



Food and Agriculture Organization
of the United Nations

Status of the World's Soil Resources

Main Report

Introductory
information

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Status of the World's Soil Resources

Main report

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Foreword

This document presents the first major global assessment ever on soils and related issues.

Why was such an assessment not carried out before? We have taken soils for granted for a long time. Nevertheless, soils are the foundation of food production and food security, supplying plants with nutrients, water, and support for their roots. Soils function as Earth's largest water filter and storage tank; they contain more carbon than all above-ground vegetation, hence regulating emissions of carbon dioxide and other greenhouse gases; and they host a tremendous diversity of organisms of key importance to ecosystem processes.

However, we have been witnessing a reversal in attitudes, especially in light of serious concerns expressed by soil practitioners in all regions about the severe threats to this natural resource. In this more auspicious context, when the international community is fully recognizing the need for concerted action, the Intergovernmental Technical Panel on Soils (ITPS), the main scientific advisory body to the Global Soil Partnership (GSP) hosted by the Food and Agriculture Organization of the United Nations (FAO), took the initiative to prepare this much needed assessment.

The issuance of this first "Status of the World's Soil Resources" report was most appropriately timed with the occasion of the International Year of Soils (2015) declared by the General Assembly of the United Nations. It was made possible by the commitment and contributions of hosts of reputed soil scientists and their institutions. Our gratitude goes to the Lead Authors, Contributing Authors, Editors and Reviewers who have participated in this effort, and in particular to the Chairperson of the ITPS, for his dedicated guidance and close follow up.

Many governments have supported the participation of their resident scientists in the process and contributed resources, thus also assuring the participation of experts from developing countries and countries with economies in transition. In addition, a Technical Summary was acknowledged by representatives of governments assembled in the Plenary Assembly of the GSP, signaling their appreciation of the many potential uses of the underlying report. Even more comprehensive and inclusive arrangements will be sought in the preparations of further, updated versions.

The report is aimed at scientists, laymen and policy makers alike. It provides in particular an essential benchmark against periodical assessment and reporting of soil functions and overall soil health at global and regional levels. This is of particular relevance to the Sustainable Development Goals (SDGs) that the international community pledged to achieve. Indeed, these goals can only be achieved if the crucial natural resources – of which soils is one – are sustainably managed.

The main message of this first edition is that, while there is cause for optimism in some regions, the majority of the world's soil resources are in only fair, poor or very poor condition. Today, 33 percent of land is moderately to highly degraded due to the erosion, salinization, compaction, acidification and chemical pollution of soils. Further loss of productive soils would severely damage food production and food security, amplify food-price volatility, and potentially plunge millions of people into hunger and poverty. But the report also offers evidence that this loss of soil resources and functions can be avoided. Sustainable soil management, using scientific and local knowledge and evidence-based, proven approaches and technologies, can increase nutritious food supply, provide a valuable lever for climate regulation and safeguarding ecosystem services.

We can expect that the extensive analytical contents of this report will greatly assist in galvanizing action at all levels towards sustainable soil management, also in line with the recommendations contained in the updated World Soil Charter and as a firm contribution to achieve the Sustainable Development Goals.

We are proud to make this very first edition of the Status of the World's Soil Resources report available for the international community, and reiterate once again our commitment to a world free of poverty, hunger and malnutrition.

JOSÉ GRAZIANO DA SILVA
FAO Director-General



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Appreciation is expressed to many Governments who have supported the participation of their resident scientists in this major enterprise. In particular, our gratitude to the European Commission who financially supported the development and publication of this report.

List of abbreviations

AAFC	Agriculture and Agri-Food Canada
ACSAD	Arab Centre for the Study of Arid Zones and Dry Lands
AD	Anno Domini
AEZ	Agro-Ecological Zones
AFES	Association Française Pour L'étude Du Sol
AFSIS	African Soil Information Service
AGES	Austrian Agency for Health and Food Safety
AGRA	Alliance for a Green Revolution in Africa
AKST	Agricultural Knowledge Science and Technology
ALOS	Advanced Land Observation Satellite
AMA	Agencia De Medio Ambiente
AMF	Arbuscular Mycorrhizal Fungi
ANC	Acid-Neutralising Capacity
AOAD	Arab Organization for Agricultural Development
AOT	Aerosol Optical Thickness
APO-FFTC	Asian Productivity Organization- Food & Fertilizer Technology Center
ARC	Agricultural Research Council
ASGM	Artisanal and Small-Scale Gold Mining
ASI	Advanced Science Institutesseries
ASP	Asia Soil Partnership
ASSOD	Assessment of Human-Induced Soil Degradation in South and Southeast Asia
AU	African Union
BASE	Biome of Australia Soil Environments
BC	(1) Black Carbon; (2) Before Christ
BD	Biodiversity
BDP	Bureau for Development Policy
BIH	Bosnia And Herzegovina
BMLFUW	Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management
BNF	Biological Nitrogen Fixing
BOM	Bureau of Meteorology
BP	Before Present (1 January 1950)
C:N	Carbon To Nitrogen Ratio
CA	Conservation Agriculture
CAAA	Clean Air Act Amendments
CAADP	Comprehensive Africa Agriculture Development Programme

