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Problems and Countermeasures for Resources Development and Environmental Renovation in the Contiguous Area of Shanxi, Shaanxi and Inner Mongolia

Shengyue FAN

ABSTRACT--The contiguous area of Shanxi, Shaanxi and Inner Mongolia of China is rich in coal and gas resources. It is expected to become the largest output base of comprehensive energy source and energy supplier in China. The present main problem is manifested in the disharmony among railway, power, water, environment and local economy, which has lowered the speed of capital construction. In the paper, according to calculate the potentiality of grain production and water resources required by agriculture and industry, it is possible that grains can be self-sufficiency in the region and water can satisfy the demand of water supply after regulated by large reservoirs. The countermeasures coordinating the relationship of resource, environment and population are put forward.

Key words: countermeasure, environmental renovation, resource development

1.Introduction

The studied area consists of 16 counties belonging to 3 provinces or autonomous region, which are Hequ, Baode, Pianguan and Xingxian counties of Shanxi province; Yulin, Shenmu, Fugu, Hengshan, Jingbian and Dingbian counties of Shaanxi provinces; Dongsheng, Togtoh, Qingshuihe counties and Ejin Horo, Dalad, Junggar banners of Inner Mongolia Autonomous Region, the total area is 69 thousand km^2.

The studied region is rich in coal resources with fine quality and better mining condition. It also abounds with natural gas resource and the gas pressure is stable. But the gas layer is thin and deep, causing a difficult exploitation and high coat. Coal and water resources match well in this region. The condition for choosing a site to build thermal power base is fully endowed by nature. Therefore, it is convenient to convert coal into electric power on the spot. As mentioned above, the contiguous area of Shanxi, Shaanxi and Inner Mongolia is expected to become a largest output base of comprehensive energy source and energy supplier in China. The development and utilization of coal, natural gas and electric power resources will play an important role in the disharmony among railway, power, water, environment and local economy, which has lowered the speed of capital construction.

2. Trying hard for grain self-sufficiency

Now there are 1463 thousand ha of cultivated land in the area, of which grain area is 1162 thousand ha, accounting for 79.4% of its total cultivated area, According to the potentiality and guarantee degree for grain production, the per capita grain-share is estimated to reach undoubtedly 310 kg by 1995, and 400 kg by 2000. In order to achieve this goal some important measures must be taken, such as to develop new irrigation area, to reconstruct old one, to speed up terraced field construction and to practice scientific cultivation.

3. Paying great attention to environmental renovation and protection

Through further observations on environmental problem, we find that the land degradation is becoming severer with the economic development of the region. There are five forms of degradation, that is, wind erosion, sandification, grassland deterioration, industrial pollution, and soil impoverishment, of which the first two are most serious. The decertified area of and the area of soil erosion make up 54.16% and 32.88% of its total area respectively. The desertification of farmland and pasture is most conspicuous. The area of desertified grassland is different from place to

Lanzhou Institute of Desert Research, Academia Sinica, Lanzhou, 730000, China
Fax: (+86-931-8889950)

place: Yulin 71.2%, Ejin Horo 58.5% and Dalad 49.3%. The percentages of desertified farmland and in total cultivated area are: Yulin 11.46%, Dalad 11.4%, Hengshan 11%, and Dingbian 10.2%. It is inferred that the non degraded land is only 0.52%; the light degraded land is 3.28%; the moderate degraded land is 45.88%, The serious degraded land is 50.28% of the total area of the studied area. It belongs to the most barren area in China, and little progress has been made in the rehabilitation of the desertified land. For example, in Abode County, where soil erosion is serious, only 25.6% of farmland has been ridded of wind erosion menace; The improved area percentage in Shenmu is 29.2% and Junggar 15%. So we should pay great attention to development and environmental renovation. More investment must be used to speed up the rehabilitation of the degraded land.

4. Water resources required by agriculture and industry

The agricultural and industrial need for water supply can be ensured by regulating the river's runoff in the region. Except for the main stream of Yellow River that runs through the whole region, local water resources are insufficient. The total runoff volume of rivers is 3.28 billion m3, and the ground water reserve is 2.26 billion m3. After deducting the overlapping, the total water resources are only 4.46 billion m3. Due to the great differences between dry and flood runoff, natural rivers mean nothing to the need for water supply unless the runoff is regulated. Taking Kuye River at Shenmu Station as an example, the greatest discharge is 13000 m3/sec, while the minimum is only 0.008 m3/sec.

The studied region has good condition for building large scale reservoir. After regulated by large reservoirs, the runoff volume can satisfy the demand of water supply for industrial and agricultural production if the energy source base.

