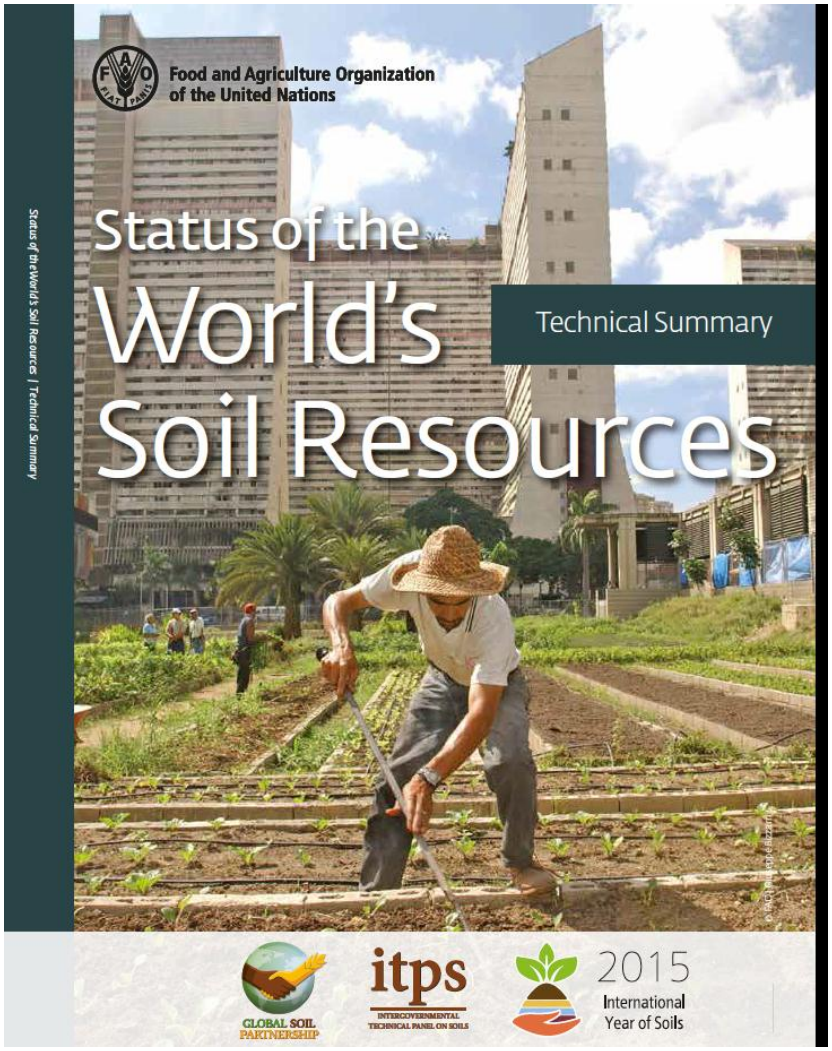
Status of the World's Soil Resources

Dr. Dan Pennock
Canadian Representative
Intergovernmental Technical Panel on Soils

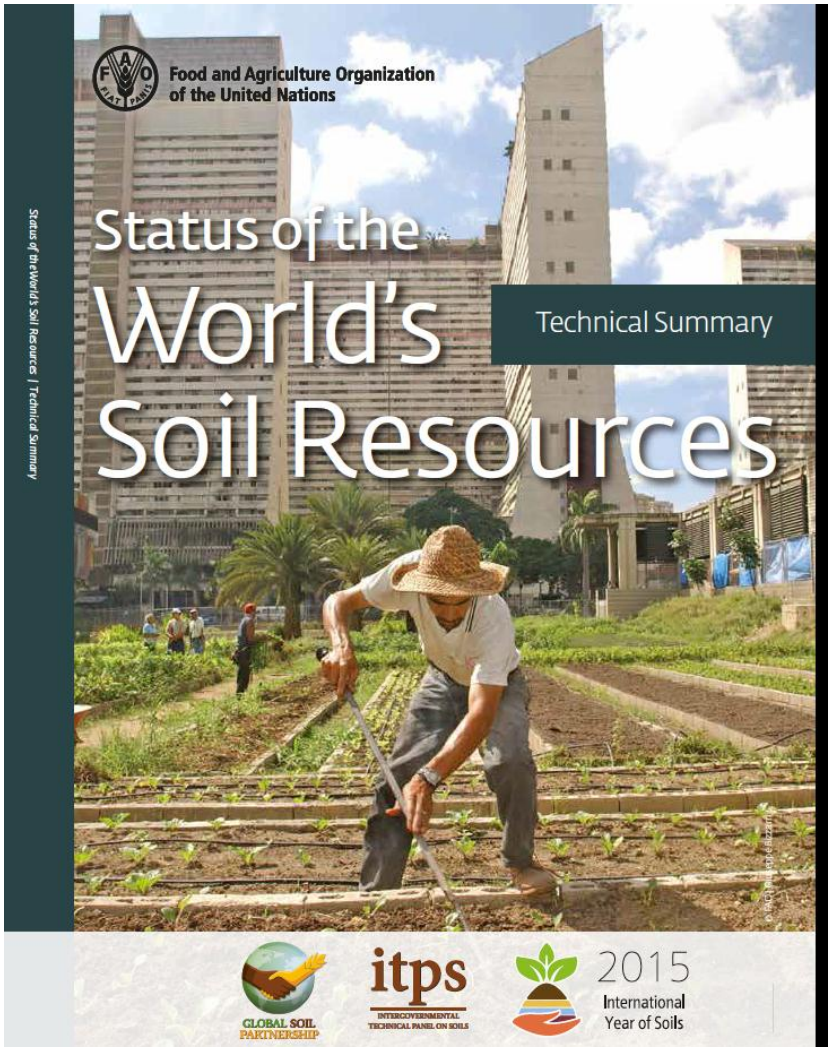


Intergovernmental Technical Panel on Soils (ITPS)

