F-91-'96/NIES

Towards solving the global desertification problem (4)

—Research on the evaluation of interaction between desertification and human activities—

砂漠化問題の解決に向けて（4）

—砂漠化と人間活動の相互影響評価に関する研究—

Edited by Tadakuni Miyazaki and Atsushi Tsunekawa

宮崎忠国・恒川篤史　編

NATIONAL INSTITUTE FOR ENVIRONMENTAL STUDIES

環境庁　国立環境研究所

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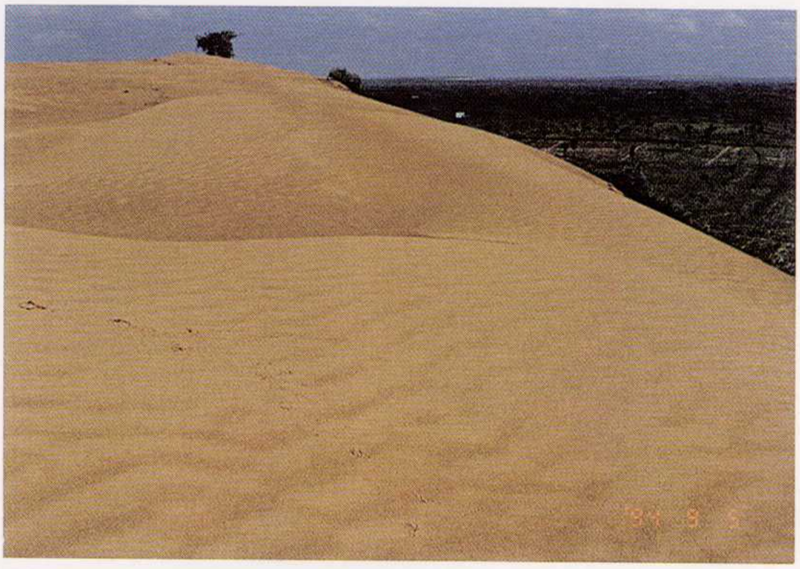

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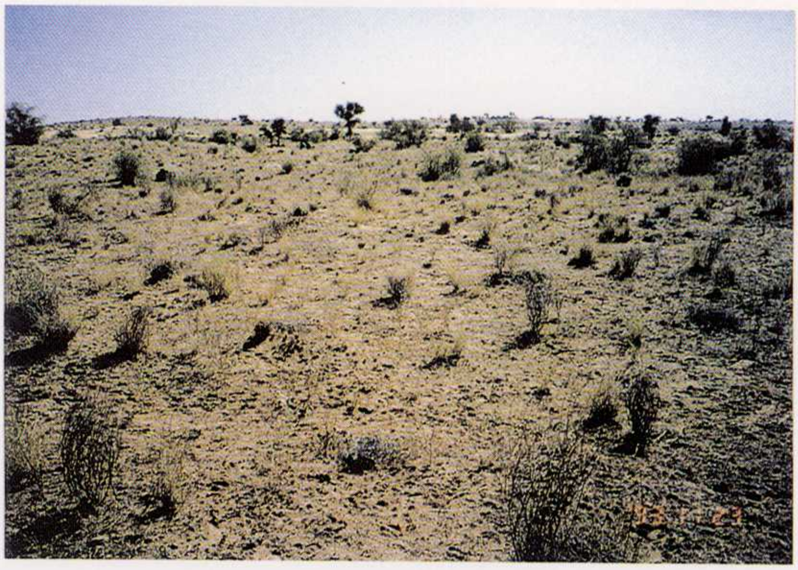

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The Thar Desert in Western India.
(a) Sand dune, (b) and (c) Open pasture land.

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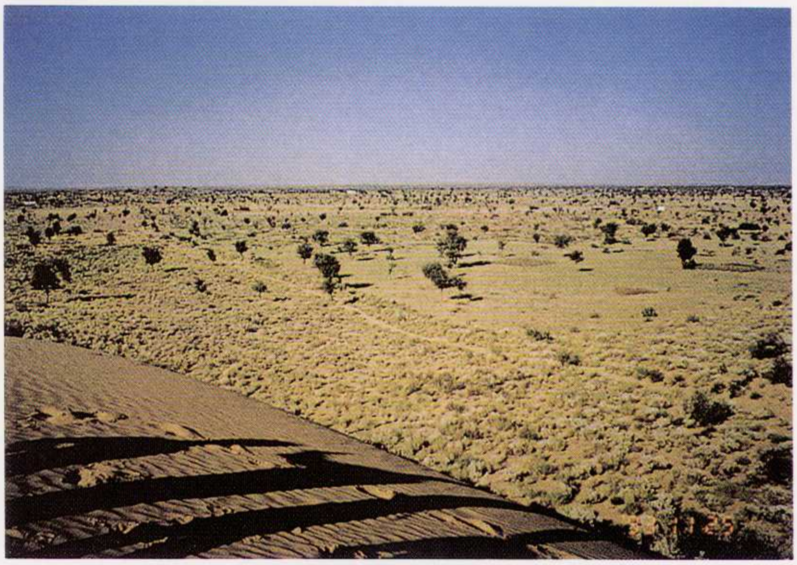

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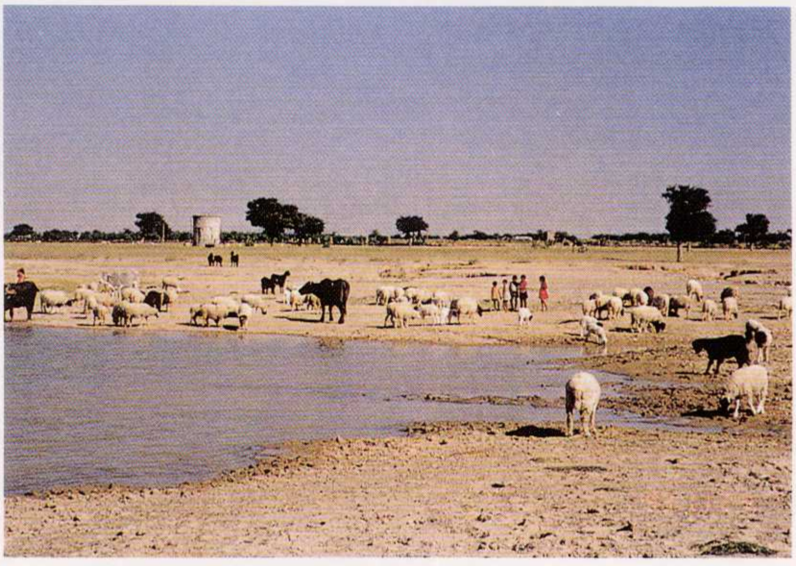

The Thar Desert in Western India.
(d) Rain fed agricultural land, (e) Irrigated agricultural land,
(f) Nadi (Water tank) - A traditional rainwater harvesting system.