In order to increase about 250 million m3 of water supply for industry and agriculture, the Zhuanlong Reservoir on Tuwuihe River is under construction in the Shenfu-dongsheng Coal field development area. After completion of the project, the water supply can increase by 367 million m3 (890 thousand ton /day) for low water year (p=75%) and 272 million m3 (746 thousand ton/day) for extreme low water year.

Shen-Yu-Heng coal, power and chemical industry developing area needs to increase 423 million m3 of water supply. The water supplies can be added 632 million m3 (1.73 million ton /day) in low water year, and 561 million m3 (1.53 million ton /day) in extreme low water year after the reservoirs being built up at Wanggedu on Wudinghe River, Lizhi on the lower reaches of Tuweihe River at Hongshanxia.

5. Coordinating the relationship of resources, environment and population

The guiding ideology has been further defined, that is to build a optimal environment and efficient agriculture. We must heighten the consciousness of coordination development in resources, population and environment, more investment should be gradually poured to build a benign environment for the sustainable development of energy source and heavy chemical industry base.

6. Countermeasures

(1) It is suggested that a special economic developing area should be founded to form an united administrative body, which will be advantageous to heighten the levels for developing energy sources and to eliminate various contradictions.

(2) The railway advancing south must be built up as quick as possible to change the situation that transport capacity decides the coal output.

(3) Policies and authority organization should be available for environmental protection, so as to strengthen the environmental renovation and to form a new prospect for both development and renovation.

(4) The scientific levels for land management must be strengthened to heighten the comprehensive benefits of land productivity and to ensure the supplies of grain and by-products for the energy source base.

(5) As to the funds, the local government can mortgage coal resources for attracting foreign capital and seeking international joint development. The local government can draw a certain proportion of money for resources compensation, so as to perfect the comprehensive economic system for regional development.

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The Yellow River Basin = A Perspective for Sustainable Development in Arid to Semi-arid Region

Michio MATSUDA *, Mitsuo KUBOTA **

Abstract: The Yellow River, being one of the most important rivers in China, runs through arid to semi-arid region. The river basin covers over three quarter of a million square kilometers. Sustainable usage of the limited water supply is essential for the balanced development of the region, and of whole China. This paper provides an introductory view to the development plan of the river basin by dividing the basin into three regions, each with distinct problems.

Key Words: Regional Development, China, Yellow river, Water Resources

1. Introduction

The Yellow River basin bears the name 'Cradle of Chinese Civilization'. This shows how important this region has been to the Chinese people. At the same time, it shows how long the region has been inhabited by men. In the course of more than four thousand years, land degradation occurred in vast areas of this river basin.

In recent years, increase in population and growing demand for land and water resources, together with industrial development, have accelerated land degradation. Various sectors both in and outside China have been involved in programs and projects to tackle the problems. However, such activities were mostly research on limited areas.

2. General Conditions

Since the river basin is very wide, problems encountered differ from location to location. In the upper reach, flow and expansion of the deserts damage roads, railroads and other infrastructure thus forcing the inhabitants to live under harsh conditions [1]. In the middle reach, erosion in the loess plateau not only degrades land, but also is the main supplier of soil into the Yellow River. The development of coal mines in this region further aggravates erosion through several concurrent reasons [2]

In the lower reach, lack of water due to widespread irrigation prevail. In addition, utilization of sand rich water lead to sand sedimentation in irrigation facilities and farmlands. Lack of sufficient slope leads to difficulties in drainage, thus increasing the threat of salinization [1] [3]

3. Regional Geographic Conditions

The Yellow River, which starts in the Qinghai Province, runs through 8 provinces and autonomous regions covering 5,464km in length and a river basin of 0.753 million sqare km [3] .When the basin is defined as the area with the dominant environmental influence of the Yellow River, a study claims that the basin covers 0.833 million square km [4] . The difference is mainly in the lower reach where irrigated farming is widely spread. Most of the regions have arid to semi-arid climate. Annual rain fall is shown in fig 1. In general, annual rainfall is inclined to have less in the northwest and more on the southeast.

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* General Manager, Business Planning Department (Environment), Global Infrastructure Fund Research Foundation, Tokyo 105, Japan, (Fax:+81-3-3432-4541)

