limited to model estimates in the absence of a global monitoring network.
- ❖ Translating yield losses to economic losses requires assumptions on crop distribution, production and price statistics...all highly uncertain.
- ❖ Assessment of O<sub>3</sub> impacts ONLY includes yield losses for 4 staple crops; effects on nutritional quality, forage quality, 'other' important agricultural crops are less well known and tend not be included.
- ❖ ....but economic losses to crop production are only one aspect e.g. potential impacts on our ecosystems due to feedbacks to climate change may also pose a serious threat.

# Impacts of SLCF and Co-benefits of Mitigation: Crop production and Regional Ecosystems

## Key 'take home' messages

Ecosystems in polluted regions globally are being affected by surface  $O_3$  and by aerosols that cause acidification, eutrophication and alter the quality of solar radiation at the Earth's surface



Efforts to control  $O_3$  will have benefits for crops, ecosystems AND climate

...benefits in terms of crop production losses of only 4 staple crops have been estimated at ~50 million tonnes by implementing  $CH_4$  and BC mitigation

....AND additional benefits related to avoided losses of C sequestration may provide even greater benefits in relation to climate change