Preface

According to a report by the United Nations Environmental Programme (UNEP), a sixth of the entire population, or one fourth of the entire land surface of the earth, has been affected by the desertification or land degradation. Food production has stagnated in these desertified regions, and the affected residents are exposed to famine and malnutrition, which are now big social problems.

Because of this situation, eighty-seven countries including Japan signed the "United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa" on October 14-15, 1994. Under the Convention, the developing countries and regions affected by desertification should prepare and implement action programmes, whereas developed countries including Japan should promote the scientific and technical cooperation relevant to the combat of desertification and the effects of drought.

The Japan Environment Agency established the Global Environment Research Fund in 1990 to enhance research activities to cope with growing global environmental problems. Under the research fund, the Desertification Research Project was started in 1990 as a "Feasibility study on the environmental assessment of desertification in arid and semi-arid areas", for which the National Institute for Environmental Studies played the role of a leading organization. The feasibility study continued for two years until March 1992.

Following the feasibility study, "Research on the evaluation of interaction between desertification and human activities" has been carried out as a three-year program from 1992 up to March 1995. It consists of the following three sub-themes;

(1) "Evaluation of human activities on desertification in arid and semi-arid areas", being conducted by NIES, in collaboration with the Indian Council of Agricultural Research (ICAR) and the Central Arid Zone Research Institute (CAZRI), taking the Thar Desert in India as its subject field.

(2) "Evaluation of human activities on desertification in semi-arid and sub-humid areas", being carried out by the National Institute of Agro-Environmental Sciences and the National Research Institute of Agricultural Economics, in cooperation with the Institute of Geography, Chinese Academy of Science, in eastern China.

(3) "Comparative study of human activities on desertification in arid and semi-arid areas of different countries", being coordinated by NIES.

During the period of the research activities, we have been publishing a series of desertification research reports, which were based on the International Symposium on Desertification held at NIES, Tsukuba. The first report of this series was entitled "Towards solving the global desertification problem (1) - Feasibility study on the environmental assessment of desertification in arid and semi-arid areas" and was issued in March, 1992. It contained chiefly the reports presented at the First Desertification Symposium held at NIES, in February, 1991.

The second of the series entitled "Towards solving the global desertification problem (2) - Research on the evaluation of interaction between desertification and human activities - ", was issued in December, 1994. This report summarized mainly the Indian study and contained a summary of the present status of desertification, reviews of the vegetation studies and methodologies for desertification monitoring using remote sensing techniques, edited in English.

The third report of the series was entitled "Towards solving the global desertification problem (3) - Desertification Bibliography Database -", issued in February 1995. In this "Desertification Bibliography Database", 2805 English and 193 Japanese scientific papers and documents are collected and the users can efficiently retrieve the requested documents by using author name, key words, and journal name.

This volume, the fourth research report of the series, consists of six parts. The part I, II and III are based on the second International Symposium on Desertification held in 22 March 1994 at NIES, Tsukuba and the part IV, V and VI are based on the third International Symposium held in 28 February 1995. The part I summarized the current trend of desertification and soil degradation research as well as the International Convention to Combat Desertification. The part II and IV are the research results from the collaborative research with CAZRI in the Thar desert, India, and the part III and V are the results from the desertification research in Chinese desert. The part VI is the research report of the comparative study of soil degradation in Northeast Thailand, East Africa and Kazakhstan.

As my editorial duties come to a close, I would like to extend my thanks to all of those who made the writing of this report possible, and I would like to thank Ms. Hiroko Okawa for the editorial support. I sincerely hope that this desertification research report would be useful for understanding the desertification phenomena and also helpful when a similar International Program is to be established.

May 1996

Dr. Tadakuni Miyazaki
National Institute for Environmental Studies

Contents

List of Contributors

Anantha Ram, K.	Central Arid Zone Research Institute Jodhpur 342003, India
Furukawa, Akio	National Institute for Environmental Studies Environment Agency of Japan 16-2, Onogawa, Tsukuba, Ibaraki 305, Japan
Fukuhara, Michikazu	National Institute of Agro-Environmental Sciences Ministry of Agriculture, Forestry and Fisheries 3-1-1, Kannondai, Tsukuba, Ibaraki 305, Japan
Ichikawa, San'ei	Japan Wildlife Research Center 2-29-3, Yushima, Bunkyo-ku, Tokyo 113, Japan
Imagawa, Toshiaki	National Institute of Agro-Environmental Sciences Ministry of Agriculture, Forestry and Fisheries 3-1-1, Kannondai, Tsukuba, Ibaraki 305, Japan
Ishida, Norio	Kyoto University Kitashirakawa, Oiwake-cho, Sakyo-ku, Kyoto 606, Japan
Kadomura, Hiroshi	Tokyo Metropolitan University 1-1, Minamiohsawa, Hachiouji, Tokyo 192-03, Japan
Kar, Amal	Central Arid Zone Research Institute Jodhpur 342003, India
Karbozova, Elmira	Soil Research Institute, Kazakh Academy of Science Almaty, Kazakhstan
Katoh, Kazuhiro	University of Tokyo 1-1-1, Yayoi, Bunkyo-ku, Tokyo 113, Japan
Khan, M. A.	Central Arid Zone Research Institute Jodhpur 342003, India
Kosaki, Takashi	Kyoto University Kitashirakawa, Oiwake-cho, Sakyo-ku, Kyoto 606, Japan
Kou, Zenwu	Institute of Applied Ecology, Chinese Academy of Science Shenyang, 110015, P. R. China

Kumar, Suresh	Central Arid Zone Research Institute Jodhpur 342003, India
Matsumura, Takashi	Environment Agency of Japan 1-2-2, Kasumigaseki, Chiyoda-ku, Tokyo 100, Japan
Mertia, R. S.	Central Arid Zone Research Institute Regional Research Station Jaisalmer 345001, India
Miyazaki, Tadakuni	National Institute for Environmental Studies Environment Agency of Japan 16-2, Onogawa, Tsukuba, Ibaraki 305, Japan
Nan, Yinhao	Institute of Applied Ecology, Chinese Academy of Science Shenyang, 110015, P. R. China
Narita, Kenji	Hokkaido University 5-chome, Kitajujo-nishi, Kita-ku, Sapporo 060, Japan
Saha, D. K.	Central Arid Zone Research Institute Jodhpur 342003, India
Takeuchi, Kazuhiko	University of Tokyo Yayoi 1-1-1, Bunkyo-ku, Tokyo 113, Japan
Tao, Wang	Institute of Applied Ecology, Chinese Academy of Science Shenyang, 110015, P. R. China
Tsujimura, Shigeo	Kyoto University Kitashirakawa, Oiwake-cho, Sakyo-ku, Kyoto 606, Japan
Tsunekawa, Atsushi	National Institute for Environmental Studies Environment Agency of Japan 16-2, Onogawa, Tsukuba, Ibaraki 305, Japan
Zhu, Zhenda	Institute of Applied Ecology, Chinese Academy of Science Shenyang, 110015, P. R. China