Formed to support work of the Global Soil Partnership

Inaugural meeting in July 2013

2015 International Year of Soils

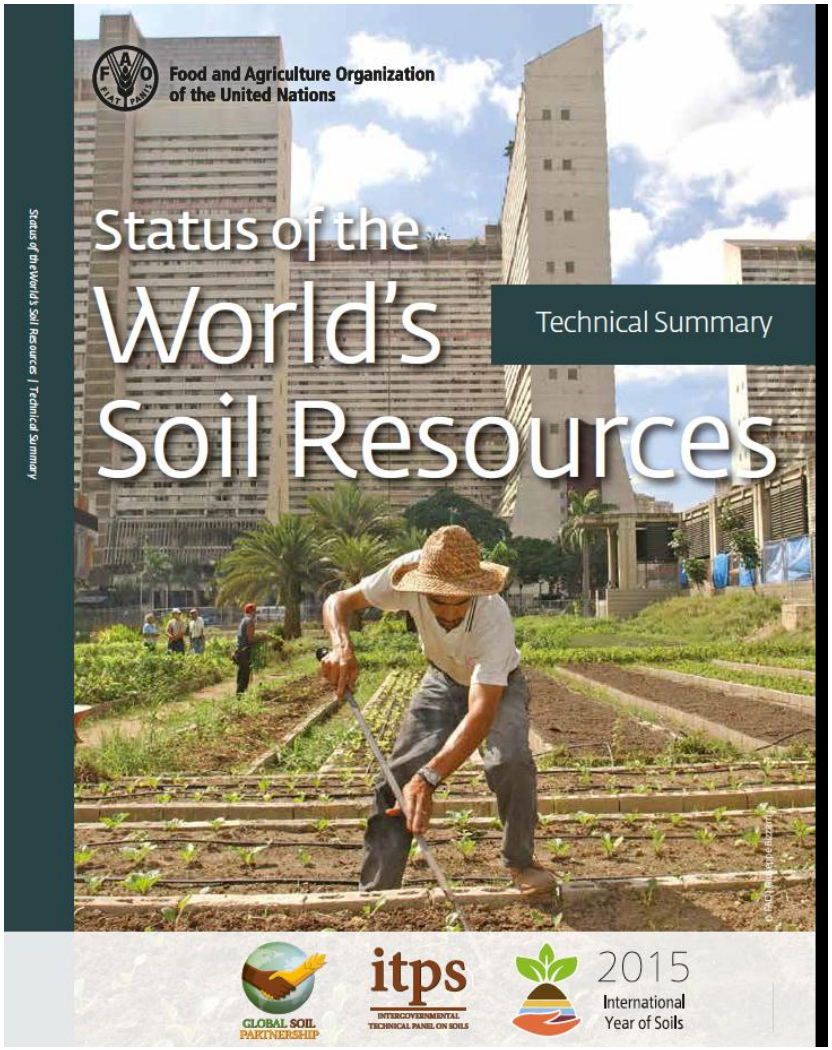


First Editorial Board meeting
for SWSR report

February 10/11 2014

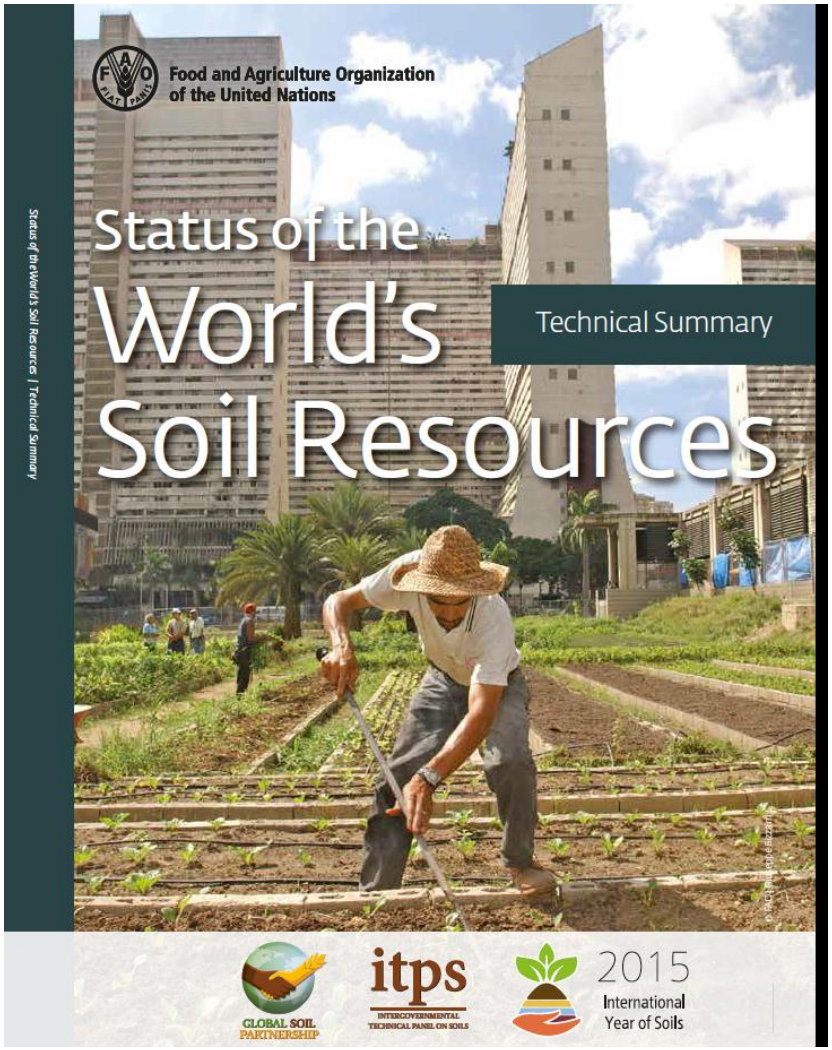
Objective:
Publication of report on
World Soil Day
in the International Year of Soil

2015
International
Year of Soils



World Soil Day

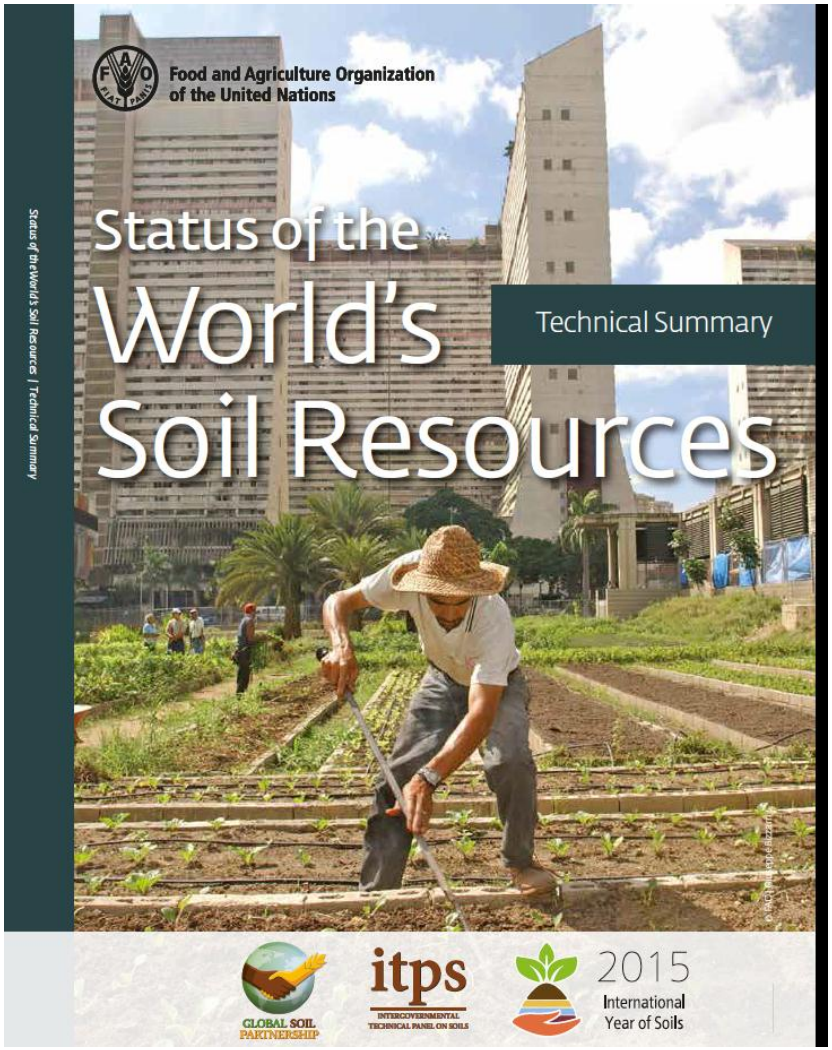
2015
International Year of Soils



Technical Summary:
94 Pages

Main report:
≅300 pages

Regional summaries:
≅300 pages



Over 200 authors from 60 countries

27 Members of ITPS

19 Coordinating Lead Authors

171 Contributing Authors

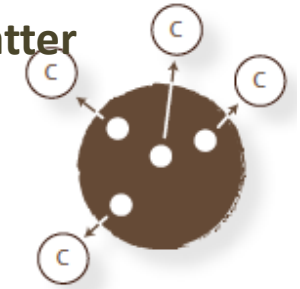
8 Members of Editorial team

1 Managing Editor

Freddy Nachtergaele

Ten Threats to Soil Functions

Soil Organic Matter Loss



Soil Erosion

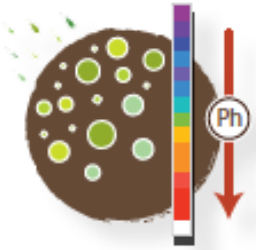
Nutrient Imbalance

Biodiversity Loss

Soil Sealing

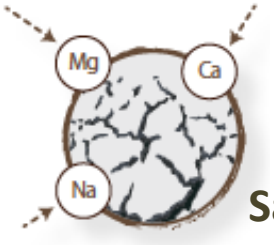
Soil Compaction

Soil Contamination



Soil Acidification

Waterlogging



Soil Salinization

Regional Reports

Status and trend of
ten threats to soil functions
in seven regions

Figure 1 | Regions used for this report. Member countries for each region are presented in the main report.

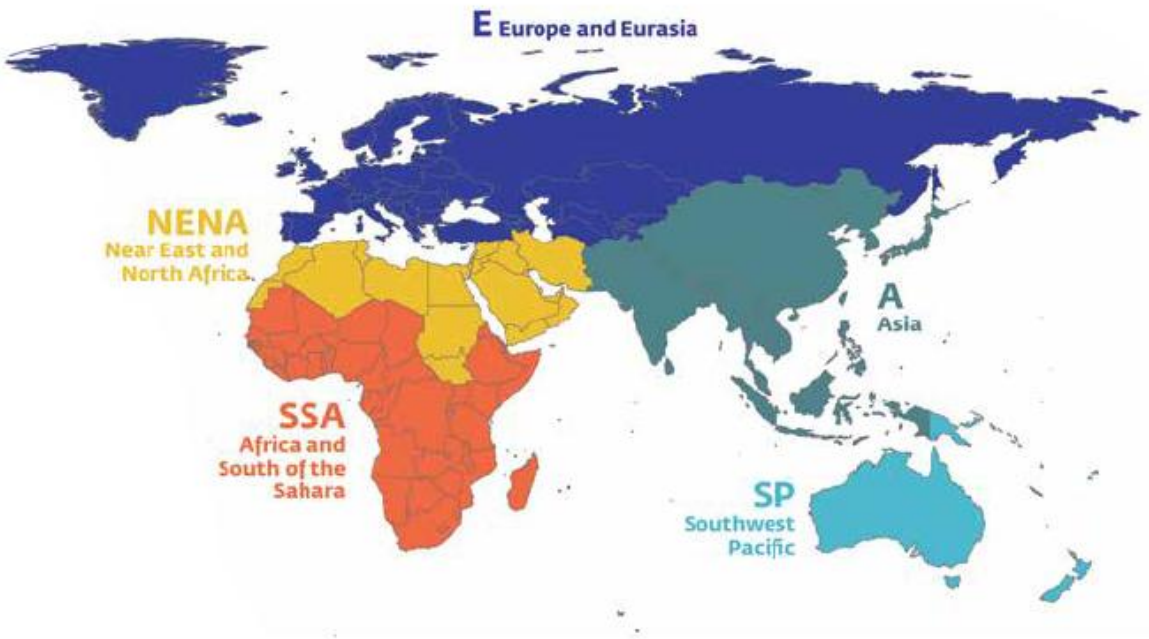
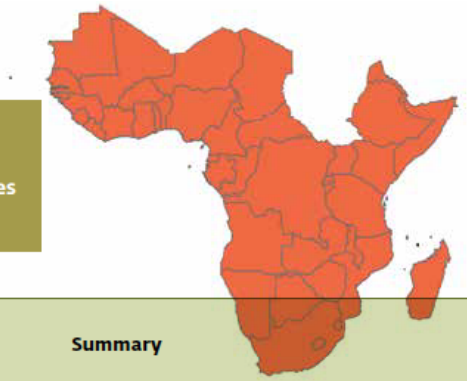


Table 1 | Summary of soil threats (listed in order of importance), condition, trends and uncertainties for South-saharian Africa