CACILM	Central Asian Countries Initiative for Land Management
CAMRE	Council of Arab Ministers Responsible For the Environment
CAZRI	Central Arid Zone Research Institute
CBD	Convention on Biological Diversity
CBM-CFS	Carbon Budget Model of the Canadian Forest Sector
CCAFS	Climate Change, Agriculture and Food Security
CCME	Canadian Council Of Ministers of the Environment
CE	Common Era (Also Current era or Christian era)
CEC	(1) Cation Exchange Capacity; (2) Commission of the European Communities
CECS	Chemicals of Emerging Concern
CEPAL	Comisión Económica Para América Latina Y El Caribe
CF	Commercial Farming
CGIAR	Global Agricultural Research Partnership
CIAT	International Center for Tropical Agriculture
CIFOR	Center for International Forestry Research
CITMA	Ministerio De Ciencia, Tecnología Y Medio Ambiente
CLIMSOIL	Review of Existing Information on the Interrelations between Soil and Climate Change
CLM	Contaminated Land Management
CMIP 5	Coupled Model Intercomparison Project Phase 5
COM	Commission Working Documents
CONABIO	Comision Nacional Para El Conocimiento Y Uso De La Biodiversidad
CONAFOR	Comisión Nacional Forestal
COSMOS	Cosmic-Ray Soil Moisture Observing System
CRC	Risk of Colorectal Cancer
CRP	Conservation Reserve Program
CSA	Climate-Smart Agriculture
CSIF-SLM	Country Strategic Investment Framework for Sustainable Land Management
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSM-BGBD	Conservation and Sustainable Management of Below-Ground Biodiversity
CSSRI	The Central Soil Salinity Research Institute
CSWCR&TI	Central Soil & Water Conservation Research & Training Institute (India)
DAFWA	Department Of Agriculture and Food, Western Australia
DBC	Dissolved Black Carbon
DDT	Dichlorodiphenyltrichloroethane
DEA	Deliberate Evacuation Area
DECA	Department Of Environment and Conservation, Australia
DED	Dust Event Days
DENR	Department Of Environment and Natural Resources

DEST	Australian Government Department of Education, Science and Training
DGVMS	Dynamic Global Vegetation Models
DIC	Dissolved Inorganic Carbon
DLDD	Desertification, Land Degradation and Drought
DNA	Deoxyribonucleic Acid
DOC	Dissolved Organic Carbon
DOI	Digital Object Identifier
DPYC	Dissolved Pyrogenic Carbon
DSEWPAC	Department Of Sustainability, Environment, Water, Population and Communities
DSI	Dust Storm Index
DSMW	Digital Soil Map of the World
EA-20km	Twenty Km Evacuation Area
EAD	Environment Agency Abu Dhabi
EC DG ENV	European Commission Directorate-General for Environment
EC	European Commission
EEA	European Environment Agency
EEAA	Egyptian Environmental Affairs Agency
EEZ	Exclusive Economic Zone
ELD	Economics of Land Degradation
EM-DAT	Emergency Events Database
ENSO	El Niño Southern Oscillation
EOLSS	Encyclopedia of Life Support Systems
EPA CERCLIS	United States Environmental Protection Agency, Comprehensive Environmental Response, Contamination and Liability Information System
EPA	United States Environmental Protection Agency
ERW	Explosive Remnants of War
ES	Ecosystem Services
ESA	United Nations Economic and Social Affairs Department
ESAFS	East and Southeast Asia Federation of Soil Science Societies
ESCWA	United Nations Economic and Social Commission for Western Asia
ESDB	European Soil Database
ESP	Exchangeable Sodium Percentage
ESRI	Environmental Systems Research Institute
EU SCAR	European Standing Committee on Agricultural Research
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
FAO-WRB	Food and Agriculture Organization World Reference Base