Part I Current Trend in Desertification

Current Trends in Desertification Studies: Major Scientific Issues in Assessing and Combating Desertification

Hiroshi Kadomura
Tokyo Metropolitan University, Japan

1. Introduction

This paper reviews some of the current major scientific issues related to an International Convention to Combat Desertification (INCD, 1994 a), based mainly on the author's own experiences from the research in the Sub-Saharan Africa (e.g., Kadomura, 1993) and the discussions at the meetings of the International Panel of Experts on Desertification (IPED), a scientific and technical assisting body of the Intergovernmental Negotiating Committee for the Elaboration of an International Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa (INCD).

The Convention is the realization of the action plans stated in the Chapter 12 of the Agenda 21 (UN, 1992), which was adopted at the United Nations Conference on Environment and Development (UNCED) held in 1992 at Rio de Janeiro, and has been expected to be elaborated in June 1994, together with the regional Annex for Africa (INCD, 1994 b). The objectives of this Convention are, through effective actions at all levels, supported by international cooperation and partnership arrangement, in the framework of an integrated approach which is consistent with Agenda 21 with a view to contributing to the achievement of sustainable development in affected areas, to combat desertification and mitigate the effects of drought, with the priority for Africa (INCD, 1994 a).

Mention is also made of research priorities in the light of the implementation of the Convention.

2. Issues related to the definition

The "desertification" has been variously defined since Aubréville (1949) first used this word to explain the process of environmental degradation in subhumid tropical Africa due mainly to adverse human impact. The United Nations Conference on Desertification (UNCOD) held Nairobi in 1977 (UN, 1978), defined the desertification as follows:

"The diminution or destruction of biological potential of the land, that can lead ultimately to desert-like conditions."

This ambiguous notion in its definition has caused such a mythical image as the progressive, overall desert march to the productive land (Fig. 1), and invited an endless debate not only among the scientists but also in the international community (Odingo, 1991).

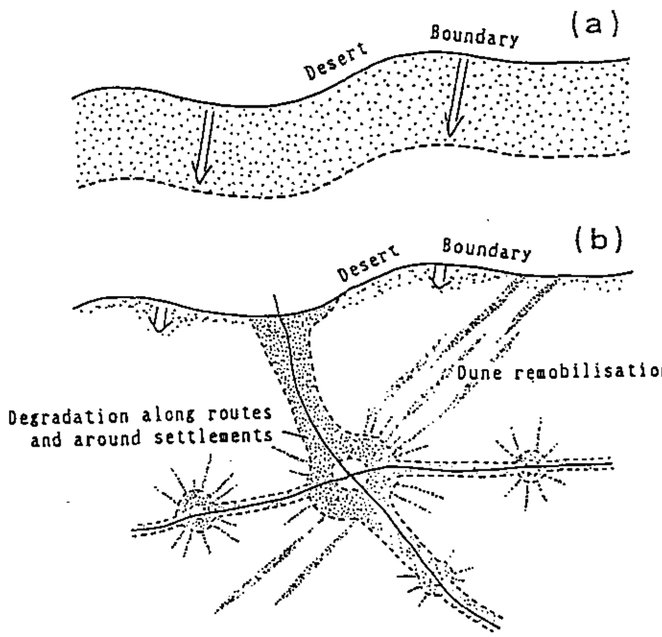

Fig. 1 A schema showing local-scale land degradation/ desertification pattern in the Sahelian "fossil sand dune zone". (a) a myth of overall desert spreading; (b) actual pattern of land degradation (dotted area).

The most recent, internationally accepted definition is that stated in the Chapter 12 (Managing Fragile Ecosystems: Combating Desertification and Drought) of the Agenda 21 (UN, 1992, p. 46).

"Desertification is land degradation in arid, semi-arid and dry subhumid areas resulting from various factors, including climatic variations and human activities."

At the present moment (21, March 1994), this definition is also used in the Negotiating Text of the Convention on Desertification (INCD, 1994 a).

"Land degradation" is much more preferable than

Received 21, March 1994

"desertification" in meaning the processes and results of damage to the sustainability of the land. However, for the purpose of the Convention, clear-cut, scientific but internationally acceptable definitions for all the words baldest in the above sentence are prerequisite, together with definition for "drought", the most important natural causative factor of the land degradation in drylands. Proposed definitions of some of the important words needing continued negotiation (INCD, 1994 a; pp. 4-5) are:

"Drought" means "[sustained, regionally extensive deficiency in precipitation resulting in a period of abnormally dry weather sufficiently prolonged for the lack of water to cause a serious hydrological imbalance;] or [the naturally occurring phenomenon that exists after one or more years during which rainfall has been significantly below average recorded levels.]"

"Land degradation" means "[reduction or loss of biological productivity and complexity of rainfed cropland, irrigated cropland, or range, pasture and forest lands by one or a combination of processes, including, among others:
(1) displacement of soil materials by wind and water erosion,
(2) internal soil deterioration through physical and chemical processes such as salinisation, acidification, crusting, water logging and subsidence;] or [reduction or loss of biological or economic productivity and complexity of rainfed cropland, irrigated cropland, or range, forest and wood lands by one or a combination of processes and land use systems, including those arising from human activities and habitation pattern, in arid, semi-arid and subhumid areas, such as:
(1) wind, water and soil erosion,
(2) deterioration of soil physical, chemical and biological properties, and
(3) long-term loss of natural vegetation.]"

"Arid, semi-arid and dry sub-humid areas" mean "[areas where the ratio of average annual precipitation to potential evapotransipilation is greater than or equal to 0.05 and less than or equal to 0.65 and where the average annual temperature is greater than 0 degrees Celsius;] or [areas where aridity index (ratio of annual precipitation to potential evapotransipilation) ranges from 0.05 to 0.65 excluding arctic and sub-arctic regions;] "

More difficult question is how and who define or designate "affected areas", "countries experiencing serious drought and/or desertification", affected countries", "affected countries needing assistance", "affected countries needing financial and/or technical assistance", and "affected developing countries", which may be listed in the Annex of the Convention. Although the scientific notions to those words should provide the baseline, listing of areas and/or countries is politically sensitive matter.

