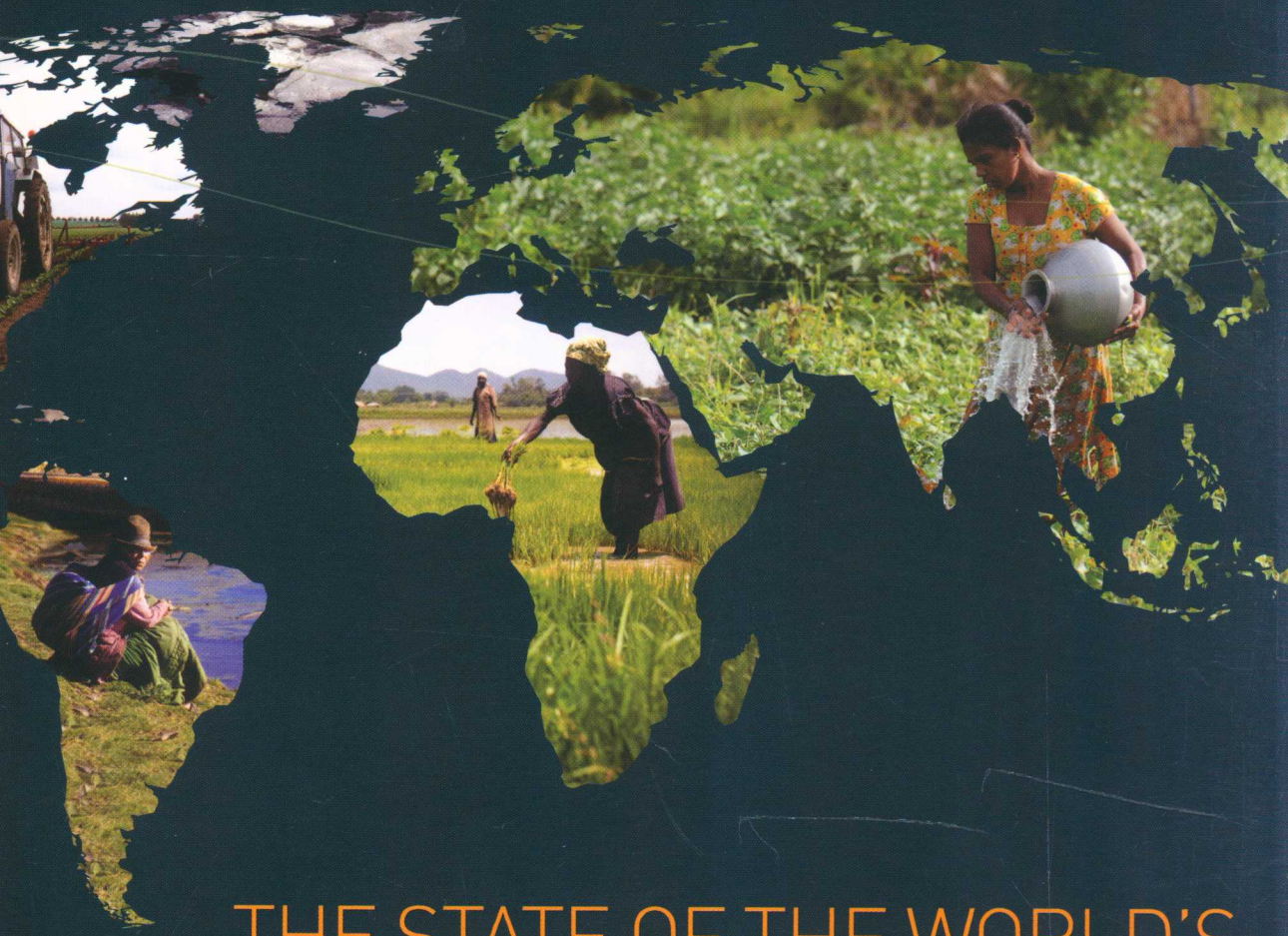

THE STATE OF THE WORLD'S LAND AND WATER RESOURCES FOR FOOD AND AGRICULTURE

Managing systems at risk

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publishing for a sustainable future

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Systems at risk are production systems where the land and water resources supporting agricultural production are constrained to a point where their capacity to meet current and future needs is seriously jeopardized. Constraints may be further exacerbated by unsustainable agricultural practices, social and economic pressures and the impact of climate change.