** Manager, Water & Irrigation Team, Project Promotion Office, KUBOTA Corporation, Tokyo 103, Japan

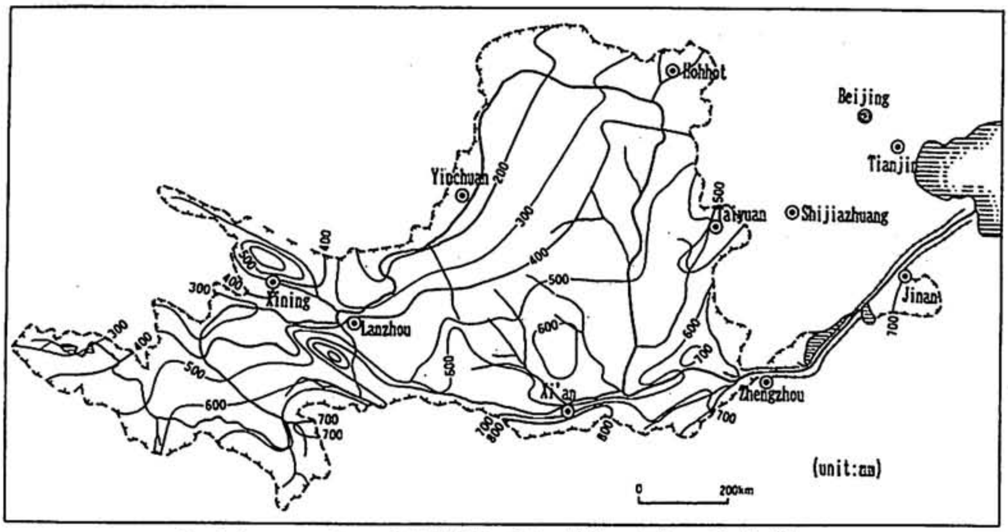

fig.1 Average Annual Rainfall of the Yellow River Basin [3]

<u>3.1 Upper Reach</u> The upper reach starts from Bayan Har Mountains of Qinghai Province up to Togutoh in Inner Mongolia autonomous district. The length of the river in this region is 3,461km and covers an area of 368 thousand square km [3]. The region can be separated into two subregions; the source and the upper reach.

The source subregion is mainly in the Qinghai province and is sparsely populated. The main environmental concern is land degradation due to overgrazing [4]. Generally, environmental degradation in this area is light compared with the other regions, and thus shall not be discussed further in this paper.

The upper reach subregion includes the northeastern part of Qinghai province and most of Gansu province and Ningxia Huizu autonomous district, together with the south western portion of Inner Mongolia district. The subregion contains deserts such as the Tennger, Ulan Buh and part of Mu Su.

<u>3.2 Middle Reach</u> The middle reach is from Togutoh to Huayuankou in Henan Province. It covers the length of 1,235km and area of 362 thousand square km [3]. It runs through Inner Mongolia district, Shanxi, Shaanxi and Henan provinces. Most parts of this region are covered by loess or the Ordos plateau. Another characteristic is that the region embodies the largest content of coal in China, while coal is still the primary fuel of this country.

<u>3.3 Lower Reach</u> The lower reach starts from Hwayuankou and covers the length of 768km [3]. Due to continuous sediment of soil in the river bed, the height of river bed is higher than surrounding grounds in 78.5% of the river length in lower reach [3]. This makes the geographic definition of basin area quite difficult. It should be considered, however, that the broadest area of influence should be taken in order to establish an integrated regional development plan. In this regard the basin will cover a wide section of the Huanhuaihai plains. The river basin in this sense covers 72 thousand square km [4] in Henan, Hebei and Shandong Provinces.

<u>4. Environmental Degradation; Its Causes and Countermeasures</u>

<u>4.1 Upper Reach</u> Infrastructures in the vicinity of the deserts are prone to be damaged by the desertification. The major cause of desertification in this area is by windshift and by human induced causes, mainly overgrazing and inadequate farmland development [1].

Cities such as Lanzhou, Yinchuan and Baotou lie in this subregion. To upgrade the harsh living conditions, adequate agricultural development is necessary to feed the population and to secure employment. It may be noted that import of food from other regions is difficult due to limited infrastructure. One reason that infrastructure development in this region is limited is the presence of deserts. One example to overcome this problem is the Baotou-Lanzhou railroad that crosses the edge of Tennger desert.

Irrigation is indispensable to underpin the production. However, excessive usage of water in this region will cut the water supply in the lower regions of the river basin. Therefore the main focus of environmental protection should be to establish a water usage plan for sustainable farming, together with the prevention of further desertification caused by windshift and human induced causes.

4.2 Middle Reach The region produces approximately 90% of sand in the Yellow River [3]. The soil is washed into the river mainly through windshift in the northern part and rainshift in the southern part [1].

The loess plateau is very easily washed by these actions. The land degradation is accelerated by human activities. In some districts, the influence dates back to at least the Han dinasty [5]. Land degradation is further aggravated by the recent large scale development of coal mines, especially in the border district between Inner Mongolia and Shaanxi [2].

To diminish this trend, short to medium measures such as the construction of small dams which collect the washed soil and restriction on undesirable farmlands which increase the rate of shifting must be taken. The long term measures, however should be to fix the soil in position. This is probably best achieved by planting regionally suitable trees and shrubs.