It should be emphasized that, contrary to our expectation, no concrete global data sets and maps indicating even the countries falling within arid, semi-arid and sub-humid areas have hitherto been available.

3. Issues related to global assessment

Various attempts have been made to assess the status of desertification/land (soil) degradation at global, regional, national and local levels. Among others, most popular assessments are those with global maps such as those prepared for the UNCOD (FAO/UNESCO/WHO, 1977), UNEP's 1984 general assessment (UNEP, 1984), GLASOD (UNEP, 1990), and World Atlas of Desertification (UNEP, 1992). However, all the pictures presented in these assessments do not show actual status but are the speculation of potential risks based on the combination of supposed vulnerability of physical conditions and human impacts. For this reason, none of these global data sets and maps are too rough to be used for designating "affected areas" or "affected countries" for the purpose of the Convention.

In spite of the past efforts, such as the IN-France in the Sahel Transects (IN-FI, 1993), no existing systems using remote sensing can yield global quantitative assessments of the extent and intensities of desertification/land degradation (UNEP/DC-PAC., 1993). This urgently requires the establishment of an operational system for monitoring and assessing the current status of desertification/land degradation at more detailed scale, i.e., at national, district, and local levels, which should be linked with early warning and long-term monitoring systems.

4. Monitoring and assessment at local level: contribution to bottom-up approach

The Convention (INCD, 1994 a) stresses everywhere the importance of bottom-up approach at local community level to the efforts for combating desertification and mitigating the effects of droughts, which should be incorporated into integrated local development programmes for affected areas, based on participatory mechanism.

For realizing this, in parallel with such socioeconomic restructuring as decentralization of decision making, reformation of land tenure regimes and population policies as well as appropriate sectoral actions for arable, pasture and range, and forest lands, water resources and energy, the establishment of following observation/information system should play a vital role in strengthening drought mitigation strategies and preventive an/or rehabilitation measures. Research priorities regarding this are:

Development and implementation of early warning system linked with local-level monitoring and assessment programmes, including,

(1) Multilevel tempo-spatial monitoring system combined with ground-aerial-satellite observations, on the basis of site- and local-level ground truth observations and linked with regional weather forecasting,

(2) Methodologies and techniques for monitoring, mapping and assessing detailed pattern and processes of land degradation at site level (1:1,000-10,000) (e.g.,UNEP/UNESCO, 1992) and local level (1:50,000-100,000) (DLR, 1993), taking into account of dynamic nature of relations between land use/human activities, morpho-pedological conditions (Fig. 2), and rainfall variations,

(3) Guidelines and handbooks (e.g., Casenave et Valentin, 1989; Herlocker, 1991) for the above used by local extension workers and trained populations for planning and implementing local action plans to combat and reverse land degradation and to assure sustainable use of natural resources, and

(4) Training programmes for capacity building, particularly of leaders of multi-disciplinary working teams, and education and public awareness.

Discussions on these topics should be centered on scale problems (e.g., Kadomura, 1993) and desertification/land degradation indicators. (Table 1).

Table 1 Basic physical indicators for local-level monitoring of desertification/land degradation and/or drought impacts in the Sudano-Sahelian Region

1. Climatic

a. Shift of 150 mm/yr or 200 mm/yr isohyet
b. Shortening of growing period
c. Lowering of Dryness Index : P/ETP (<0.05 = hyperarid, 0.05-0.2 = arid)
* Problems regarding different responses inherent in local/regional edaphic conditions and delayed response in morphological and ecological processes

2. Hydrological

a. Shrinkage and drying-up of streams and lakes
b. Lowering of groundwater level
c. Decrease in soil moisture

3. Morpho-Pedological

a. Sand creeping/shifting
b. Dune mobilisation/remobilization
c. Deflation/blow-outing
d. Rainsplash, rilling, gullying, sand fan formation
e. Spreading of rocky/stony surface (reg-, hamada-like landscape)
f. Spreading of lateritic cuirass outcropping (Bovarisation)
g. Increased frequency of large-scale dust storms
h. Encrusting and other physical deterioration
i. Salinisation and other chemical deterioration
* Problems regarding different responses in relation to local/regional landforms, edaphic conditions, and human activities.

4. Vegetation

a. Decline or disappearance of tree species: e.g. *Acacia albida, A senegal, A. tortilis, Commiphora africana.*
b. Predominance of tree species by more resistant to dryness: e.g., *Caltropis procera, Boscia senegalensis, Balanites eagyptiaca.*
c. Replacement of grass species by more registant to dryness: e.g, from *Andropogon gayanus* to *Cencrus bifrolus, Aristida* spp.
d. Increase /predominance of unpliable, useless species like *Cartropis procera*
e. Decrease in diversity, community density and height
* Problems of irresistibility/resilience in relation to local/regional landforms, edaphic conditions, and human activities.

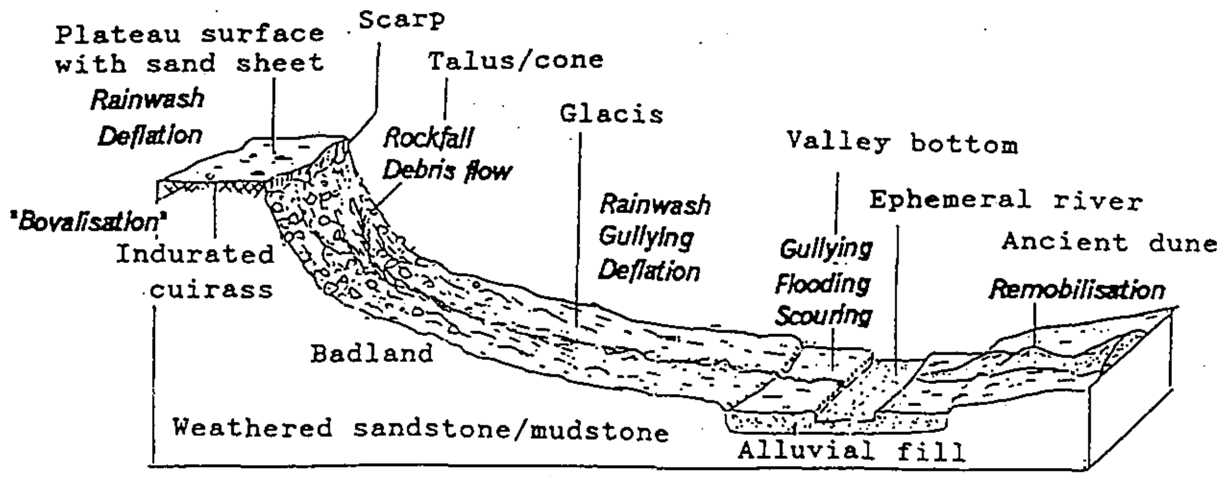

Fig. 2 A schematic representation of local-scale land degradation patterns and processes in cuirass-capped, dissected plateaux in the Sudan-Sahelian Region. Note the spatial differentiation in geomorphic degradational processes by landform types and superficial materials.