Threat to soil function	Summary	Condition and Trend					Confidence	
		Very poor	Poor	Fair	Good	Very good	In condition	In trend
Soil erosion	Soil erosion Erosion constitutes >80% of land degradation in SSA, affecting about 22% of agricultural land and all countries in the region. The majority of causes related to the exposure of the bare soil surface by cultivation, deforestation overgrazing and drought.		↓					
Organic carbon change	The replacement of the natural vegetation reduces nearly always the soil carbon level. Further carbon release from the soil is caused by complete crop removal from farmlands, the high rate of organic mater decomposition by microbial decomposition accentuated by high soil temperature and termite activates in parts of SSA.		↓					
Nutrient imbalance	Nutrient imbalance, which is generally manifested by the deficiency of key essential nutrients is mainly due to the fact that fertilization has not been soil and crop specific, farmers are unable to pay the price for fertilizers and the inability to follow the rates that are recommended. Nearly all countries in the region show a negative nutrient balance.		↓					
Loss of soil biodiversity	SSA suffers the world's highest annual deforestation rate. The areas most affected are the in the moist areas of West Africa and the highland forests of the Horn of Africa. Cultivation, introduction of new species, oil exploration and pollutions reduce the population of soil organisms thus reducing faunal and microbial activities.			↓				
Soil acidification	Over 25% of soils in Africa are acidic. Most of these occur in the moister parts of the Continent. In South Africa it poses as a serious chemical problem and the greatest production-limiting factor.		↓					
Salinisation	Salinisation is the build-up of salt in the soil due to irrigation from ground water high soluble salt and poor drainage. It can lead to a decrease in soil productivity.		↑↓					
Waterlogging	Most waterlogging threats are due to rise in water table due to poor infiltration/drainage or occurrence of impervious layer in the subsoil. Waterlogging generally reduces crop productivity, but in paddy fields are deliberate and beneficial.				=			
Compaction	The major cause of compaction is impact of pressure on the soil from heavy machinery. It is more serious in forested regions where land clearing (and even other cultivation activities) cannot be done without mechanization.				=			
Soil sealing and land take	These constitute problems mainly in peri-urban agriculture and valley sites used for dry-season vegetable production				=			
Soil pollution	Soil contamination by chemicals (fertilizers, petroleum products, pesticides, herbicides, mining) has affected agricultural productivity and other ecosystem services negatively. Nigeria and South africa may be most affected.				↓			

Region	Soil erosion	Organic carbon change	Nutrient imbalance	Salinization	Soil sealing	Loss of biodiversity	Soil pollution	Acidification	Compaction	Water-logging
 Sub-Saharan Africa	Poor ↘	Poor ↘	Poor ↘	Fair ⇄	Good =	Fair ↘	Good ↘	Poor ⇄	Good =	Good =
 Asia	Poor ↘	Poor ⇄	Poor ↘	Poor ⇄	Poor ↘	Fair ⇄	Poor ↘	Poor ↘	Poor ↘	Fair ↘
 Europe and Eurasia	Fair ↗	Poor ⇄	Poor ⇄	Poor ↘	Poor ↘	Fair ↘	Poor ↗	Poor ⇄	Fair ⇄	Fair ⇄
 Latin America and the Caribbean	Poor ↘	Poor ↘	Poor ↘	Poor ↘	Fair ⇄	Poor ↘	Fair ⇄	Fair ⇄	Poor ↘	Fair =
 Near East and North Africa	Very Poor ↘	Poor ↘	Good ⇄	Fair ↘	Very Poor ↘	Poor ↘	Very Poor ↘	Good ⇄	Poor ↘	Good ⇄
 North America	Fair ↗	Fair ↗	Poor ↘	Good ↗	Fair ↘	Good ⇄	Good ↗	Poor ↘	Fair ⇄	Good ⇄
 Southwest Pacific	Fair ↗	Fair ⇄	Fair ↘	Good ⇄	Good ↘	Good ⇄	Good ↗	Fair ↘	Fair ⇄	Good ⇄

Threat to soil function	Condition and Trend				
	Very poor	Poor	Fair	Good	Very good
Soil erosion	↓ NENA	↓ A ↓ LAC ↓ SSA	↑ E ↑ NA ↑ SP		
Organic carbon change		↑↓ A ↑↓ E ↓ LAC ↓ NENA ↓ SSA	↑ NA ↑↓ SP		
Nutrient imbalance		↓ A ↑↓ E ↓ LAC ↓ SSA ↓ NA	↓ SP	↑↓ NENA	
Salinization and sodification		↑↓ A ↓ E ↓ LAC	↓ NENA ↑↓ SSA	↑ NA ↑↓ SP	
Soil sealing and land take	↓ NENA	↓ A ↓ E	↑↓ LAC ↓ NA	= SSA ↓ SP	
Loss of soil biodiversity		↓ NENA ↓ LAC	↑↓ A ↓ E ↓ SSA	↑↓ NA ↑↓ SP	
Contaminaton	↓ NENA	↓ A ↑ E	↑↓ LAC	↓ SSA ↑ NA ↑ SP	
Acidification		↓ A ↑↓ E ↑ SSA ↓ NA	↑↓ LAC ↓ SP	↑↓ NENA	
Compaction		↓ A ↓ LAC ↓ NENA	↑↓ E ↑↓ NA ↑↓ SP	= SSA	
Waterlogging			↓ A ↑↓ E = LAC	↑↓ NENA = SSA ↑↓ NA ↑↓ SP	

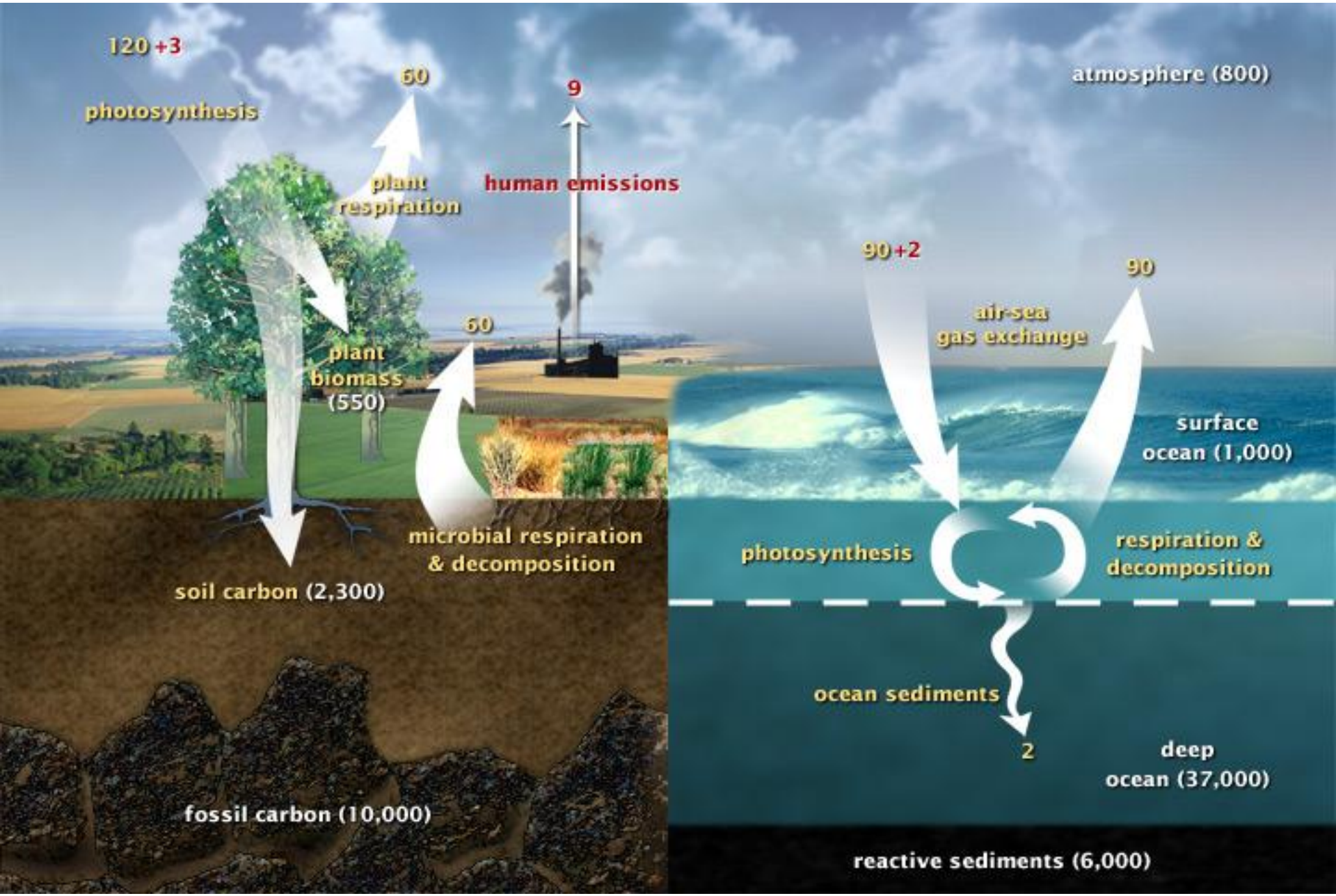
Stable = Variable ↑↓ Improving ↑ Deteriorating ↓

Based on the summary of the regional reports, the ITPS designated four key actions to address the highest priorities

Priority 1

Soil Organic Carbon and Climate Change

Soils are the greatest terrestrial reservoir of carbon



http://earthobservatory.nasa.gov/Features/CarbonCycle/

Priority 1

Sustainable soil management can increase the amount of carbon stored in soils and hence decrease the carbon content of the atmosphere

The « 4 for 1000 »

Fighting climate change by storing carbon in soil biomass

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE

MINISTÈRE
DE L'AGRICULTURE
DE L'AGROALIMENTAIRE
ET DE LA FORÊT

"This international research program combines food security and climate change mitigation objectives, and can therefore commit all involved countries to COP 21"

Stéphane LeFoll, Minister of Agriculture, Food and Forest

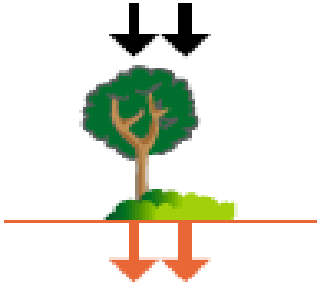
Greenhouse gas **emissions** coming from fossil carbon represent **8.9** billion tons of carbon per year

8,9

CO_2 **emissions**

Soils worldwide contain **2400** billion tons of organic carbon

CO_2 absorption by plants



Organic carbon storage in soils

2 400

Carbon emitted in CO_2 form **8,9** / Carbon stored in organic form **2 400** = ratio **4‰**

Thus,

if we increase carbon stored in soil by 4‰, we compensate CO_2 emissions coming from fossil carbon, which are mainly responsible for greenhouse effect and climate change.