4.3 Lower Reach The lower reach is one of china's most prosperous areas for agriculture. For example, Shandong Province boasts the largest province-wise agricultural production. Sustainable use of water is essential to maintain the region's productivity. Measures to cut out the excessive irrigation/poor drainage must be incorporated. Such measures not only reduce total water usage, but the sedimentation of soil in the irrigation system and salinization is also alleviated.

5. The requirement of an Integrated River Basin Program

Since the Yellow River runs through all these areas, the problems encountered must be handled not individually but in an integrated program that optimize water utilization and minimize land degradation of the entire basin. Such integrated program must incorporate the product of existing research programs and development efforts while diminishing its side effects.

Special attention must be taken so that the water usage of upper shed will not hurt the sustainability of irrigation in the lower shed. The decrease and prevention measures for the soil washed into the Yellow River in the middle reach is also very important.

Global Infrastructure Fund Research Foundation, a nonprofit organization focusing on the better management of limited global resources, has organized the subcommittee on the greening and regional development of desert area. The subcommittee, composed of members from various sectors, is now planning to execute a research program in cooperation with its Chinese counterpart to promote the formation of such integrated program.

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PV Based Rural Electrification in Nepal - Problems and Prospects

Jagan Nath SHRESTHA*

Abstract- More than 90% of the total population of Nepal, a small Himalayan kingdom, do not have access to electricity. Electrification of most of remote areas in the near future is not foreseen.

The findings of Pulimarang PV Lighting Programme, a PV based rural electrification pilot project, are highlighted with particular reference to socio-economic impacts of standalone PV electrification. Subsidy policy of His Majesty's Government of Nepal on commercial energy is analyzed referring the solar economics in the Nepalese context. Suggestions are given on how PV based Solar Home System can be made affordable.

Key words: Rural electrification, solar economics, subsidy

1. Introduction

It is estimated that more than two billion people on earth do not have access to electricity - the single most important boon of mother nature to human beings. The per capita consumption of electrical energy of a country is a measure of the progress, development and the physical quality of life index (PQLI) of that country.

Electricity is no longer considered a luxury - in fact it has become a basic need even in rural areas for survival needs - water supply and disinfection, health care and development and basic needs - electric lighting, education, rural telephone, TV and radio, air ventilation, water pumping, irrigation, insect control, workshops and cottage industries. This is why physical quality of life index (PQLI) is usually plotted against energy consumption. The PQLI focuses on four measures of well being: infant mortality, life expectancy, literacy and access to information. These indicators are considered to reflect the most basic desire of people: that is to live longer with better health, better education and better opportunity.

Just a few watts of reliable electricity can bring a dramatic change to the standard of living and social progress. All these facts indicate one thing - access to electricity is the fundamental right of every citizen of a country.

2. Electricity in Nepal

Nepal Electricity Authority (NEA) reports that total available electrical energy for 1994 was estimated to be 1034 GWH out of which only 765 GWH will be sold to 426,350 customers. Out of this it is estimated that only 275 GWH will be sold to 405,663 domestic consumers mainly in urban areas. The average consumption of electrical energy among these consumers comes out be about 370 WH per person per day, considering five members in each family. This means more than 90% of the total population and almost all people in rural areas are deprived of electricity. The major source of electrical energy in Nepal is hydro power.

3. Solar Electricity in Nepal

For a large part of the rural population consuming low electrical energy, there is no viable alternative to solar electricity for rural electrification. The operation and maintenance cost of diesel generators is

* Institute of Eng., Tribhuvan Univ., Kathmandu, Nepal (Fax:+9771521985)

too high, biogas technology does not work satisfactorily on the fairly cold high plains or in the mountains and would be difficult to realize with roving herds of cattle. Small hydro turbines need specific topographical conditions that are only found near a small percentage of users dwellings. Solar electricity generating systems which do not need fuel or extensive infrastructure, are easy and quick to install and are thus the single most attractive alternative in many locations of the country.

It is not claimed that solar electricity (Solar Home Electric Lighting System-SHS) can solve rural electrification issues completely. The Solar Home System too has limitations and problems but these can be overcome with proper planning.

There are six basic preconditions to be met if rural electrification problems are to be solved with the Solar Home Electric Lighting System :

a) Proper SHS planning;
b) Sufficient and stable solar irradiance over the whole year;
c) Low energy need of potential users;
d) No electric grid connection in the foreseeable future;
e) Proper maintenance schedule; and
f) Active participation of the SHS users.

Solar Home Systems (SHSs) are basically meant to supply direct current for such things as fluorescent tubes with electronic ballast, TV sets, radios and cassette or video players. These systems may also seem very attractive to the consumers because they are modular and they offer a measure of independence from the utility service.