5. Long-term monitoring

Since processes of both degradation and recovery in land and vegetation dynamics and in land use systems, as well as human response to environmental change, are generally slow but long-lasting phenomena, long-term, integrated ecological monitoring must play a crucial role in the implementation of medium to long-term anti-desertification programmes. For this purpose the proposal of the ROSET (Reseau d'Observatoire de Surveillance Ecologique à Long Term = Network of long Term Ecological Monitoring) Programme linked with global climate change (SSO/IARE, 1993) by the International Association, OSS (Observatoire du Sahara et du Sahel = SSO: Sahara and Sahel Observatory) (SSO, 1994) may deserve special attention. The ROSET is expected to play an active role in the future implementation of the Convention, because of the following aspects:

It adopts an integrated observation acting systems, for collecting, organizing and processing data on environment in order to put together data which will be compatible with local development problems and regional targets for harmonizing the network. The observation will have the following objectives:

(1) Monitoring natural resources and forecasting their long-term development,

(2) Monitoring the human activities in the area concerned,

(3) Restoring the biological resources,

(4) Establishing a trade-off between resources and land users in order to define optimal land use rate for different types of ecosystems, and

(5) Development of forecast models for long-term ecological successions.

The observation lay-out is designed to allow the integration of ecological, agricultural, and socio-economic data from different regions and environments, both spatially and over time. For the data collecting units, following three levels are considered:

1) ecological site, 2) landscape, and 3) region.

6. Other important issues

Other items needing accelerated research in relation to the Convention are:

(1) Interactions of Desertification and Climate Change;

Despite the efforts made by a joint WMO/UNEP study (Williams and Balling, 1993) and related IPCC works, there are still full of uncertainties as to the effects of land degradation on local and regional climate, and the linkage between anticipated global warming and dryland degradation,

(2) Desertification and Biodiversity;

In spite of their harsh and fragile environments, drylands are the habitat of a variety of flora and fauna, and are the cradle of many of our food crops (e.g., Imevbore, 1993). In view of this the IPED Subgroup on Biodiversity launched a project to compile an inventory of biodiversity and endangered spices in the world drylands, and

(3) Socio-economic Dimensions;

Participatory mechanism, land tenure, decentralization, and alternative livelihoods are the central issues at local-level studies (Toumlin, 1993). Environmental impacts of drought- and desertification-triggered migration, both domestic and transnational, have received increased attention (Anon., 1994).

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Acronyms

GLASOD: Global Assessment of Desertification

IARE: Institute des Aménagements Régionaux et de l'Environnement (Montpellier)

IN-FI: Institute Géographique National-France International

IIED: International Institute for Environment and Development

INCD: Intergovernmental Negotiating Committee for the Elaboration of an International Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa.

IPED: International Panel Experts on Desertification

SSO: International Association, Sahara and Sahel Observatory = **OSS**: Observatoire du Sahara et du Sahel

UNCED: United Nations Conference on Environment and Development

UNCOD: United Nations Conference on Desertification

UNDP: United Nations Development Programme

UNEP: United Nations Environment Programme

UNEP/DC-PAC: UNEP/Desertification Control Programme Activity Center

UNSO: United Nations Sudano-Sahelian Office

Desertification (Soil Degradation) Due to Soil Salinization under Large-scale Irrigation Agriculture in Kazakhstan, Central Asia.

Takashi Kosaki*, Shigeo Tsujimura*, Elmira Karbozova** and Norio Ishida*
* Kyoto University, Japan
** Soil Research Institute, Kazakh Academy of Science, Kazakhstan

1. Introduction

Salt-affected soils in North and Central Asia occupy more than 200 million ha, which corresponds to about 20 % of the total area of such soils in the world (Szabolcs, 1986). The Soviet Union started many large-scale irrigation projects for the establishment of rice- and/or cotton-based agriculture in arid regions in Central Asia in the 1960s. It has recently been reported that the introduction of irrigation water into a farm from major rivers drained off to the Aral Sea and Lake Balkhash, causing a decrease in the surface area and depth of these water bodies (Williams and Aladin, 1991), resulting in soil salinization and adverse effects on human health (Mainguet, 1991). Rozanov (1984) showed 1 million ha of land was lost in Central Asia because of erroneous irrigation practices. According to Khakimov (1981), the percentage of moderate to severe salinized soils in irrigated areas reached 60 to 70 % and crop yields decreased by 30 to 33 % in Kazakhstan.

This study aims to investigate the distribution pattern of saline soils in a farm and its surroundings in order to understand the mechanism of salinization due to irrigation practices, and to establish an appropriate technology for sustainable agricultural production in arid climates. Kazakhstan can be considered one of the representative places for conducting such a case study, and the outcome may be transferred to other areas having similar constraints in a temperate zone.

2. Study site and soil sampling

We set up a study site near Bereke, 250 km north of Alma Ata in Kazakhstan (Fig. 1). Bereke is at an elevation of 375 m above sea level and located in the flood plain of River Ili, originating in the Tien-Shan Mountains. Bereke has a precipitation of about 150 mm per annum, total evapotranspiration of about 1000 mm, and an average air temperature of 9 °C, ranging from -11 °C in January to 27 °C in July.

The study site belongs to a former state farm established in 1979. Farms are mainly planted with rice, alfalfa and barley, besides being utilized for the grazing of sheep and beef cattle. Rice is irrigated and water-logged for four months of the growing season, while alfalfa and barley are not, although irrigation water does