FDNPS	Fukushima Dai-Ichi Nuclear Power Station
FFS	Farmer Field School
FIA	Forest Inventory and Analysis
FSI	Forest Survey in India
FSR	Fund-Service-Resources
GAP	Southeast Anatolia Development Project Region
GDP	Gross Domestic Product
GEF	Global Environment Facility
GEO	Global Environmental Outlook
GHG	Greenhouse Gases
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft Für Internationale Zusammenarbeit (GIZ) GmbH
GLADA	Global Land Degradation Assessment
GLADIS	Global Land Degradation Information System
GLASOD	Global Assessment of Human-Induced Soil Degradation
GLC 2000	Global Land Cover 2000 Project
GLC-SHARE	Global Land Cover SHARE
GLRD	Gender and Land Rights Database
GRACE	Gravity Recover and Climate Experiment
GRID	Global Resource Information Database
GSBI	Global Soil Biodiversity Initiative
GSM	Global Soil Map
GSP	Global Soil Partnership
HORTNZ	Horticulture New Zealand
HTAP	Hemispheric Transport of Air Pollution
HWSD	Harmonized World Soil Database
HYDE	History Database of the Global Environment
IAASTD	International Assessment of Agricultural Knowledge, Science and Technology for Development
IAATO	International Association of Antarctic Tour Operators
ICAR	Indian Council of Agricultural Research
ICARDA	International Center for Agriculture Research In The Dry Areas
ICBA	International Center for Biosaline Agriculture
ICBL	International Campaign to Ban Landmines
ICRAF	International Center for Research in Agroforestry
IDP	Internally Displaced Peoples
IFA	International Fertilizers Association
IFAD	International Fund for Agricultural Development

IFADATA	International Fertilizer Industry Association Database
IFPRI	International Food Policy Research Institute
IGT-AMA	Instituto De Geografía Tropical Y La Agencia De Medio Ambiente
IIASA	International Institute for Applied Systems Analysis
ILCA	International Livestock Centre for Africa
IMAGE	Integrated Modelling Of Global Environmental Change
IMBE	Mediterranean Institute of Biodiversity and Ecology
IMF	International Monetary Fund
IMK-IFU	Institute of Meteorology and Climate Research Atmospheric Environmental Research
INIA	Instituto De Investigaciones Agropecuarias (Chile)
IPBES	Intergovernmental Panel on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
IROWC-N	The Indicator of Risk of Water Contamination by Nitrogen
IROWC-P	Indicator of Risk of Water Contamination by Phosphorus
ISA	Impervious Surface Area
ISAM	Integrated Impacts of Climate Change Model
ISBN	International Standard Book Number
ISCO	International Soil Conservation Organization
ISCW	Institute for Soil, Climate and Water
ISFM	Integrated Soil Fertility Management
ISO	International Standards Organization
ISRIC	International Soil Reference and Information Centre
ISS-CAS	Institute of Soil Science – Chinese Academy of Sciences
ISSS	International Society for the Systems Sciences
ITPS	Intergovernmental Technical Panel on Soils
IUSS	International Union of Soil Sciences
IW	International Waters
JRC	Joint Research Centre (European Commission)
LAC	Latin America and the Caribbean
LADA	Land Degradation Assessment in Drylands
LCCS	Land Cover Classification System
LD	Land Degradation
LDCS	Least Developed Countries
LPFN	the Landscapes for People, Food and Nature
LPJ-GUESS	Lund-Potsdam-Jena General Ecosystem Simulator
LRTAP	Long-Range Transboundary Air Pollution
LS	Topographic Factors