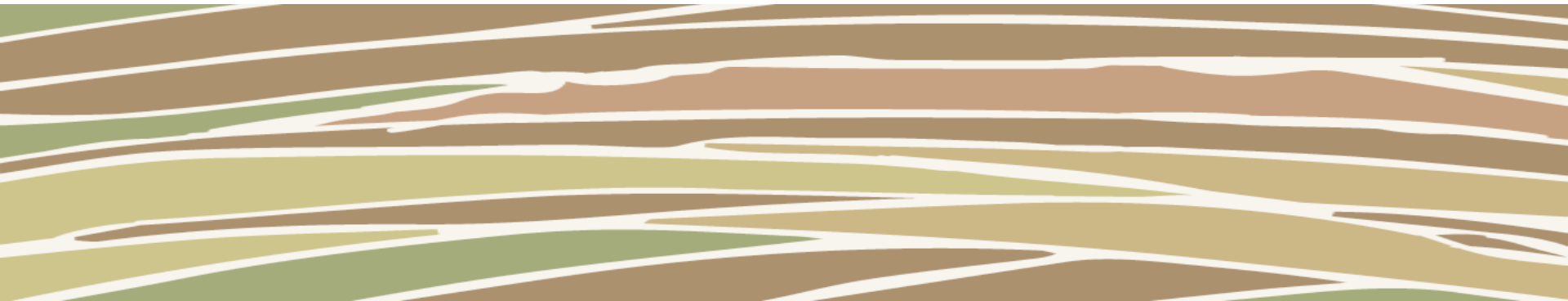
Increase in CO_2 absorption by plants: agricultural land, grassland and forests

+4‰ carbon stored in soil worldwide = 0 CO_2 emissions in the air

Action:

The global stores of soil organic matter (i.e. soil organic carbon (SOC) and soil organisms) should be stabilized or increased.

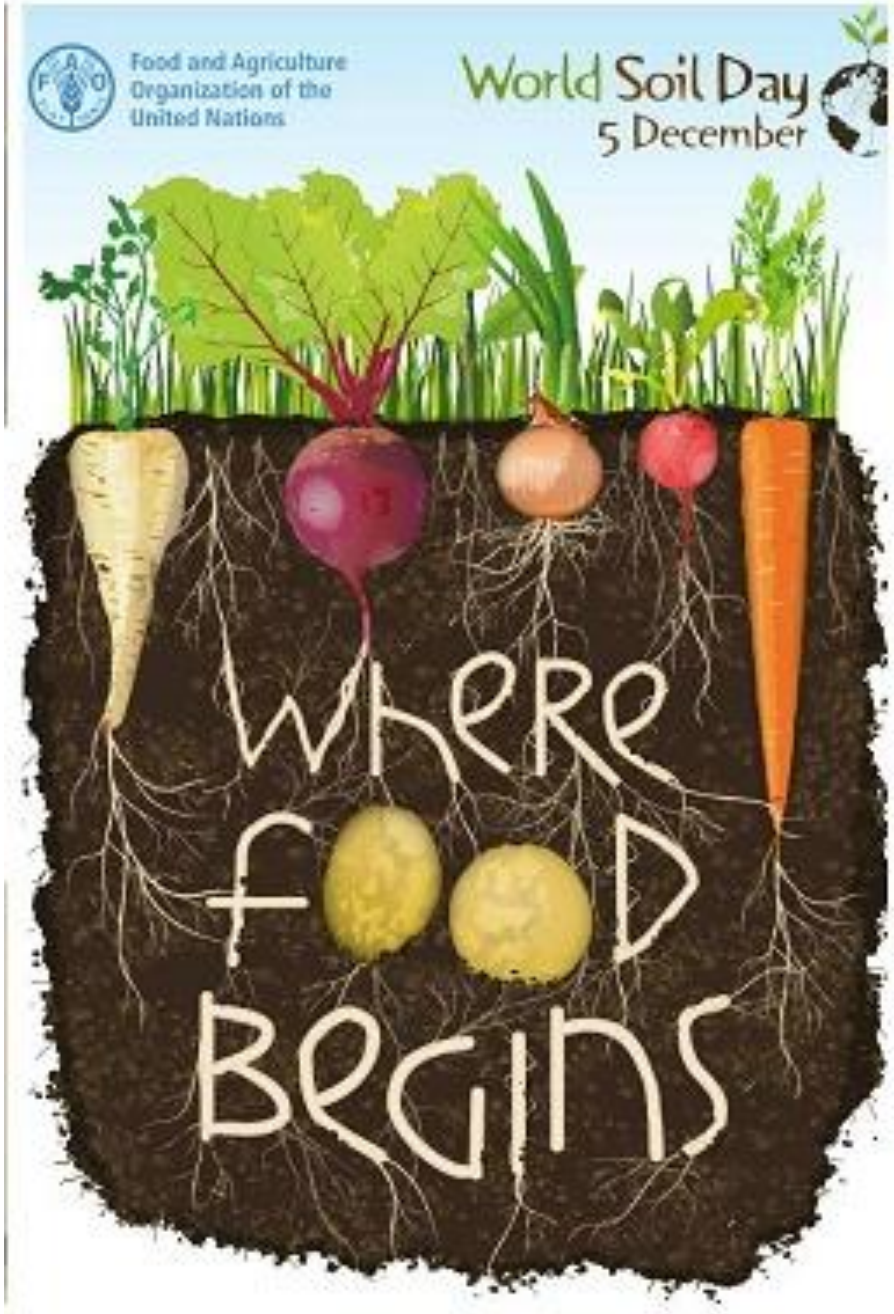
Each nation should work towards a national level goal of achieving a stable or positive net SOC balance.



Priority 2

Soils and Food Security

The soil provides nutrients and water that are essential for plant production

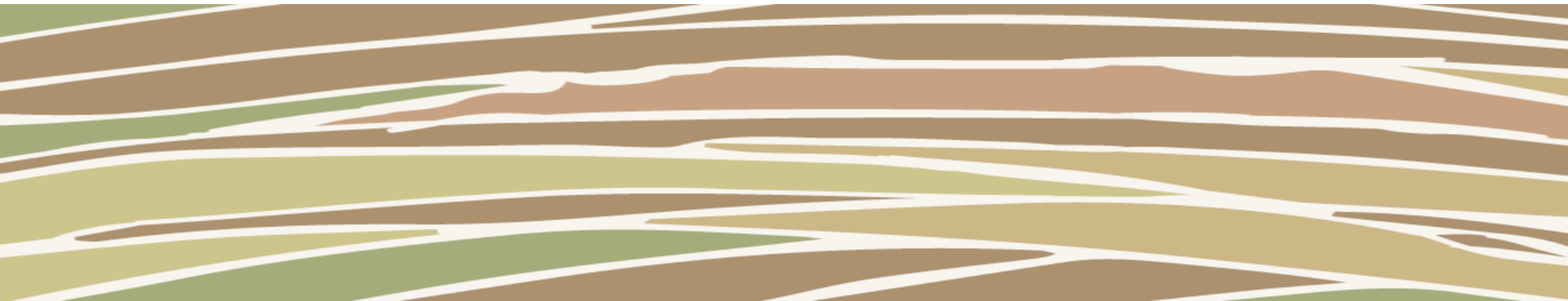

Food and Agriculture Organization of the United Nations
World Soil Day
5 December
where food begins