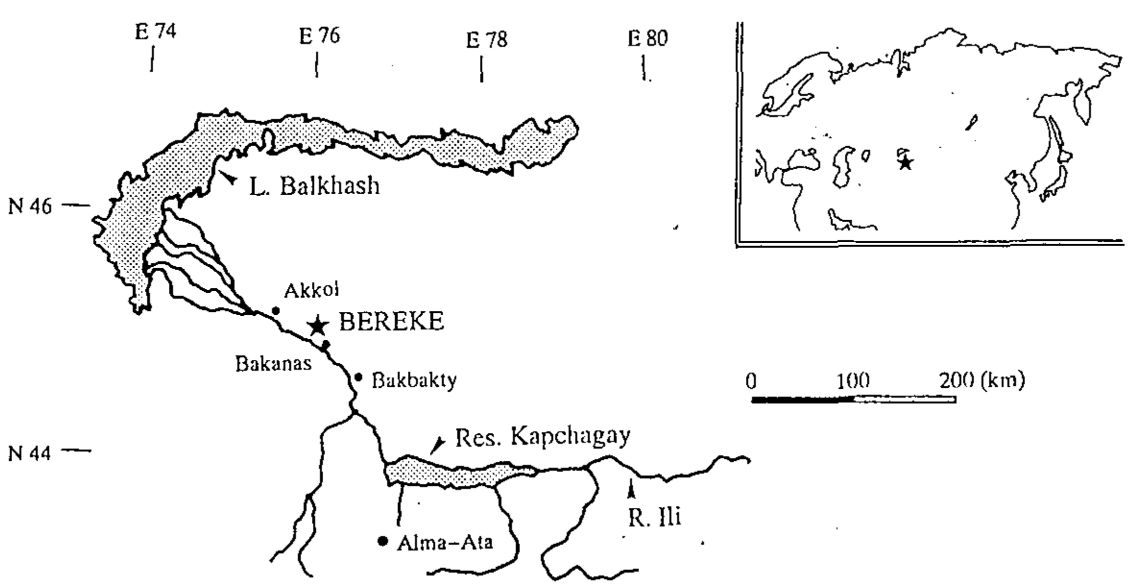

Fig. 1 Location of the study area.

Received 21, March 1994

run in canals during the growing season for early May to early September every year. The yield of rice is reported to be about 4 t/ha. Individual farms are planted with a 4 year rotation, i.e. barley and alfalfa for the first year, alfalfa for the second and rice for the third and forth. Soils encountered in the farms are Sierozems in the Russian Classification System, correlated with Gypsiorthids and/or Calciorthids in Soil Taxonomy and Gypsisols and/or Calcisols in the FAO/UNESCO systems.

The study site included about 2 ha of virgin land, 2 ha of farm planted with barley and alfalfa at the time of sampling, and irrigation canals between them (Fig. 2). While the farm was leveled, such virgin lands have an undulating topography with a difference of 250 cm in elevation from the level of a valley bottom to the top of a sand dune. Zero point of the relative elevation was set on the level of a bridge across the irrigation canal in the study site. The crest parts of dunes are dominated by shrubs of sakusaul (*Haloxylon aphyllum*), the valley bottom by reed (*Polygonum orientale*) and hill slopes of sand dunes by holophytic weeds such as *Karelinea caspia* and *Atriplex tatarzca*.

The surface soils were sampled at an average interval of 25 m along four transects, being 50 m apart from each other, both in the virgin land and the farm (Fig. 2). Seven soil profiles were prepared from representative sites with respect to the topography of the study site, and soil samples were collected from soil horizons designated in these profiles. Irrigation water was running in the canals in the study site at the time of soil sampling in late June. Additionally, we investigated some soil profiles and collected samples under natural sakusaul forest some distance from the study site, from which we observed no effect of irrigation on the morphology of soils but similar environmental conditions in terms of parent material, climate, topography etc.

The collected soils were air-dried, sieved and analyzed for selected physicochemical properties such as pH (1:2.5 in water), electrical conductivity (1:5 in water), water soluble cations and anions (1:5 water extraction), CEC (pH 7.0 in ammonium acetate), organic carbon (Tyurin method) and soil texture.

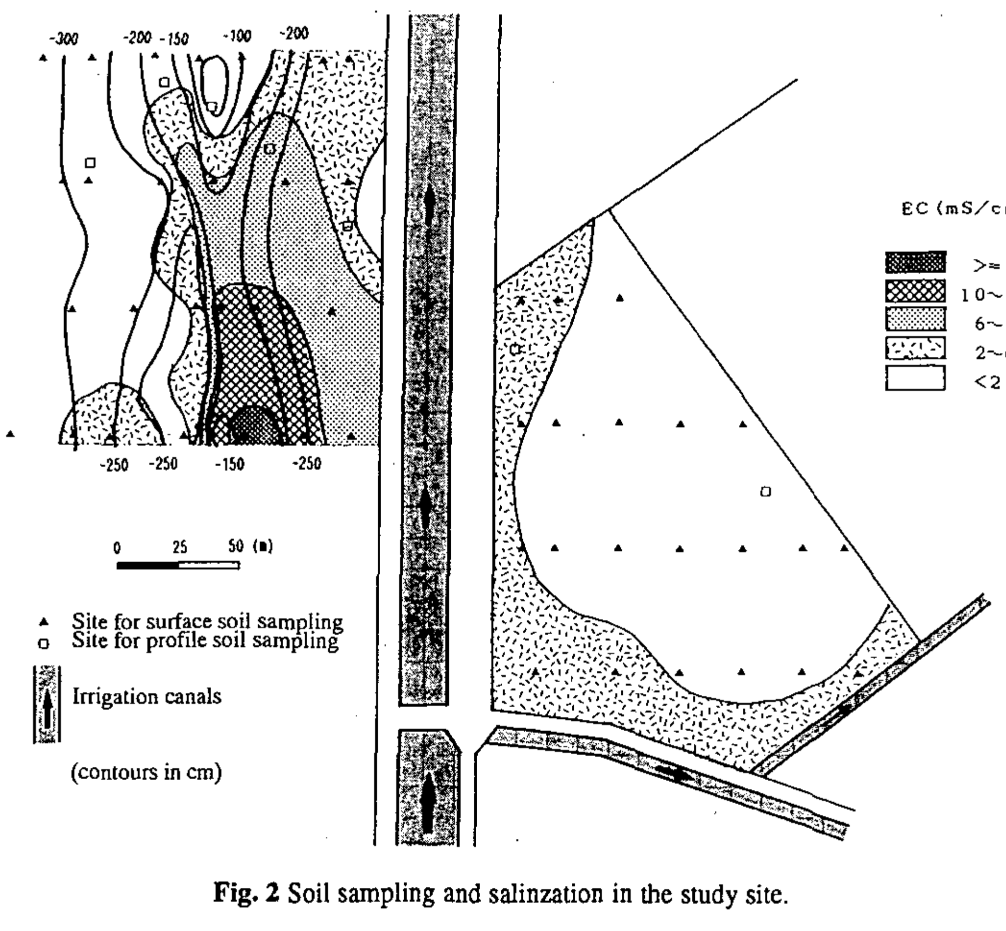

Fig. 2 Soil sampling and salinzation in the study site.

