Soil and the SDGs: challenges and need for action

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IPCC special report on climate change and land

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www.ipcc.ch/report/SRCCL
Report Structure

1: Framing and context
2: Land-climate interactions
3: Desertification
4: Land degradation
5: Food security
6: Interlinkages between desertification, land degradation, food security and GHG fluxes:
   Synergies, trade-offs and integrated response options
7: Risk management and decision making in relation to sustainable development

The report outline proposed by the scoping meeting was agreed, after some refinement, by the Panel
Authors included:
Scientists engaged with IPBES and UNCCD; FAO employees
Emissions and Land

- Gross emissions from AFOLU make up **23% of total global emissions**.
- Land accounts for **44% of net anthropogenic methane emissions**.
- **50% of the nitrogen applied** to agricultural land is **not taken up** by the crop, resulting in nitrous oxide emissions.
- Grazing lands are responsible for more than one-third of total anthropogenic nitrous oxide emissions and one-half of agricultural emissions.
Land Degradation

- Land degradation adversely affects people’s livelihoods and occurs over ¼ of the Earth’s ice-free land area.

- Land use changes and unsustainable land management are direct human causes of degradation. Agriculture is a dominant sector driving degradation.

- Climate change exacerbates the rate and magnitude of land degradation processes.

- There are implications for natural resource-based livelihoods and societal groups.
  - People in degraded areas who depend on natural resources for subsistence, food, and income, including women & youth are especially vulnerable to land degradation & climate change.

- Climate change will have detrimental effects on livelihoods, habitats, & infrastructure due to degradation.
Significant mitigation potential for response options in the global food system

Emissions from the global food system are estimated to be 21-37% of total net anthropogenic GHG emissions.

Response options across the entire food system, from production to consumption, including food losses and wastes, can be deployed and scaled up to support adaptation and mitigation.

A number of agricultural response options (e.g. soil carbon sequestration and agroforestry) deliver co-benefits across land-based challenges.

The total technical mitigation potential from crop and livestock activities and agroforestry is estimated to be between 2.3 and 9.6 Gt CO$_2$e per year by 2050.
Combating desertification and land degradation: co-benefits for the climate

The fight against land degradation has immediate and long-term co-benefits for adaptation and mitigation (high confidence)

Many activities to combat desertification can contribute to climate change adaptation and reduce biodiversity loss with positive spin-offs for sustainable development

Avoiding, limiting and reversing desertification would improve soil fertility, increase carbon storage in soils and biomass, while promoting agricultural productivity and food security (high confidence)
Risks to food supply stability as a result of climate change

The stability of food supply is projected to decrease as the magnitude and frequency of extreme weather events that disrupt food chains increases

Increased atmospheric CO₂ levels can also lower the nutritional quality of crops

Median economic models project a 7% increase in food prices due to climate change by 2050 leading to increased risks of food insecurity

The most vulnerable people will be more severely affected

Increased warming may amplify migration both within countries and across borders
Across countries, the greater the number of land challenges, the fewer the responses with only co-benefits and the lower the human development index (HDI).

<table>
<thead>
<tr>
<th></th>
<th>Challenges</th>
<th>Responses</th>
<th>HDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Challenges</td>
<td>-0.57***</td>
<td>-0.45***</td>
<td>-0.45***</td>
</tr>
<tr>
<td>Responses</td>
<td>-0.04 (NS)</td>
<td>-0.04 (NS)</td>
<td>0.04 (NS)</td>
</tr>
</tbody>
</table>

After IPCC, SR CCL, SPM and Chap. 6, 2019
Potential global contribution of response options to mitigation, adaptation, combating desertification and land degradation, and enhancing food security

Example from Response options based on land management
INCREASED SOIL ORGANIC CARBON CONTENT

<table>
<thead>
<tr>
<th>Increased soil organic carbon content</th>
<th>Mitigation</th>
<th>Adaptation</th>
<th>Desertification</th>
<th>Land degradation</th>
<th>Food security</th>
<th>Cost</th>
</tr>
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<tbody>
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<td></td>
<td>H</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>L</td>
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</tr>
</tbody>
</table>

Key for criteria used to define magnitude of impact of each integrated response option