Solar electricity, depending upon its generating size, is still 2 to 6 times more expensive than heavily subsidized grid supplied electricity which costs as little as Rs. 3 (US$ 0.06) per unit. Therefore Solar Home Systems seems to be hopelessly uneconomical where grid supplied electricity is available. But it is illogical to compare two similar things when both of them are not available at the same time and at the same place. Furthermore, Solar Home Systems are meant to satisfy basic needs. With a grid supply, the user has more options for the consumer appliances. Provided it is reliable, a grid supply is always more attractive to a user than solar home systems. Nevertheless, because of the higher installation and operating cost, a grid supply will very often not be the best option for electricity companies specially when rural electrification has to be considered. It is clearly shown that the cost of generating solar electricity is more than four times cheaper if energy consumption is 6 KWh/day and if the user is located at a distance of 2.7 Km. from the utility grid (Perez,1993).

Nepal Telecommunications Corporation has become the most significant user of solar electricity amounting to more than 600 KWp generating about 3000 KWh/day of electrical energy at more than 250 locations of the country. Similarly the Department of Civil Aviation (DCA) is using more than 14 KWp of solar electricity at 43 locations for communication equipment. So far there have been no complaints against this technology at these locations probably due to good solar insolation prevalent at these places. Nepal Electricity Authority has installed centralized PV based generating stations with a total capacity of 130 KWp at three different locations. The operation of these systems are found to be not satisfactory because of the centralized system approach.

Solar Electricity Co., Wisdom Light Group and Lotus Energy, the Nepalese enterprises involved in PV based rural electrification, are producing balance of systems and laminating PV modules locally. These companies are reported to have sold more than 200 SHS in more than 30 districts of Nepal within last two years. Centre for Renewable Energy, the only Nepalese NGO promoting renewable energy technologies, is heavily involved in managing and promoting PV based rural electrification.

There is a government policy of significant subsidy for micro hydropower plants. This amounts upto 75% of the total cost of electrical equipment. Likewise there is a heavy subsidy on imported kerosene and national electricity grid supply specially for those consumers who consume about 20 KWh per month. A successful subsidy program for bio-gas is also being implemented in Nepal. It is hoped that the policy makers will consider this matter and recommend some subsidy also in the case of PV solar electric home light system in very near future.

4. A Pilot Project on PV based rural electrification in Nepal

A pilot project on PV based rural electrification was launched in 1993 at Pulimarang, a remote village in the Western Development Region of Nepal. The basic stand alone Solar Home System (SHS) consisted of a 35 Wp solar module, 70 Ah automotive battery, charge controller, three 8 Watt fluorescent lights and accessories. The total cost of the system including installation was Rs. 23,000.00 (US$ 460.00). The users of SHS have formed a Solar Users Group to manage the electrification programme.

After the installation of 47 solar PV home systems in Pulimarang the following initial socio-economic impacts have been observed:

- consumption of kerosene has been reduced from 35 litres to less than 10 litres per month in the village;
- students study one hour more per day during evening;
- an evening shawl knitting training progamme for women has been started;
- solar electricity is used now to power radios in the morning and daytime, thus reducing consumption of dry cell batteries;
- the TV news is watched daily and many Nepal Television programmes are very popular amongst Pulimarang people;
- normal bed time has shifted from sun-set to as late as 22:00 hours;
- the adult education programme in the village is becoming more popular and six such programmes are being run as against one before solar electricity was available in the village;
- the district development committee is planning to allocate budget for supporting alternate energy projects in the annual programme;
- nearby villagers have also shown a great interest in electrifying their own village homes;
- the trained technicians of Pulimarang have installed two PV home systems at neighboring villages; and
- the previous inhabitants of Pulimarang currently residing in urban areas are thinking to come back to own village specially after the availability of solar electricity in the village.

It is estimated that more than 250 households in the rural areas of Nepal have been using SHS for the last 5 years without any significant maintenance problem. First anniversary of successful operation of the Pulimarang Solar Electric Lighting Project indicates that SHS is reliable provided local participation is ensured from the beginning.

5. How can solar electricity be made affordable ?

What everybody, including the 'think tanks' of the government's energy sector, generally think is that solar electricity is expensive compared to hydro-electricity. It may be true if compared with a heavily subsidized grid supply. When compared with unsubsidized hydro-electricity and other conventional sources of electricity, the solar electricity becomes comparable or even cheaper. To check whether it is true, let us, for time being, list out the data available:

- Almost 50% of the NEA consumers pay Rupees 0.5 less per unit than the actual cost thus amounting a subsidy of Rupees 24 million annually.
- Ninety percent of the Nepalese population use kerosene for lighting.
- Nepal has imported nearly 161 million liters of kerosene in 1993/94.
- Almost 10% of thus imported kerosene is used for lighting purposes.
- Considering that a subsidy of Rs. 1.78 per liter is granted to kerosene, the kerosene lighting people consume almost Rupees 286 million of subsidy.