3. Results and discussion

The distribution pattern of electrical conductivity (EC) of surface soils is shown in Fig. 2. The soils near irrigation canals in the farm showed high salinity. The relative elevations of the farm and the surface of irrigation water was -330 cm and -230 cm, respectively. Irrigation water at a higher level than the farm suggests that the high salinity was induced by seepage water from irrigation canals. Although the surface soils of virgin land generally showed a similar pattern, their salt contents were also affected by topography. The highest salinity was observed in the mid-slope of high sand dunes as well as in the crest and mid-slope of low to medium sand dunes, which correspond to areas at a relative elevation between -250 cm and -150 cm. The virgin land generally showed a higher salinity than that of the farm.

Fig. 3 shows the distribution pattern of water-soluble salts in the soil profiles investigated in the study site. The profiles located in the areas showing high salinity in Fig. 2, i.e. P103 and P104, accumulated high amounts of salts in the surface layers. In contrast, salt accumulated layers were observed in the subsoils of profiles P108 and P105, which were located in the crest part of the high sand dunes and in the area distant from the irrigation scheme and, therefore not affected by irrigation practices.

The distribution pattern of water soluble salts in soil profiles suggests that salts originally accumulated in the subsoils in natural conditions were dissolved with irrigation water, then moved upward with evapotranspiration of soil moisture through capillaries, and finally precipitated on soil surface. This upward movement and precipitation in the soil surface of water soluble salts must continue as far as capillary water is held between the water table and soil surface. Profiles P103 and P104 showed water tables shallow enough to keep the capillaries.

In contrast, no water table was observed within 120 cm in profiles P108 and P105, where capillary fringe never reached the soil surface. Profile P109 showed some salt accumulation in a subsurface horizon, i.e. 20 to 60 cm depth, in spite of the fact that no water table was observed at the time of sampling. This suggests fluctuation of the water table, which may come up to within a 100 cm depth to carry salts upward during some period in a year. Even so, it should be noted there is a clear difference in EC between the surface layer and

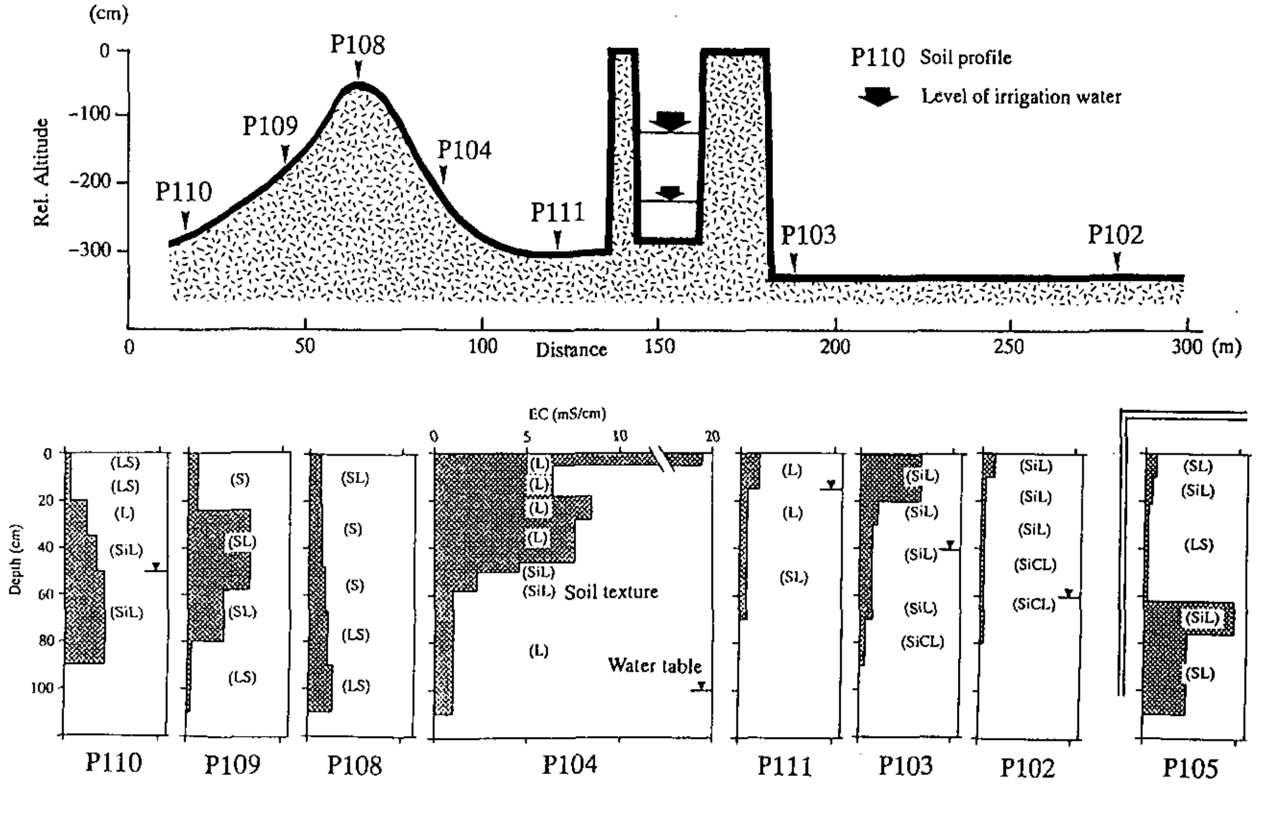

Fig. 3 Distribution of water-soluble salts in soil profiles.

subsurface layer. Textural changes may affect the movement of salts. The surface layer of P109 has a coarser texture than the subsurface layer, thus, capillaries may be cut off to avoid salt accumulation on the soil surface. This mechanism possibly works in Profile P110 as well.

The low EC of profile P111 may be due to seasonal leaching, laterally as well as vertically, produced by too high a water table. A similar mechanism seems to take place in the farm. Water-logging for rice cultivation for 2 cropping seasons out of 4 promotes the leaching of salts, resulting in a lower EC in the farm than in the virgin land in the study site. This effect was also reported as the decrease in alkalinity due to mono-cultivation of rice (Titkov and Gusev, 1989).

Table 1 Electrical conductivity and cationic composition of surface water in selected sites near the study site

Sampling site	EC (mS/cm)	K	Na (ppm)	Ca	Mg
(Non-irrigated area)					
Kapuchagai reservoir	0.47	0.5	21.4	23.0	8.1
(Irrigated area)					
Irrigation canals	0.48	1.4	26.5	23.7	8.3
Seepage	0.74	0.9	43.8	33.9	12.8
Drainage canals	0.97	3.5	48.8	39.4	17.5

The quality of surface water standing or running around the study site was summarized in Table 1. All cation concentrations were the lowest in the Kapuchagai reservoir and the highest in the drainage canals of the study area. This means irrigation water dissolved naturally accumulated salts in the subsoils of the farm and transported some of them to drainage canals and the rest to the soil surface as precipitates. In other words, precipitated salts on the surface originated from subsoils but not irrigation water. An analysis of water soluble salts of salt accumulated layers of selected soil profiles (Table 2) in the study site and its surroundings indicated that sodium sulfates dominated in irrigated areas, both in the farm and virgin land, and gypsum dominated in non-irrigated areas. These results agree with the fact that sodium ions are more mobile than calcium ions.