Priority 2

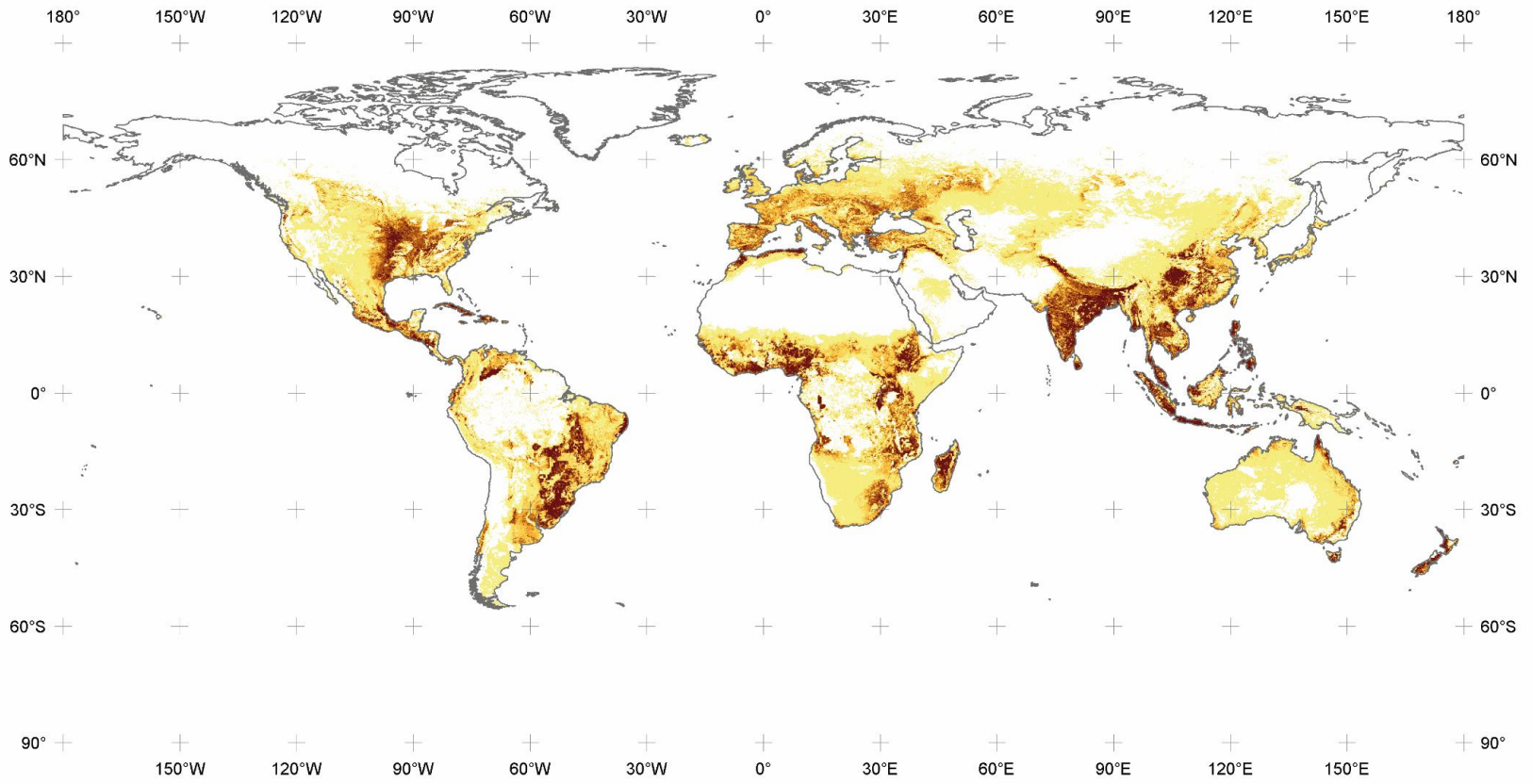
Soils and Food Security

Soil degradation reduces crop yields

Report examines effect of 10 soil threats on food production



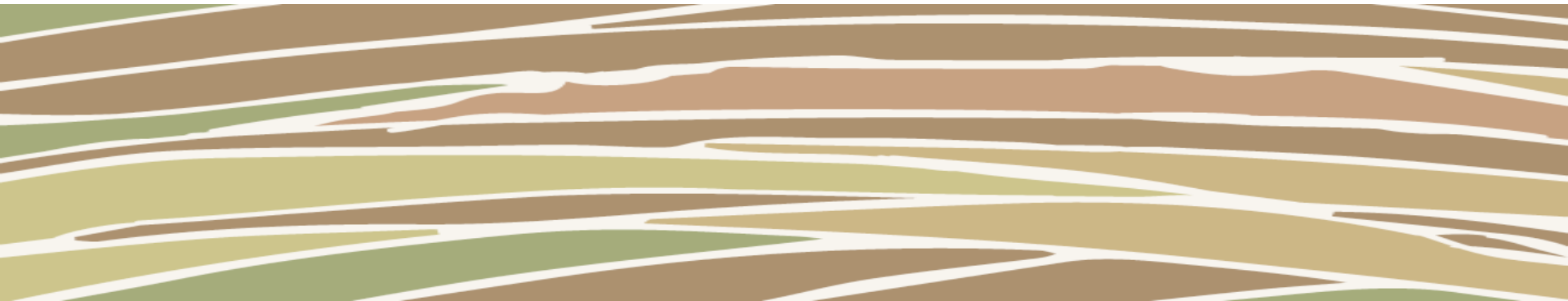
Soil Erosion



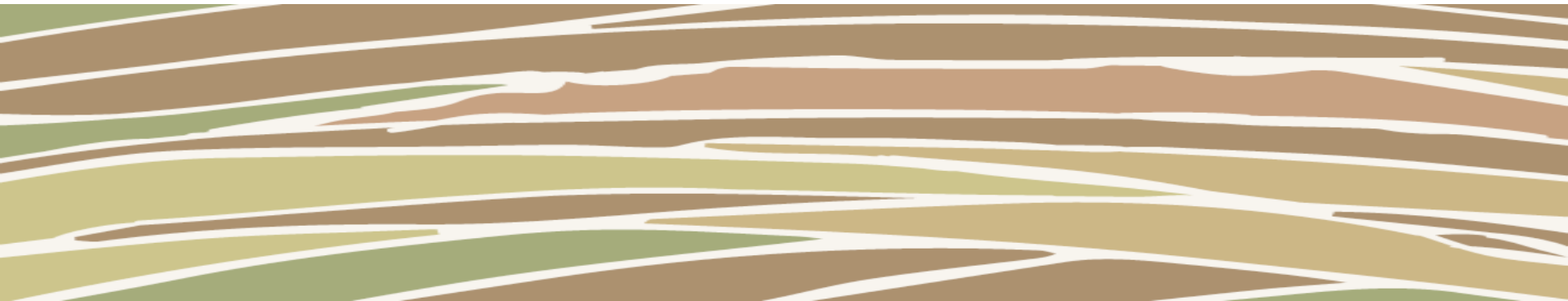
Soil Erosion

Annual crop losses due to erosion have been estimated at 0.3% of global crop yields.

If erosion continues at this rate, a total yield reduction of over 10 percent could take place by the year 2050.



Yield losses due to degradation must be replaced by either bringing new land into agriculture or increasing yields on currently used crop land



ITPS Action:

We should minimize further degradation of soils and restore the productivity of soils that are already degraded in those regions where people are most vulnerable.

This action specifically addresses two SDG targets

SDG Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture.

By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality

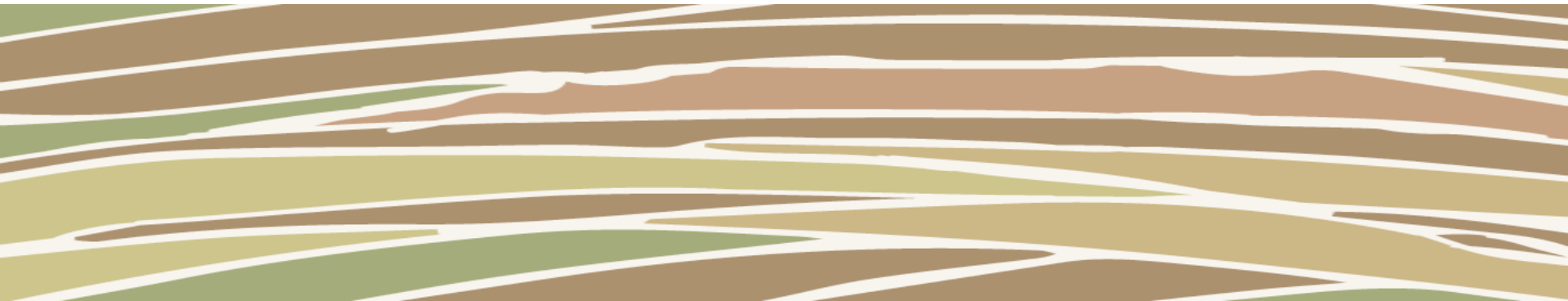
SDG Goal 15: Sustainably manage forest, combat desertification, halt and reverse land degradation, halt biodiversity loss.

By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world

Priority 3

Soils and Ecosystem Services

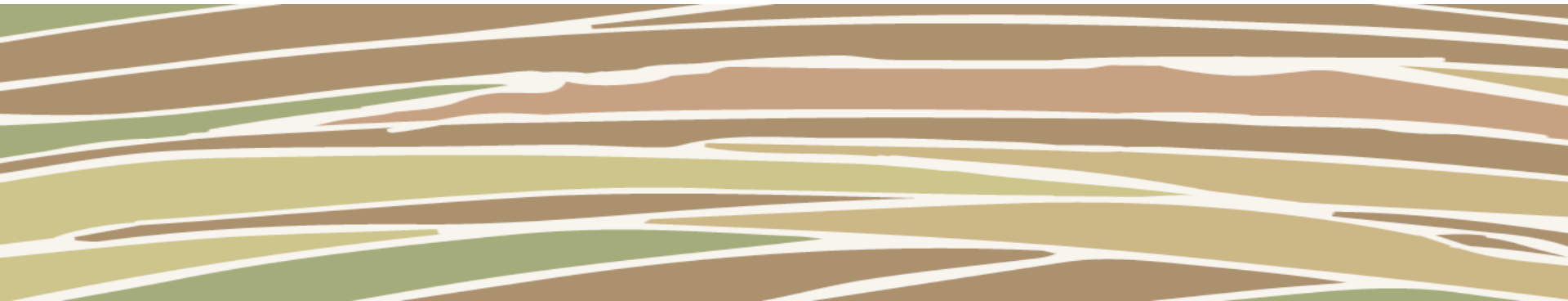
Soils provide a range of ecosystem services such the regulation of water quality and water quantity and are a major reservoir for global biodiversity