<table>
<thead>
<tr>
<th>Positive</th>
<th>Mitigation Gt CO₂-eq yr⁻¹</th>
<th>Adaptation Million people</th>
<th>Desertification Million km²</th>
<th>Land Degradation Million km²</th>
<th>Food Security Million people</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large</td>
<td>More than 3</td>
<td>Positive for more than 25</td>
<td>Positive for more than 3</td>
<td>Positive for more than 3</td>
<td>Positive for more than 100</td>
</tr>
<tr>
<td>Moderate</td>
<td>0.3 to 3</td>
<td>1 to 25</td>
<td>0.5 to 3</td>
<td>0.5 to 3</td>
<td>1 to 100</td>
</tr>
<tr>
<td>Small</td>
<td>Less than 0.3</td>
<td>Less than 1</td>
<td>Less than 0.5</td>
<td>Less than 0.5</td>
<td>Less than 1</td>
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<tr>
<td>Negligible</td>
<td>No effect</td>
<td>No effect</td>
<td>No effect</td>
<td>No effect</td>
<td>No effect</td>
</tr>
</tbody>
</table>

Confidence level
Indicates confidence in the estimate of magnitude category.

H  High confidence
M  Medium confidence
L  Low confidence

Cost range
See technical caption for cost ranges in US$ tCO₂-e⁻¹ or US$ ha⁻¹.

Variable: Can be positive or negative
- no data
- na not applicable

After IPCC, SR CCL, SPM, 2019
## Land management responses and their global impacts on land based challenges

### Co-benefits and trade-offs

<table>
<thead>
<tr>
<th>Response options based on land management</th>
<th>Mitigation</th>
<th>Adaptation</th>
<th>Land degradation or Desertification</th>
<th>Food Security</th>
<th>Biodiversity</th>
<th>Ground water stress</th>
<th>Water quality</th>
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</thead>
<tbody>
<tr>
<td>Increased food productivity</td>
<td></td>
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<td>Agroforestry</td>
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<td>Improved cropland management</td>
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<td>Improved livestock management</td>
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<td>Improved grazing land management</td>
<td></td>
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<td>Integrated water management</td>
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<td>Reduced grassland conversion to cropland</td>
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<td>Forest management</td>
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<tr>
<td>Reduced deforestation and degradation</td>
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<td>Reforestation and forest restoration</td>
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<td></td>
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<td>Increased soil organic carbon content</td>
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<tr>
<td>Fire management</td>
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<tr>
<td>Restoration &amp; reduced conversion of coastal wetlands</td>
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<td>Restoration &amp; reduced conversion of peatlands</td>
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<td>Bioenergy and BECCS</td>
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</table>

### Impact of each response option
- **Positive (co-benefit)**
- **Negligible**
- **Negative (trade-off)**

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Limits to Adaptation and Land Based Carbon Sinks

There are limits to the ability to prevent and reverse desertification and land degradation
• Where desertification results in the complete loss of land productivity, the adaptation options available are limited
• For land degradation there are limited options to address: coastal erosion, thawing of permafrost and extreme soil erosion

There are limits to the capacity of the land system to act as a carbon sink (in terms of carbon stored in soils and biomass)
• Mature vegetation and soil carbon reservoirs reach saturation points
• The carbon stored in these systems are vulnerable to loss due to disturbance (e.g. climate events or poor land management)
Some answers are not appropriate to all local challenges

Large-scale deployment of mitigation options such as bioenergy and afforestation would have negative impacts on food security, biodiversity and land degradation:

- From 0.1 to 1 million km² in scenarios with high population and low environmental policies (SSP3)

- From 1 to 4 million km² in low population scenarios and strong environmental policies (SSP1)
### Value chain and risk management response options