4. Conclusions

1. Irrigation water has caused and is advancing soil salinization in the farm and its surroundings in the study site. The extent of salinization depends on topography, the level of water table, soil texture and land use.

2. Salinization resulted from the dissolution of water-soluble salts from subsoils into soil solutions supplied with irrigation water, followed by the transportation of salt containing soil solutions through capillaries and the precipitation of free salts when soil water is evapotranspired.

3. When compared to the virgin land, regular water-logging for rice cultivation washed out accumulated salts and reduced salinization. Salinization may be enhanced by changes in the method of land preparation, the type and sequence of crop rotations, and the amount, quality and the method of application of irrigation water.

Table 2 Composition of water-soluble salts in salts accumulation horizons in selected soil profiles (me/100g soil)

Site/	Cations				Anions					
Horizon	Ca	Mg	K	Na	CO_3	HCO_3	Cl	SO_4	NO_2	NO_3
(Non-irrigated area)										
Virgin land/B	24.8	5.5	0.3	4.6	0.0	0.2	9.4	24.8	0.0	0.0
(Irrigated area)										
Farm/A	4.9	4.1	0.8	6.3	0.0	0.6	2.1	14.5	0.0	0.2
Virgin land/A	16.8	13.7	3.0	92.4	0.0	1.0	10.2	114.1	0.0	0.5

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International Convention to Combat Desertification : Its Brief History and Japan's Role

Takashi Matsumura
Environment Agency of Japan

It is said that at present desertification threatens about 3.6 billion hectares - 70 per cent of potentially productive drylands, or nearly one-quarter of the total land area of the world. It is also said that about one-sixth of the world's population is affected.

In response to these threats, the International Convention to Combat Desertification was adopted last June in Paris, which is the first post-Rio legally binding instrument for sustainable development. And the UN General Assembly adopted, at its 49th session in 1994, the Resolution proclaiming June 17 as World Day to Combat Desertification and Drought.

1. Before Rio

Combating desertification has a long history. In the wake of several years of harsh drought and famine in Africa, particularly in the Sahel region, UN General Assembly decided to convene a conference. The UN Conference on Desertification (UNCOD), convened in 1977 in Nairobi, adopted the UN Plan of Action to Combat Desertification (UN/PACD). UNEP reviewed the status of desertification and implementation of the PACD in 1984 and 1991. The assessments revealed that efforts undertaken until then had not been adequate to cope with the magnitude of the problem and process of desertification remained the same as before.

2. Agenda 21 and convention negotiations

During the UNCED preparatory process, the idea of a convention to combat desertification was discussed. It was only in Rio, however, where language was adopted as the part of Agenda 21 requesting the General Assembly to establish an intergovernmental negotiating committee for the purpose of negotiating a convention. The UN/GA, during its 47th session in 1992, adopted the resolution calling for the establishment of the INCD with the aim of finalizing the Convention by June 1994.

After its organizational session in January 1993, the INCD chaired by Ambassador Bo Kjellen (Sweden) were held in Nairobi, Geneva, New York and Paris. In the course of the negotiations, financial provisions of the Convention had been naturally the biggest issues. There were times during the final session in Paris that delegates thought they would never reach agreement on the provisions. After three all-night sessions, the Convention was finally adopted. Resolutions on Urgent Actions for Africa and Interim Arrangements were also adopted in Paris.

3. Convention to combat desertification

The Convention is the first post-Rio sustainable development convention. Reflecting past failures, the Convention is notable for its innovative approach in recognizing: the physical, biological and socio-economic aspects of desertification; the importance of redirecting technology transfer so that it is demand driven; and the involvement of local populations in the development of national action programes.

The core of the Convention is the development of national and sub-regional/regional action programs to combat desertification. These action programes are to be developed by national governments in close cooperation with donors, local populations and NGOs. An establishment of a series of instruments for science and technology is another essential element of the Convention.

The Convention will enter into force 90 days after it has been ratified by legislatures in 50 countries. It has already been signed by nearly 100 countries (See Table 1). However, ratifications by the countries are still in the process. A process is expected to take about two years.

4. Japan's activities and role

Japan has been actively participated in the negotiating process, who was the coordinator for the Resolution on Urgent Actions for Africa. The negotiations of the Convention have been concluded. The adoption of the Convention, however, is not a goal of combating desertification. Rather, it is a starting point of further efforts. Now, time has come to implement the Convention: translation of the provisions into

Received 27, February 1995

actions.

First task is to ratify the Convention as soon as possible. Without ratification by major donors including Japan, the Convention can not be a effective instrument for curbing desertification.

Also very important are active contributions for on-going activities by INCD for the preparation of the first Conference of the Parties. Not financial supports but intellectual inputs are indispensable. In particular, Japan was recently elected as the Chairman of the Working Group II of INCD whose responsibilities include science and technology issues, and is expected to make positive contributions in this field.

Table 1 States Signing the Convention on Desertification (as of 9 January 1995)

Algeria	Denmark	Ivory Coast	Philippines
Angola	Djibouti	Japan	Portugal
Argentina	Egypt	Kazakhstan	Republic of Korea
Armenia	Equatorial Guinea	Kenya	Saint Vincent and Grenadines
Australia	Eritrea	Lesotho	Senegal
Bangladesh	Ethiopia	Lebanon	Seychelles
Benin	European Union	Libya	Sierra Leone
Bolivia	Federated States of Micronesia	Luxembourg	Spain
Brazil	Finland	Madagascar	Sudan
Burkina Faso	France	Mali	Sweden
Burundi	Gambia	Malta	Switzerland
Cambodia	Georgia	Mauritania	Syria
Cameroon	Germany	Mexico	Tanzania
Canada	Ghana	Mongolia	Togo
Cape Verdi	Greece	Morocco	Tunisia
Central African Republic	Guinea	Namibia	Turkey
Chad	Guinea-Bissau	Netherlands	Uganda
China	Haiti	Nicaragua	United Kingdom
Colombia	India	Niger	United States
Comoros	Indonesia	Nigeria	Uzbekistan
Congo	Iran	Norway	Zaire
Costa Rica	Ireland	Pakistan	Zambia
Croatia	Israel	Paraguay	Zimbabwe
Cuba	Italy	Peru	