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Foreword

This edition of *The State of the World's Land and Water Resources for Food and Agriculture* (SOLAW) fills an important thematic gap in FAO's flagship publication series, and presents objective and comprehensive information and analyses on the current state, trends and challenges facing two of the most important agricultural production factors: land and water.

Land and water resources are central to agriculture and rural development, and are intrinsically linked to global challenges of food insecurity and poverty, climate change adaptation and mitigation, as well as degradation and depletion of natural resources that affect the livelihoods of millions of rural people across the world.

Current projections indicate that world population will increase from 6.9 billion people today to 9.1 billion in 2050. In addition, economic progress, notably in the emerging countries, translates into increased demand for food and diversified diets. World food demand will surge as a result, and it is projected that food production will increase by 70 percent in the world and by 100 percent in the developing countries. Yet both land and water resources, the basis of our food production, are finite and already under heavy stress, and future agricultural production will need to be more productive and more sustainable at the same time.

A major objective of this publication is thus to build awareness of the status of land and water resources, and inform on related opportunities and challenges. Across the years, FAO has established itself as a unique source for a variety of global data on land and water. These data have been fully exploited in the preparation of this book, presenting the most comprehensive and up-to-date global overview of the availability of land and water resources, their use and management, as well as related future trends and developments. This further takes into consideration major drivers of global change, including demands driven by demographics, changing consumption patterns, biofuel production and climate change impacts.

The variety of situations that characterize the world's agricultural landscapes is at the core of SOLAW. It identifies geographic zones with high population densities, where rainfed and irrigated crop production systems are under increasing pressure and are at heightened risk of reaching limits to increased production and productivities. These 'systems at risk' are drawn to the attention of the global community for concerted and timely remedial intervention, including through investments and inter-

national cooperation, not only on a global scale but locally, where the consequences of lack of action on agricultural livelihoods are likely to be greatest.

SOLAW also highlights the essential but often understated contribution that appropriate policies, institutions and investments make in assuring equitable access to resources and their sustainable and productive management, while assuring acceptable levels of economic development. It also discusses options and strategies for addressing evolving issues such as water scarcity and land degradation.

SOLAW contains numerous examples of successful actions undertaken in various parts of the world, which illustrate the multiple options available that are potentially replicable elsewhere. The necessary planning and negotiating mechanisms for doing so are highlighted. Given increasing competition for land and water resources, choices of options inevitably require stakeholders to evaluate trade-offs among a variety of ecosystem goods and services. This knowledge would serve to mobilize political will, priority setting and policy-oriented remedial actions, at the highest decision-making levels.

Jacques Diouf
Director-General
Food and Agriculture Organization
of the United Nations (FAO)

Preface

Feeding a growing population

Land and water resources and the way they are used are central to the challenge of improving food security across the world. Demographic pressures, climate change, and the increased competition for land and water are likely to increase vulnerability to food insecurity, particularly in Africa and Asia. The challenge of providing sufficient food for everyone worldwide has never been greater.

The world's population continues to rise. Today's population of around 7 billion is expected to increase to about 9 billion by 2050 (United Nations, 2009). By this time, another one billion tonnes of cereals and 200 million extra tonnes of livestock products will need to be produced every year (Bruinsma, 2009). The imperative for such agricultural growth is strongest in developing countries, where the challenge is not just to produce food but to ensure that families have access that will bring them food security.

Today almost 1 billion people are undernourished, particularly in Sub-Saharan Africa (239 million) and Asia (578 million). In developing countries, even if agricultural production doubles by 2050, one person in twenty still risks being undernourished – equivalent to 370 million hungry people, most of whom will again be in Africa and Asia. Such growth would imply agriculture remaining an engine of growth, vital to economic development, environmental services and central to rural poverty reduction.

For nutrition to improve and for food insecurity and undernourishment to recede, future agricultural production will have to rise faster than population growth. This will have to occur largely on existing agricultural land. Improvements will thus have to come from sustainable intensification that makes effective use of land and water resources as well as not causing them harm.