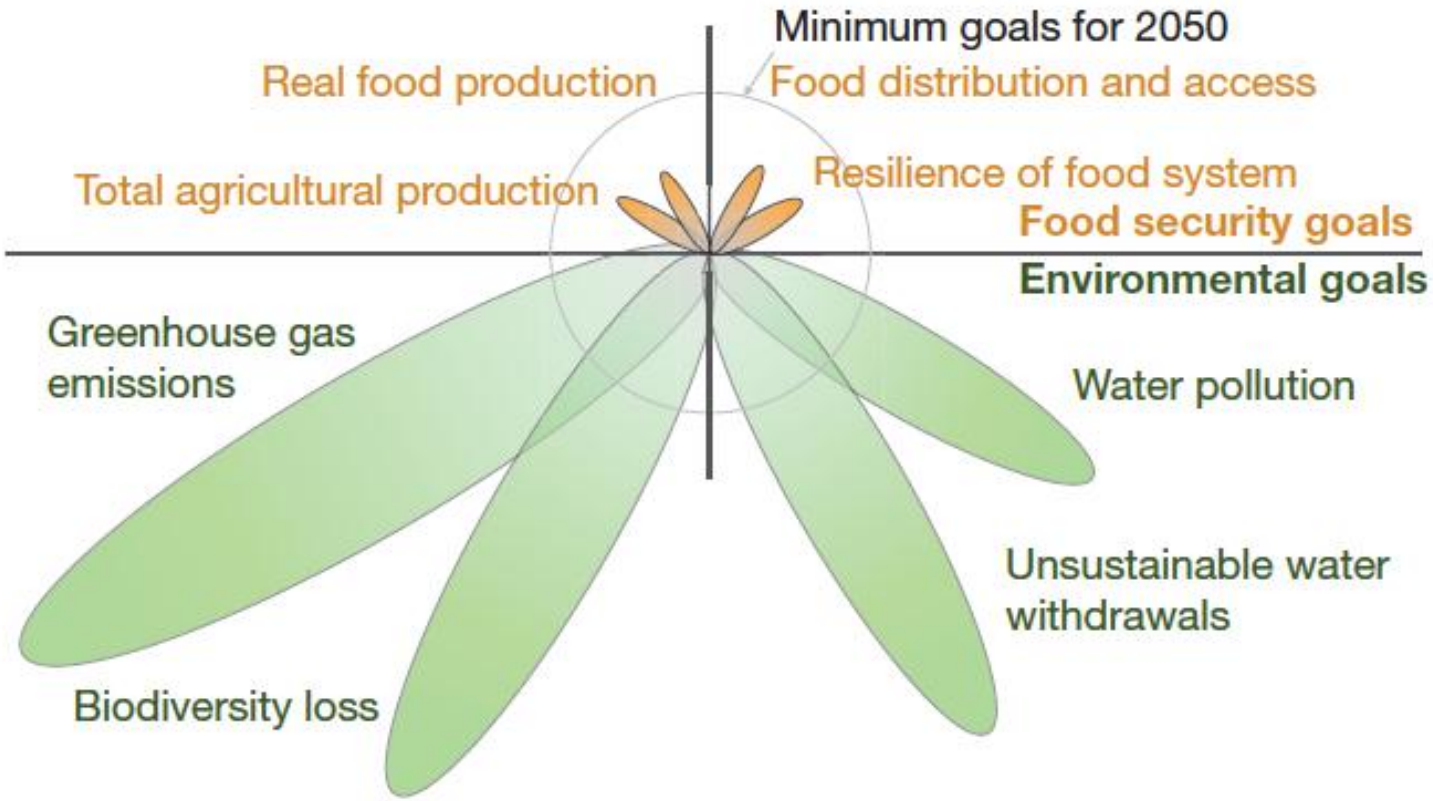


Priority 3

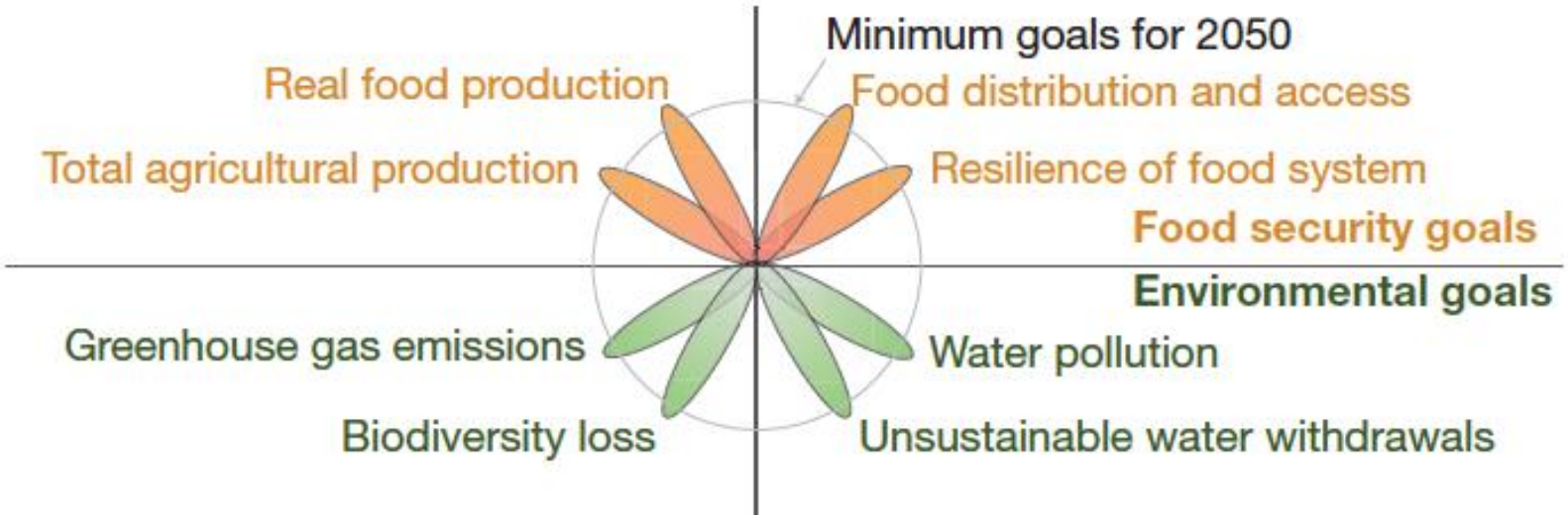
Soils and Ecosystem Services

Balancing food production and maintenance of other essential ecosystem services a key aspect of sustainable soil management