<table>
<thead>
<tr>
<th>Response options based on value chain management</th>
<th>Mitigation</th>
<th>Adaptation</th>
<th>Desertification</th>
<th>Land degradation</th>
<th>Food security</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced post-harvest losses</td>
<td>H</td>
<td></td>
<td>L</td>
<td>L</td>
<td>H</td>
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<tr>
<td>Dietary change</td>
<td>H</td>
<td></td>
<td>L</td>
<td>H</td>
<td>H</td>
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<tr>
<td>Reduced food waste (consumer or retailer)</td>
<td>H</td>
<td></td>
<td>L</td>
<td>M</td>
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<tr>
<td>Sustainable sourcing</td>
<td></td>
<td>L</td>
<td></td>
<td>L</td>
<td>L</td>
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<tr>
<td>Improved food processing and retailing</td>
<td>L</td>
<td>L</td>
<td></td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Improved energy use in food systems</td>
<td>L</td>
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<table>
<thead>
<tr>
<th>Response options based on risk management</th>
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<th>L</th>
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</thead>
<tbody>
<tr>
<td>Livelihood diversification</td>
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<td>L</td>
<td>L</td>
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<td>Management of urban sprawl</td>
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<td>L</td>
<td>L</td>
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<td>L</td>
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<tr>
<td>Risk sharing instruments</td>
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<td>L</td>
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</tbody>
</table>
Food losses and waste contribute to 8-10% of anthropogenic GHG emissions. 25 to 30% of food production is lost or wasted (average confidence). A reduction of these losses and wastes could release millions of km² of land by 2050.

Diversification of diets (more fruits, vegetables, protein crops and nuts) and production systems (integrated systems, diversified rotations, genetic diversity, resilient and low-emission livestock) supports climate change adaptation and 'mitigation'.

By 2050, food transitions towards healthy diets could release millions of km² of land with co-benefits for the environment and health and bring about an emission reduction of between 0.7 and 8.0 Gt CO₂eq.
Risks to humans and ecosystems of changes in land based processes as a result of climate change

B. Different socioeconomic pathways affect levels of climate related risks

Socio-economic choices can reduce or exacerbate climate related risks as well as influence the rate of temperature increase. The SSP1 pathway illustrates a world with low population growth, high income and reduced inequalities, food produced in low GHG emission systems, effective land use regulation and high adaptive capacity. The SSP3 pathway has the opposite trends. Risks are lower in SSP1 compared with SSP3 given the same level of GMST increase.

IPCC, SR CCL, SPM, 2019
Pathways linking socioeconomic development, mitigation responses and land

Socioeconomic development and land management influence the evolution of the land system including the relative amount of land allocated to cropland, pasture, bioenergy cropland, forest, and natural land. The lines show the median across Integrated Assessment Models (IAMs) for three alternative shared socioeconomic pathways (SSP1, SSP2 and SSP5 at RCP1.9); shaded areas show the range across models. Note that pathways illustrate the effects of climate change mitigation but not those of climate change impacts or adaptation.

A. Sustainability-focused (SSP1)
Sustainability in land management, agricultural intensification, production and consumption patterns result in reduced need for agricultural land, despite increases in per capita food consumption. This land can instead be used for reforestation, afforestation, and bioenergy.

B. Middle of the road (SSP2)
Societal as well as technological development follows historical patterns. Increased demand for land mitigation options such as bioenergy, reduced deforestation or afforestation decreases availability of agricultural land for food, feed and fibre.

C. Resource intensive (SSP5)
Resource-intensive production and consumption patterns, results in high baseline emissions. Mitigation focuses on technological solutions including substantial bioenergy and BECCS. Intensification and competing land uses contribute to declines in agricultural land.
Enabling Response Options

- **Measuring and monitoring** land use change supported by new information and communication technologies, climate services and climate information

- **Investments in human and institutional capacities** including access to observation, early warning systems, seasonal forecasts are critical

- Government support and **improved access to credit** can overcome barriers to adoption

- Better **access to markets, livelihood diversification strategies, drought preparedness, weather and health insurance, social protection, finance** can address multiple challenges

- **Engaging people** and **good governance** matter
Delivering climate change mitigation and adaptation measures in all sectors will have increasingly negative effects on land and reduce the prospects for sustainable development

Late action in all sectors can reduce the potential of all these options in most parts of the world and limit their effectiveness (high confidence) - could also have irreversible impacts on some ecosystems

Rapid action on climate change mitigation and adaptation, aligned with sustainable land management and sustainable development, will reduce the risks to millions of people from climate extremes, desertification, land degradation and climate change, food insecurity and livelihoods (high confidence)

Postponing GHG emission reductions from all sectors leads to ever greater economic impacts for many countries in many parts of the world (high confidence)
Climate Change and Land

An IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems

Summary for Policymakers

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