The initial system cost of a small solar electric home system (SHS), even though just Rs. 23,000.00, is still a substantial amount for an average Nepali living in rural area. But it is certain that most of the rural dwellers can pay a monthly installment if it is not too high. Therefore for those who can not be accessed through MHP grid, effective stand alone PV based electric installation can be made operative through various schemes. For example if the government can keep aside just Rupees 0.05 per unit sale of grid electricity, almost 3000 households can be electrified annually. Similarly, just 10% of the amount of the subsidy given to kerosene can be kept aside for electrifying additional 2000 households annually. Government or other similar agencies can develop a suitable installment scheme to get the electrification cost recovered from the users. Even if the government is reluctant to invest on solar rural electrification, it can instruct the commercial banks to provide a low interest lending to those willing to install SHS against land as collateral.

6. Conclusion

Solar electricity is a prime example of a good technology : modular, non-polluting, quiet, clean, benign, trouble free, sustainable, long lasting, easy to install, universally available and independent of economy of scale.

It is indicated that the key issues identified at the Earth Summit in Rio as threats to the environment - climatic change, destruction of the ozone layer, soil, air, and water pollution, desertification and deforestation, poverty and migration etc. - are all energy problems. According to Scheer the only approach that will allow these issues to be tackled effectively is to aim for a global solar energy economy: the complete replacement of fossil fuel and atomic power generation by renewable sources of energy. He stresses that the solar revolution needs new supporters in society, in politics, in economics, in science and in the media (Scheer,1994).

For stand alone PV home power systems to succeed, their modest maintenance requirements must be met, and maintenance costs are not negligible. The users of PV solar home systems must be given the information, access to subsidized financing, and access to information on alternatives, so that they can choose the best. It is important to educate as many people as possible (including planners and executives ?) regarding the benefits and potential of solar electricity for rural development in as much as there are many detractors who preferred the old ways of supplying energy, and who denounce solar energy, whenever they have chance.

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Approach to Desertification Control Measures via Agricultural and Rural Development - In line with the Demonstration Study of Desertification Control Measures in Niger -

Mitsuhiro Goto, Norio Nawa, Ken Nishida
Japan Agricultural Land Development Agency

Abstract - Although both natural and social causes can be found for desertification, of particular note is that it is caused by human activities that exceed the permissible limits of the fragile ecology in which they are carried out. Taking the example of villages as the smallest socio-economic unit, we learn of many cases in which desertification is promoted outside the village when the land and water resources required by the main industries of agriculture, livestock farming, and forestry (or firewood production) are in short supply inside the village and therefore rely on outside sources. Therefore, sustainable development at the village level in line with future increases in population is thought to be the basis for desertification control measures

Therefore, we have studied a desertification control plan via uniform agricultural and rural development of agriculture, livestock farming, and forestry, taking the village of Magou in Niger as our model.

1. Introduction

Since 1990 JALDA has been conducting a "Demonstration Study of Desertification Control Measures", scheduled to last for 6 years in all. Its objective is to apply existing technology to areas affected by desertification and to demonstrate its efficacy locally while at the same time identifying more effective technology and control measures. On the basis of the results of this study, we have studied the village of Magou as a model. A demonstration study of a desertification control plan via agricultural and rural development has been underway here.

2. The state of desertification in Magou

The village of Magou is located some 60 kilometres southwest of the capital Niamey, and is part of Torodi district, the main region supplying food and firewood for the capital. Its population is 1,137, with 113 households.

2.1 The relationship between farming economy and desertification

Using Landsat data and the satellite-based global positioning system, we have elucidated the state of land use in Magou (as of December 1992), as shown in Table 1.

Table 1 Topographical divisions and land use (unit: ha)

Topographical divisions	Laterite/ exposed rock	Sparse grasslands	Fallow land	Millet fields	Grasslands/ scrublands	Sparse woods	Forests	Settle-ments	Total
Plateau with small hills	34	43	91	70	23	38	10	-	309
Gently sloping land	53	95	271	494	86	202	32	13	1,246
Lowlands	8	25	64	88	22	62	19	-	288
Total	95	163	426	652	131	302	61	13	1,843

2.2 Food production

Table 2 shows the results of interview research and actual field figures for the single millet harvest of 1994.

Calculating the state of self-sufficiency in grains (Table 3) on the basis of these survey results, we see that production is 330 tons as against a minimum annual grain requirement of 284 tons, thus self-sufficiency has been achieved. However, in the current low-investment method, this single harvest is easily affected by the amount and frequency of rainfall, and it is anticipated that this will gradually become smaller as land fertility decreases.