The policies, practices and technologies needed to boost production and strengthen food security have long been discussed. Institutional mechanisms, the development of trade and markets and the financial facilities needed to raise productivity in a sustainable way have been negotiated at the international level. At national level, measures to raise output and strengthen food security are being put in place, including investment in pro-poor, market-friendly policies, institutions and incentives, as well as the infrastructure and services needed to improve productivity. Yet the challenge still remains.

Increased competition for land and water

And there are warning signs. Rates of growth in agricultural production have been slowing, and are only half the 3 percent annual rate of growth seen in developing countries in the past. In 2007 and 2008, any complacency was jolted by food price shocks, as grain prices soared. Since then, the growing competition for land and water are now thrown into stark relief as sovereign and commercial investors begin to acquire tracts of farmland in developing countries. Production of feedstock for biofuels competes with food production on significant areas of prime cultivated land. A series of high profile floods, droughts and landslides further threaten the stability of land and water resources.

Deeper structural problems have also become apparent in the natural resource base. Water scarcity is growing. Salinization and pollution of water courses and bodies, and degradation of water-related ecosystems are rising. In many large rivers, only 5 percent of former water volumes remain in-stream, and some rivers such as the Huang He no longer reach the sea year-round. Large lakes and inland seas have shrunk, and half the wetlands of Europe and North America no longer exist. Runoff from eroding soils is filling reservoirs, reducing hydropower and water supply. Groundwater is being pumped intensively overpumped and aquifers are becoming increasingly polluted and salinized in some coastal areas. Large parts of all continents are experiencing high rates of ecosystem impairment, particularly reduced soil quality, biodiversity loss, and harm to amenity and cultural heritage values.

Agriculture is now a major contributor to greenhouse gases, accounting for 13.5 percent of global greenhouse gas emissions (IPCC, 2007). At the same time, climate change brings an increase in risk and unpredictability for farmers – from warming and related aridity, from shifts in rainfall patterns, and from the growing incidence of extreme weather events. Poor farmers in low income countries are the most vulnerable and the least able to adapt to these changes.

The steady increase in inland aquaculture also contributes to the competition for land and water resources: the average annual per capita supply of food fish from aquaculture for human consumption has increased at an average rate of 6.6 percent per year between 1970 and 2008 (FAO 2010a), leading to increase demand in feed, water and land for the construction of fish ponds.

The deteriorating trends in the capacities of ecosystems to provide vital goods and services are already affecting the production potential of important food-producing zones. If these continue, impacts on food security will be greatest in developing countries, where both water and soil nutrients are least abundant. Yet in some locations, better technology, management practices and policies (which take into consideration the need for appropriate tradeoffs between environmental needs and agricultural

production) have arrested and reversed negative trends and thus indicate pathways towards models of sustainable intensification. The risks, however, are considerable. On present trends, a series of major land and water systems and the food outputs they produce are at risk.

Scope of the book

This book deals primarily with the issue of land and water for crops. It examines the kinds of production responses needed to meet demand. It also assesses the potential of the world's land and water resources to support these desired increases in output and productivity. Risks and tradeoffs are examined, and options reviewed for managing these without harm to the resource base.

While the use of land and water for forestry and livestock is briefly discussed in Chapter 1, these subjects have been addressed in greater detail in two earlier FAO reports to which the reader is referred: *The State of the World's Forests* (FAO, 2009a) and *The State of Food and Agriculture* (FAO, 2009b). Similarly, more detailed analyses of trends and challenges on inland fisheries and aquaculture are provided in the recent FAO, report *The State of World Fisheries and Aquaculture* (FAO, 2010a). These global reports are supplemented by comprehensive analysis of gender in agriculture in FAO and World Bank reports (FAO, 2011a; World Bank, 2009b).

Chapter 1 analyses the current status of land and water resources together with trends. It assesses the biophysical and technical aspects of the resources and their use, and presents projections for the year 2050. Chapter 2 reviews current institutional arrangements, and assesses socio-economic and environmental impacts of current land and water management. Chapter 3 reviews current and future threats to land and water and their implications for a series of major systems at risk. Chapter 4 examines requirements and options to achieve the necessary levels of output and productivity required in a sustainable way. Chapter 5 assesses the institutional responses at local, national and international levels, with an analysis of lessons for the future. Finally, Chapter 6 draws conclusions and advances policy recommendations. These centre on the pragmatic step by step approaches towards a new paradigm of more sustainable, lower-carbon intensive agricultural production, based on more ecologically-sensitive management of land and water by farmers, supported by policies, institutions and incentives from national governments and the global community.