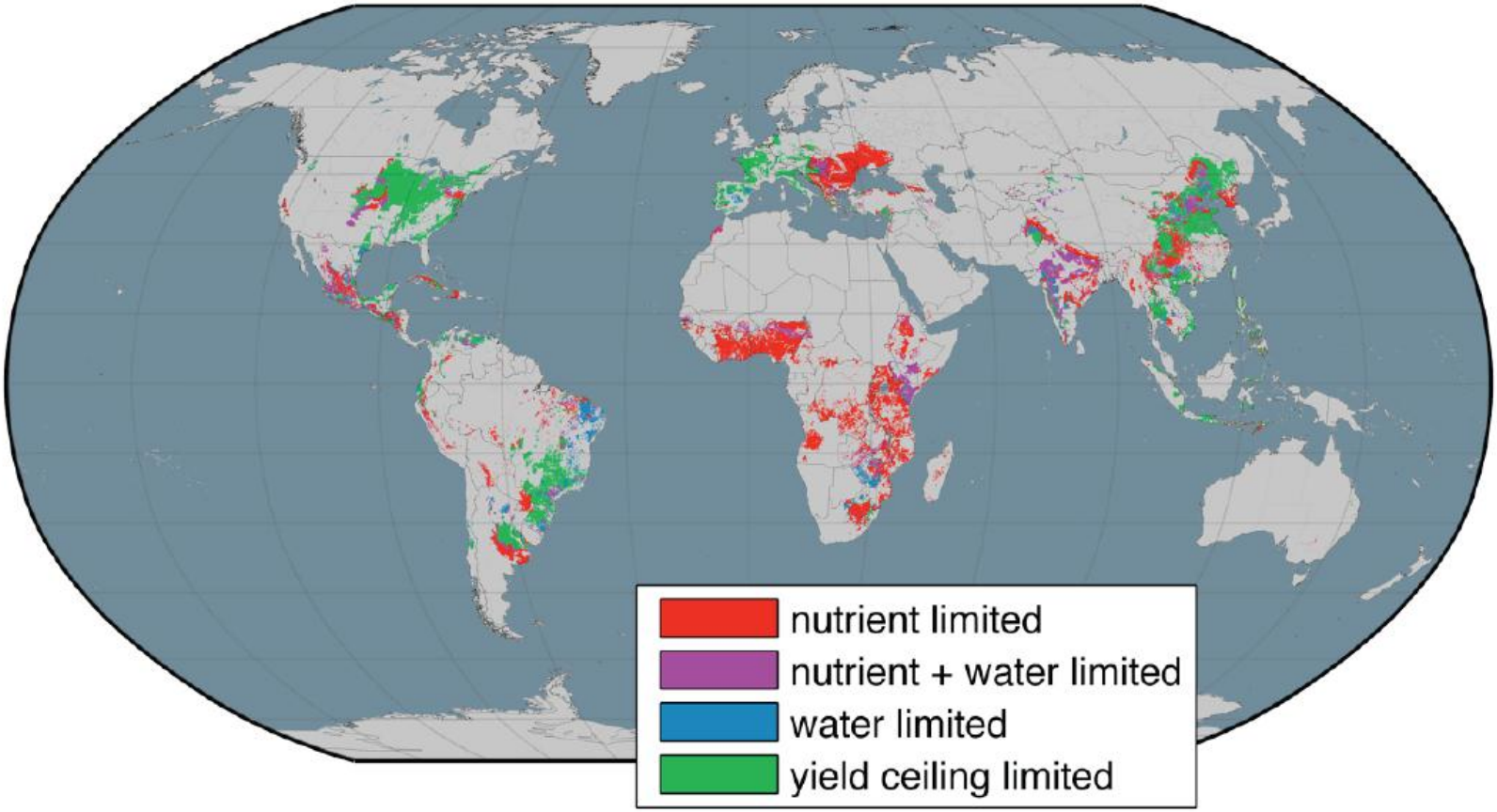


Foley et al. Nature. 2011

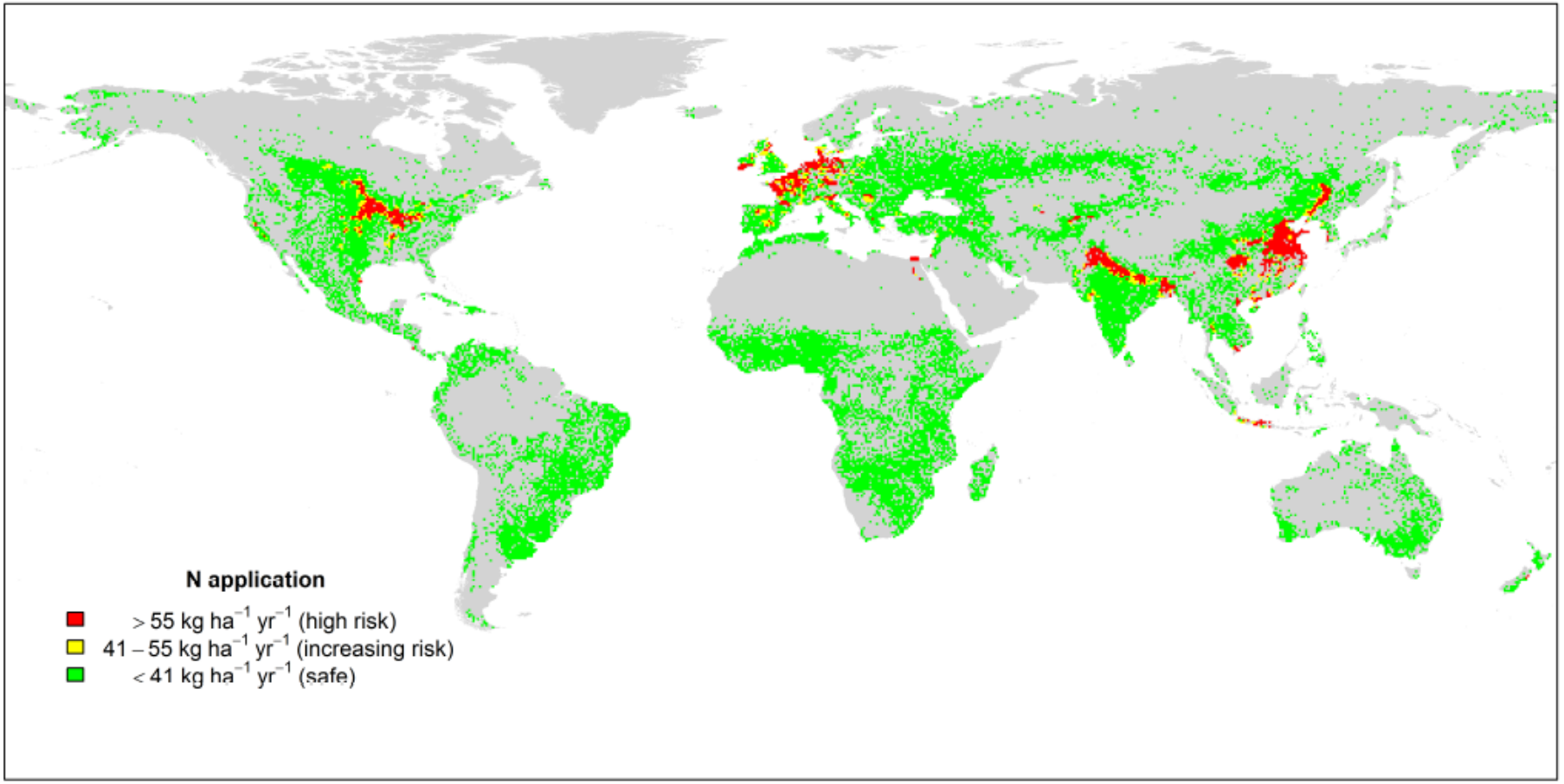


Foley et al. Nature. 2011

maize: factors limiting yield increase of 50%



Foley et al. Nature. 2011



Steffen et al. 2015

Action:

We should act to stabilize or reduce global nitrogen and phosphorus fertilizer use while simultaneously increasing fertilizer use in regions of nutrient deficiency.

Increasing the efficiency of nitrogen and phosphorus use by plants is a key requirement to achieve this goal.

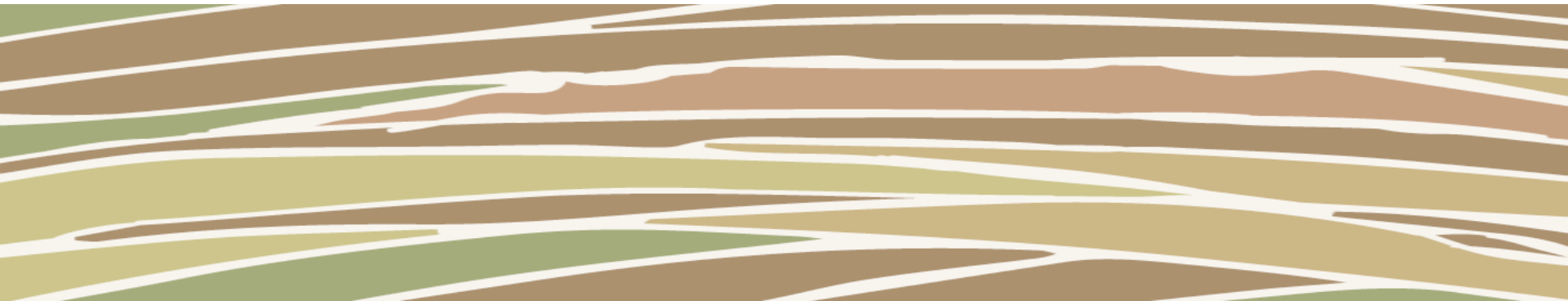
Priority 4:

Is the adoption of sustainable soil management at the global scale increasing or decreasing?

Is the adoption of sustainable soil management at the global scale increasing or decreasing?

The regional assessments in this report frequently base their evaluations on studies from the 1990s based on observations made in the 1980s or earlier.

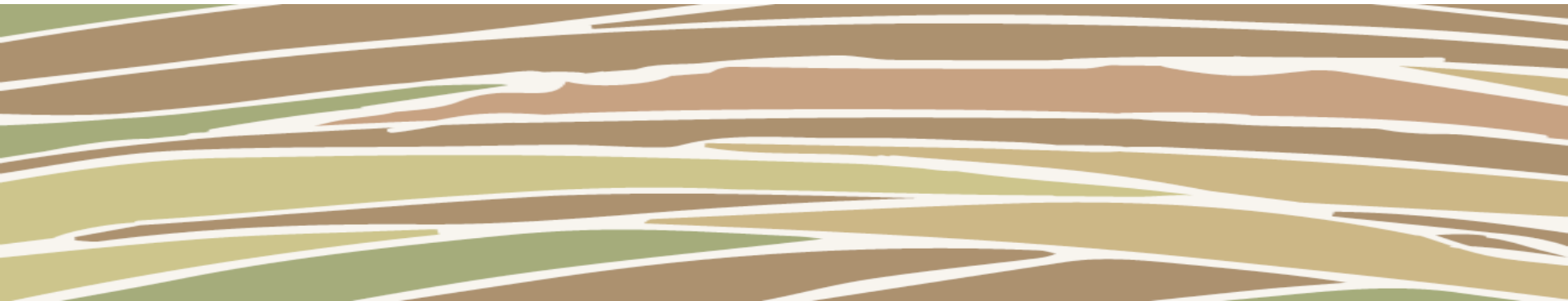
Twenty-five years or more out of date.

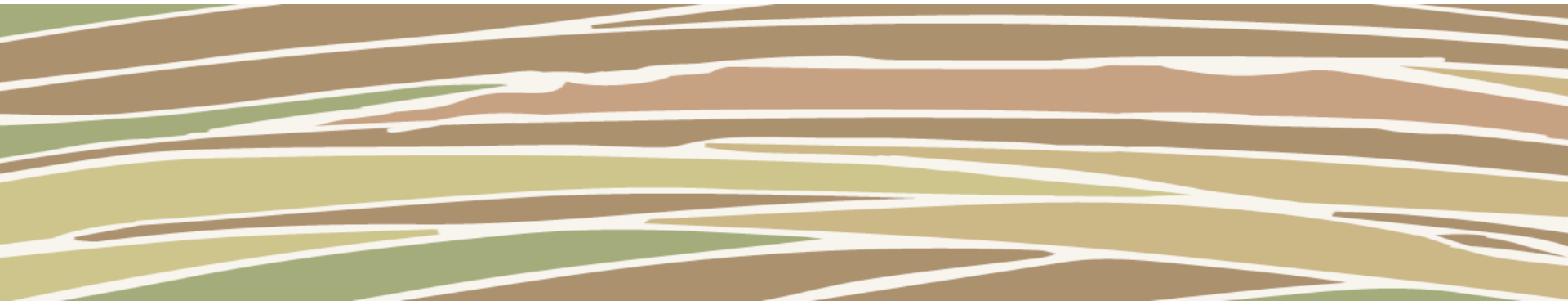


Action:

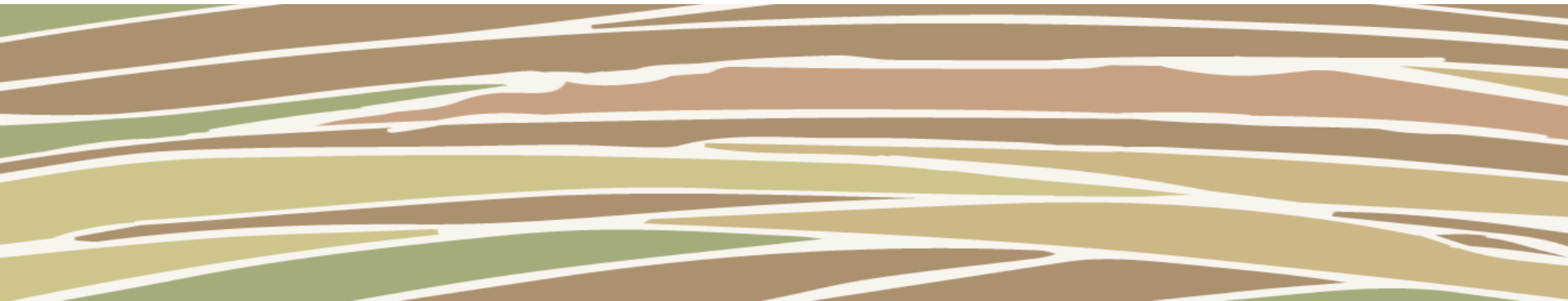
We must improve our knowledge about the current state and trend of the soil condition.