Table 2 Single millet harvest (1994)

Total land area: 28.157 ha	Single harvest: 566 kg/ha (simple average)	Single harvest: 510 kg/ha (weighted average)

Table 3 Grain self-sufficiency estimation (1994)

Category	Unit Quantities	Production/Requirement
Millet-farming area 652 ha	510 kg/ha	333 tons
Population 1,137	250 kg / person / year	284 tons
Surplus		49 tons

2.3 Livestock

We estimated the number of domestic livestock from the average numbers owned in selected farms. There were 1,020 head of cattle, 900 sheep, and 1,240 goats. We know that the dry feed requirement for cattle is 0.75 UBT, while that for sheep and goats is 0.1 UBT (the UBT or unit dry fodder intake is 6.25 kg/day). On the basis of this the annual (dry) fodder requirement in the village is calculated at 2,232 tons. We surveyed the fodder production capacity in the village, and found it to be 500 kg/ha in sparse grasslands, 2,800 kg/ha in sparse woodlands (except in lowlands), 1,300 kg/ha in spare woodlands (lowlands), 1,400 kg/ha in fallow land, and 1,010 kg/ha in millet residues, thus the amount of fodder produced is estimated at about 1,402 tons, leaving a shortfall of 830 tons.

2.4 Firewood collection

Although the amount of firewood consumed over the year is 1.17m^3 per person and 1,330m^3 for the village as a whole, in a vegetation survey of forests etc. the firewood that can be collected in the village has been estimated at 110m^3. Thus 1,220m^3 have to be collected and transported in from outside the village, showing there to be a net shortage of firewood forest resources in the village.

2.5 Economic situation

The average farming income of the 32 households in the selected survey is 580,000 FCFA, and the average non-farming income is 200,000 FCFA, giving a total of 780,000 FCFA. On the other hand, running expenses are 150,000 FCFA, leaving 630,000 FCFA. 69% of the farming income is taken up by income from the sale of livestock etc., this consisting of the sale of 6 head of cattle, 6 sheep, 6 goats, and 11 chickens. 30% of non-farming income involves the sale of screens processed from millet stalks processed.

The running expenses are broken down into 43% for food provisions, 44% for accommodation, 8% for medical expenses, and 5% for education. The remaining amount is set aside for material possessions (bicycles, motorbikes, radio-cassette players, etc.) as well as being used for the purchase of livestock as a form of savings.

3. The Magou Comprehensive Agricultural and Rural Development Plan for Desertification Control Measures

3.1 Outline of the Plan

The current situation in Magou is that it basically depends on outside resources and that this is contributing to the advance of desertification. Therefore the basic objective of this Plan is to develop land and water resources in Magou over the space of 6 years, and to achieve self-sufficiency in food, fodder, and firewood in the village by the year 2010 without having to introduce resources from outside, to improve farm economies, and to materialize a sustainable agriculture, livestock farming, and forestry.

In drafting this Plan we assumed a 3% rate of increase in livestock and in firewood consumption, respectively, and that the annual rate of increase in population would be fixed at 3.36% (the increase rate for Niger).

3.2 Land use plans

The Land Use Plan has the target of achieving self-sufficiency in food, fodder, and firewood in Magou and the recovery of vegetation in a harmonious form (Table 4).

The characteristics of the Plan are as follows.

(1) By diverting livestock manure to millet fields and improving productivity, the land area kept as fallow land will be reduced and will be used as livestock pasture, short-term nursery plantations, and conventional tree-and-pasture mixed forests.
(2) The currently underutilized sparse woodlands, grasslands/scrublands, and sparse grasslands will be converted to high-productivity pastures and conventional tree-and-pasture mixed forests.
(3) Part of the wadi flood plain will be used as paddy fields and irrigated crop fields.
(4) Existing forests will be protected.
(5) Individually-owned trees and fruit trees will be planted on boundaries between fields in order to increase tree density in field areas.