LU	Land Use
MA	Millennium Ecosystem Assessment
MADRP	Ministère De l'Agriculture Du Développement Rural et Des Pêches Maritimes
MAF	New Zealand Ministry of Agriculture and Forestry
MAFF	Ministry of Agriculture, Forestry and Fishery of Japan
MDBA	Murray–Darling Basin Authority (Australia)
MDGS	Millennium Development Goals
MENARID	Integrated Natural Resources Management in the Middle East And North Africa
MGAP	Ministry of Livestock, Agriculture and Fisheries
MNP	Netherlands Environmental Assessment Agency
MODIS	Moderate Resolution Imaging Spectroradiometer
NAAS	National Academy of Agricultural Sciences of India
NAIP	National Agricultural Investment Plan
NAMA	Nationally Appropriate Mitigation Action
NAP	(1) National Action Programme; (2) National Action Plan
NAPA	National Adaptation Programme of Action
NBSAP	National Biodiversity Strategy and Action Plan
NBSS&LUP	National Bureau Of Soil Survey And Land Use Planning
NDVI	Normalized Difference Vegetation Index
NENA	Near East And North Africa Region
NEPAD	The New Partnership for Africa's Development
NEST	Nigerian Environmental Study Action Team
NGO	Non-Governmental Organization
NISF	National Institute for Soils And Fertilizers
NLWRA	National Land and Water Resources Audit
NOAA AVHRR	National Oceanic and Atmospheric Administration - Advanced Very High Resolution Radiometer
NPK	Nitrogen (N), Phosphorus (P) and Potassium (K)
NPL	National Priorities List
NRC	National Research Council USA
NRCAN	Natural Resources Canada
NREL	National Resource Ecology Laboratory
NRI	National Resources Inventory Program
NRM	Natural Resources Management
NRSA	National Remote Sensing Agency (India)
NSW	New South Wales
NT	No-Tillage
NUE	Nitrogen Use Efficiency

OECD	Organization for Economic Co-Operation And Development
OM	Organic Matter
ÖNORM	National Standard Published By the Austrian Standards Institute
ÖPUL	Austrian Environment Programme for Agriculture
ORNL-CDIAC	Oak Ridge National Laboratory-Carbon Dioxide Information Analysis Center
OSWER	Office of Solid Waste and Emergency Response
PAH	Polycyclic Aromatic Hydrocarbon
PAM	Polyacrylamide
PCB	Polychlorinated Biphenyl
PCM	Pyrogenic Carbonaceous Matter
PEA	Participatory Expert Assessment
PHC	Petroleum Hydrocarbon
PL	Plastic Limit
PLAR	Participatory Learning-Action-Research
PMID	Pubmed Identifier
PNUD	Programa De Las Naciones Unidas Para El Desarrollo
POC	Particulate Organic Carbon
POP	Persistent Organic Pollutant
PVC	Polyvinyl Chloride
Radar-AMEDAS	Radar-Automated Meteorological Data Acquisition System
RAPA	Regional Office for Asia and the Pacific
RELMA	Sida's Regional Land Management Unit
ROTAP	Review Of Transboundary Air Pollution
RSN	Residual Soil Nitrogen
RUSLE	Revised Universal Soil Loss Equation
SAGYP-CFA	Secretaría De Agricultura, Ganadería Y Pesca – Consejo Federal Agropecuario
SAV	Submerged Aquatic Vegetation
SCAN	Soil Climate Analysis Network
SCARPS	Salinity Control and Reclamation Projects
SCWMRI	Soil Conservation and Watershed Management Research Institute
SD	Soil Degradation
SDGS	Sustainable Development Goals
SEC	Staff Working Documents of European Commission
SEEA	System of Environmental Economic Accounting
SEED	Sustainable Energy and Environment Division
SF	Subsistence Farming
SFR	Stock-Flow-Resources

SKM	Sinclair Knight Merz
SLAM	Sustainable Land and Agro-Ecosystem Management
SLC	Soil Landscapes of Canada
SLM	Sustainable Land Management
SMAP	Soil Moisture Active Passive
SMOS	Soil Moisture Ocean Salinity
SOC	Soil Organic Carbon
SOE	State of the Environment
SOER	European Environment State and Outlook Report
SOLAW	State Of Land and Water
SOM	Soil Organic Matter
SOTER	Soil and Terrain Database
SOW-VU	Centre for World Food Studies of the University Of Amsterdam
SPARROW	Spatially Referenced Regressions on Watershed Attributes
SPC	Secretariat of the Pacific Community
SPI	Science-Policy Interface
SRI	Salinity Risk Index
SSA	Sub-Saharan Africa
SSM	Sustainable Soil Management
SSR	Shift Soil Remediation
SSSA	Soil Science Society of America
ST	Soil Taxonomy
STATSGO 2	Digital General Soil Map of the United States
STEP-AWBH	Soil, Topography, Ecology, Parent Material – Atmosphere, Water, Biotic, Human Model
SWC	Soil and Water Conservation
SWSR	Status of the World's Soil Resources
TEEB	Economics of Ecosystems and Biodiversity
TEOM	Tapered Element Oscillating Microbalances
TOC	Total Organic Carbon
TOMS	Total Ozone Mapping Spectrometer
TOT	Transfer of Technology
TSBF	Tropical Soil Biology and Fertility
UN	United Nations
UNCCD	United Nation Convention to Combat Desertification
UNCED	United Nations Conference on Environment And Development
UNDCPAC	United Nations Desertification Control Program Activity Center
UNDESA	United Nations Department of Economic And Social Affairs
UNDP	United Nations Development Program