An initial emphasis should be on improving observation systems to monitor our progress in achieving the three priorities outlined above





Soils are Fundamental to Life on Earth



Soils are Fundamental to Life on Earth

Status of the World's Soil Resources

GLOBAL SOIL PARTNERSHIP

itps

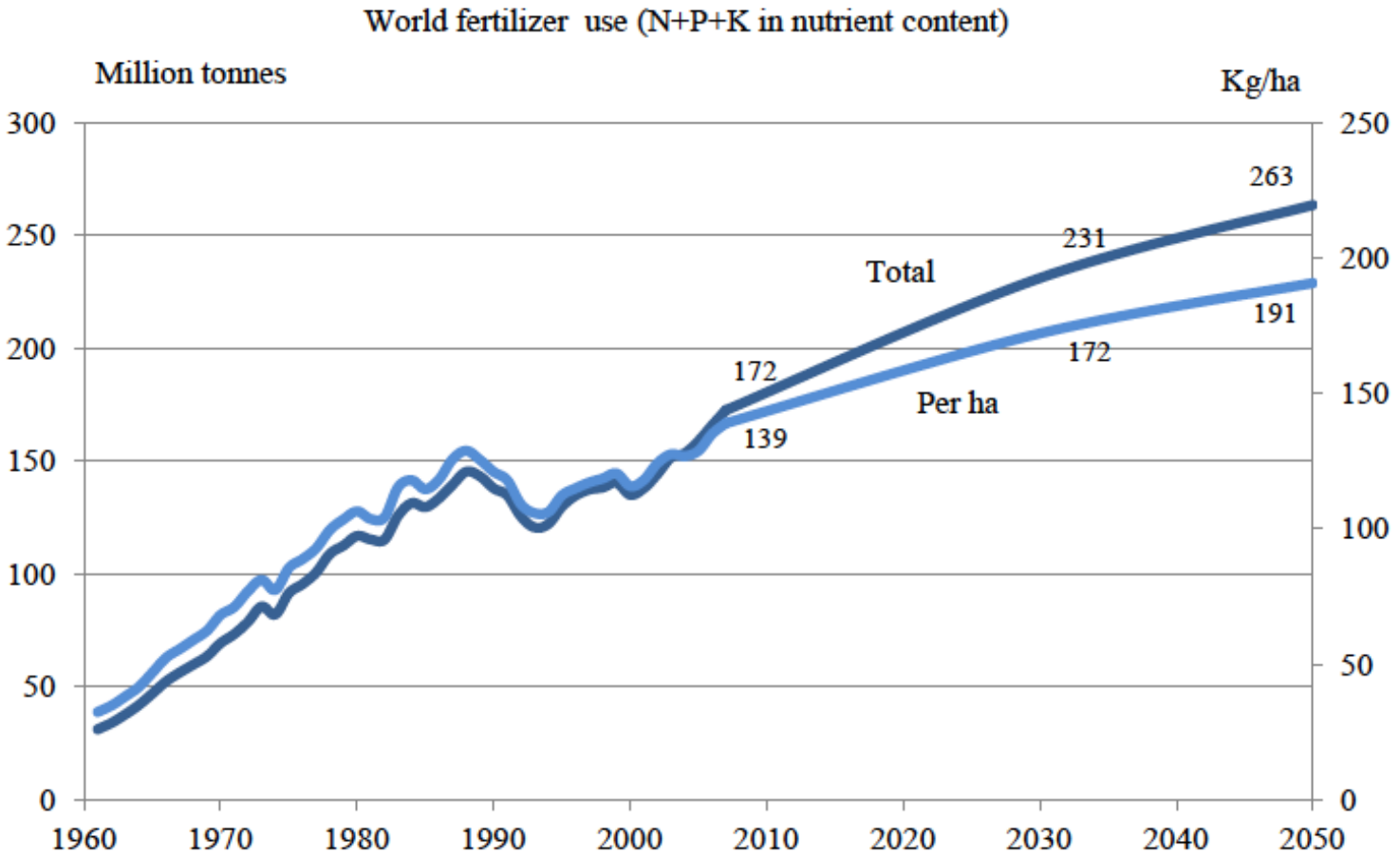
INTERGOVERNMENTAL TECHNICAL PANEL ON SOILS

2015 International Year of Soils

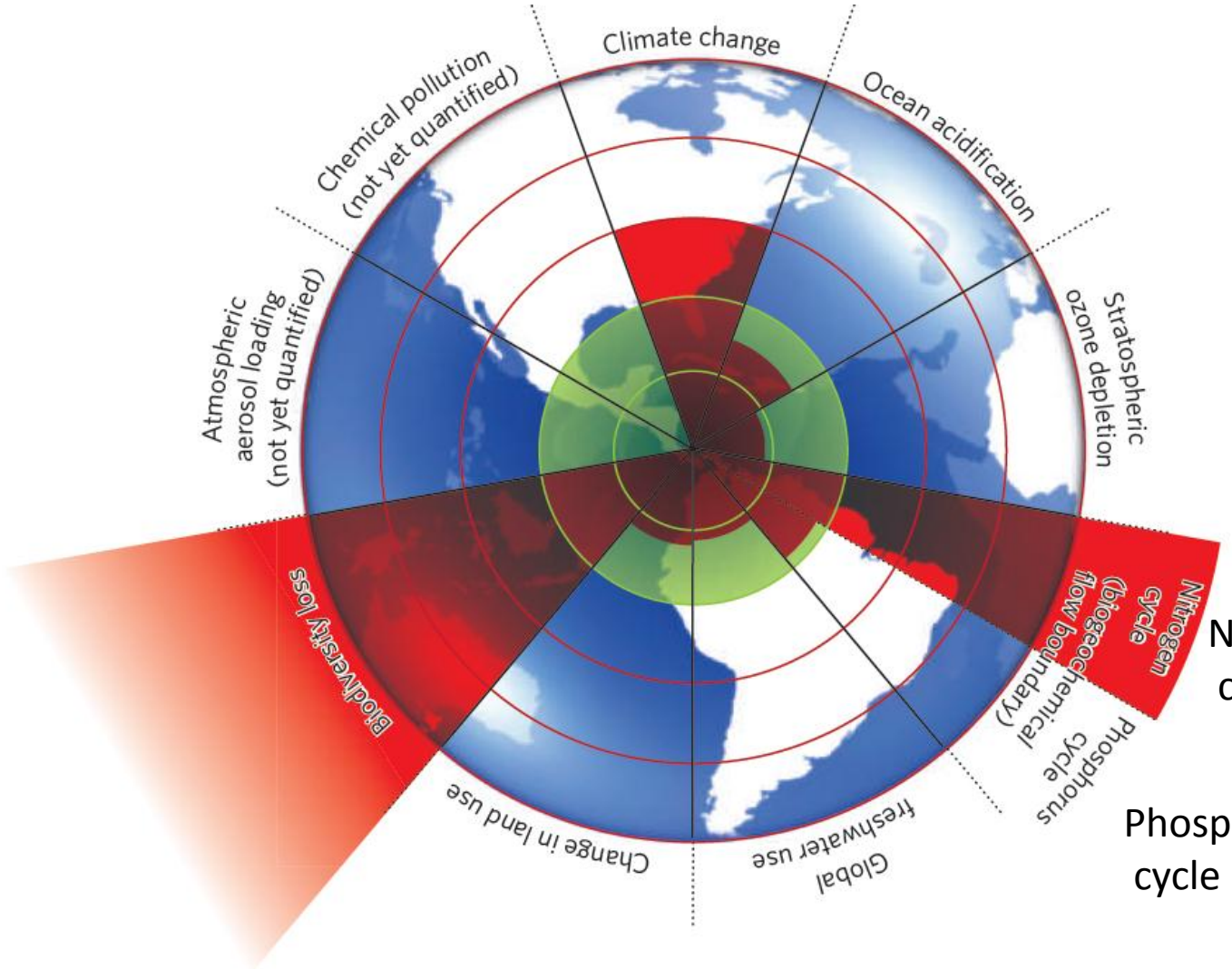
2015

International Year of Soils

Figure 4.12 World fertilizer consumption: past and projected



Alexandratos and Brunisma, 2012
World Agriculture Towards 2030/50
FAO



Nitrogen cycle

Phosphorus cycle

Figure 1 | Beyond the boundary. The inner green shading represents the proposed safe operating space for nine planetary systems. The red wedges represent an estimate of the current position for each variable. The boundaries in three systems (rate of biodiversity loss, climate change and human interference with the nitrogen cycle), have already been exceeded.

Rockström et al. Nature. 2009