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List of abbreviations

AEZ	agro-ecological zoning
AGTER	Association for the Governance of Land, Water and Natural Resources
AgWA	Partnership for Agricultural Water in Africa
APFAMGS	Andhra Pradesh Farmer Managed Groundwater Systems
AQUASTAT	FAO's global information system on water and agriculture
ARID	Association Régionale de l'Irrigation et du Drainage en Afrique de l'Ouest et du Centre (West Africa)
ASEAN	Association of Southeast Asian Nations
AU	African Union
CA	conservation agriculture
CAADP	Comprehensive Africa Agriculture Development Programme
CBD	United Nations Convention on Biological Diversity
CBO	community-based organization
CCX	Chicago Climate Exchange
CDE	Centre for Development and Environment
CDM	Clean Development Mechanism
CEC	cation exchange capacity
CEOS	Committee on Earth Observation Satellites
CGIAR	Consultative Group on International Agricultural Research
DFID	UK Department for International Development
EIA	environmental impact assessments
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária
ENSO	El Niño southern oscillation
ESA	European Space Agency
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	FAO statistical database
FCT	Forest Carbon Tracking Task
FDI	foreign direct investment
FIVIMS	Food Insecurity and Vulnerability Information and Mapping Systems
FLO	Fairtrade Labelling Organizations International
GAEZ	Global Agro-Ecological Zones
GEF	Global Environment Facility
GEO	Group on Earth Observations

GEOSS	Global Earth Observation System of Systems
GHG	greenhouse gas
GIAHS	Globally Important Agricultural Heritage Sites
GIS	geographical information system
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
GLADIS	Global Land Degradation Information System
GLASOD	Global Assessment of Soil Degradation
GTOS	Global Terrestrial Observing System
GWP	Global Water Partnership
HASHI	Hifadhi Ardhi Shinyanga (Shinyanga Land Rehabilitation Programme, Tanzania)
IDA	International Development Association (World Bank)
IEA	International Energy Agency
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IIASA	International Institute for Applied Systems Analysis
IIED	International Institute for Environment and Development
IMAWESA	Improved Management of Agricultural Water in Eastern and Southern Africa
IMT	irrigation management transfer
INM	integrated nutrient management
IPM	integrated pest management
IPCC	Intergovernmental Panel on Climate Change
IPPC	Integrated Pollution and Prevention Control (Directive)
IRWR	internal renewable water resources
IWMI	International Water Management Institute
LADA	Land Degradation Assessment in Drylands
LCBC	Lake Chad Basin Commission
LIFDC	low-income food-deficit countries
M&E	monitoring and evaluation
MASSCOTE	Mapping System and Services for Canal Operation Techniques
MDG	Millennium Development Goal
MEA	Millennium Ecosystem Assessment
MICCA	Mitigation of Climate Change in Agriculture
NGO	non-governmental organization
NPK	nitrogen, phosphorus, potassium (fertilizer)
OAS	Organization of American States
ODA	official development assistance
OECD	Organisation for Economic Co-operation and Development

PES	payment for environmental services
PIM	participatory irrigation management
PNTD	participatory and negotiated territorial development
PPP	public-private partnership
PRA	participatory rural appraisal
PRODEBALT	Lake Chad Basin Sustainable Development Program
RAE	Rehabilitation of Arid Environments
REDD+	Reducing Emissions from Deforestation and Forest Degradation and the enhancement and conservation of forest carbon stocks and sustainable management of forests in developing countries
SADC	Southern African Development Community
SARIA	Southern Africa Regional Irrigation Association
SLM	sustainable land management
SLWM	sustainable land and water management
SNIF	National Land Reclamation Society (Romania)
SOLAW	State of the World's Land and Water Resources for Food and Agriculture
SRI	system of rice intensification
UNCCD	United Nations Convention to Combat Desertification
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UN-REDD	United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries
WFD	Water Framework Directive (EU)
WFP	World Food Programme
WOCAT	World Overview of Conservation Approaches and Technologies
WTO	World Trade Organization
WUA	water user association
WWAP	World Water Assessment Programme
WWC	World Water Council

List of tables

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