UNEP DEWA	United Nations Environment Programme and Department of Early Warning and Assessment
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNFPA	United Nations Population Fund (Formerly the United Nations Fund for Population Activities)
UNISDR	United Nations Office for Disaster Risk Reduction
UNSO	United Nations Development Programme - Office to Combat Desertification and Drought
USDA	United States Department Of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
USLE	Universal Soil Loss Equation
UXO	Unexploded Ordnance
WANA	West Asia-North Africa
WCED	World Commission on Environment and Development
WFP	United Nations World Food Programme
WMO	World Meteorological Organization
WOCAT	World Overview of Conservation Approaches and Technologies
WOTR	Watershed Organization Trust
WRB	World Reference Base for Soil Resources
WRI	World Resources Institute
WWF	World Wildlife Fund

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Preface

The main objectives of **The Status of the World's Soil Resources** are: (a) to provide a global scientific assessment of current and projected soil conditions built on regional data analysis and expertise; (b) to explore the implications of these soil conditions for food security, climate change, water quality and quantity, biodiversity, and human health and wellbeing; and (c) to conclude with a series of recommendations for action by policymakers and other stakeholders.

The book is divided into two parts. The first part deals with global soil issues (Chapters 1 to 8). This is followed by a more specific assessment of regional soil change, covering in turn Africa South of the Sahara, Asia, Europe, Latin America and the Caribbean, the Near East and North Africa, North America, the Southwest Pacific and Antarctica. (Chapters 9 to 16). The technical and executive summaries are published separately.

In Chapter 1 the principles of the World Soil Charter are discussed, including guidelines for stakeholders to ensure that soils are managed sustainably and that degraded soils are rehabilitated or restored. For long, soil was considered almost exclusively in the context of food production. However, with the increasing impact of humans on the environment, the connections between soil and broader environmental concerns have been made and new and innovative ways of relating soils to people have begun to emerge in the past two decades. Societal issues such as food security, sustainability, climate change, carbon sequestration, greenhouse gas emissions, and degradation through erosion and loss of organic matter and nutrients are all closely related to the soil resource. These ecosystem services provided by the soil and the soil functions that support these services are central to the discussion in the report.

In Chapter 2 synergies and trade-offs are reviewed, together with the role of soils in supporting ecosystem services, and their role in underpinning natural capital. The discussion then covers knowledge- and knowledge gaps - on the role of soils in the carbon, nitrogen and water cycles, and on the role of soils as a habitat for organisms and as a genetic pool. This is followed in Chapter 3 by an overview of the diversity of global soil resources and of the way they have been assessed in the past. Chapter 4 reviews the various anthropogenic and natural pressures - in particular, land use and soil management - which cause chemical, physical and biological variations in soils and the consequent changes in environmental services assured by those soils.

Land use and soil management are in turn largely determined by socio-economic conditions. These conditions are the subject of Chapter 5, which discusses in particular the role of population dynamics, market access, education and cultural values as well as the wealth or poverty of the land users. Climate change and its anticipated effects on soils are also discussed in this chapter.

Chapter 6 discusses the current global status and trends of the major soil processes threatening ecosystem services. These include soil erosion, soil organic carbon loss, soil contamination, soil acidification, soil salinization, soil biodiversity loss, soil surface effects, soil nutrient status, soil compaction and soil moisture conditions.

Chapter 7 undertakes an assessment of the ways in which soil change is likely to impact on soil functions and the likely consequences for ecosystem service delivery. Each subsection in this chapter outlines key soil processes involved with the delivery of goods and services and how these are changing. The subsections then review how these changes affect soil function and the soil's contribution to ecosystem service delivery. The discussion is organized according to the reporting categories of the Millennium Ecosystem Assessment, including provisioning, supporting, regulating and cultural services.

Chapter 8 of the report explores policy, institutional and land use management options and responses to soil changes that are available to governments and land users.

The regional assessments in Chapters 9 to 16 follow a standard outline: after a brief description of the main biophysical features of each region, the status and trends of each major soil threat are discussed. Each chapter ends with one or more national case studies of soil change and a table summarizing the results, including the status and trends of soil changes in the region and related uncertainties.