Table 4 Existing and planned land use

Existing		Planned	
	ha		ha
Millet fields	652	Millet fields	150
		Millet fertilized fields	450
Fallow land	426	Fallow land	151
		Sorghum fields	20
		Cassava fields	20
		Paddy fields	10
		Irrigated fields	20
		Pastures	191
Laterite exposed rock plateau	95	Short-term nursery plantations	285
Sparse grasslands	163	Conventional tree-and-pasture mixed forests	463
Grasslands/scrublands	131		
Sparse woodland	302		
Forests	61	Forests	61
Settlements	13	Settlements	22
		Boundary trees (number)	2854
		Boundary fruit trees (number)	1202
Total	1843		1843

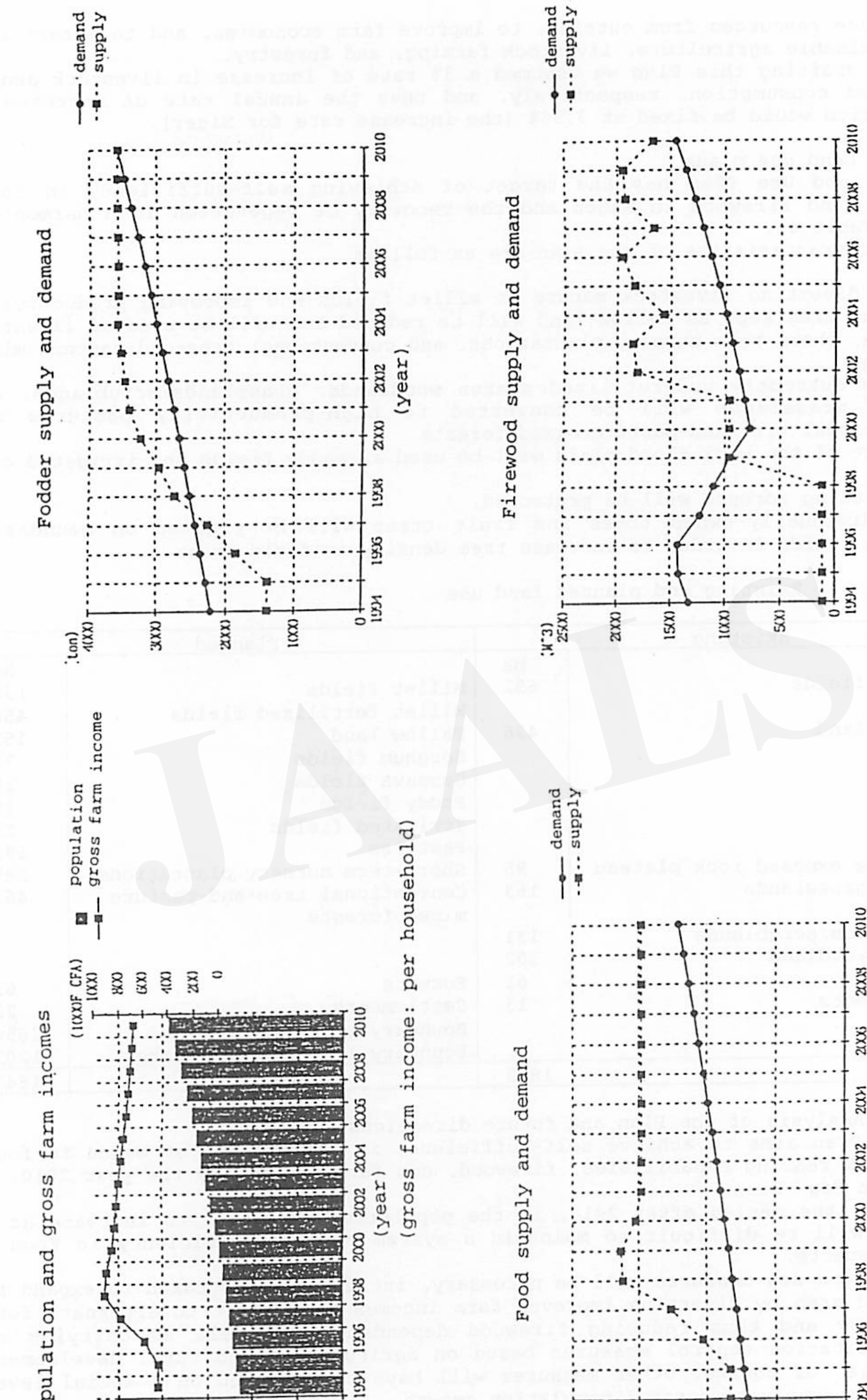
3.3 Analysis of the Plan and future directions

This Plan aims to achieve self-sufficiency in the village of Magou in food, livestock rearing capabilities, firewood, and farm incomes by the year 2010, as shown in Fig. 1.

As for the period after 2010, if the population continues to increase as it is, it will be difficult to maintain a system of self-sufficiency in food or other aspects.

Therefore new measures will be necessary, including steps taken to expand the farmland area by diverting improved farm incomes to a shift to alternate forms of energy and thus reducing firewood dependency, as well as carrying out desertification control measures based on agricultural and rural development. Meanwhile, of course, other measures will have to be taken on a social level, such as measures to control population growth.

Fig. 1


Population and gross farm incomes
(persons)
2500
2000
1500
1000
500
0
(1000F CFA)
1000
800
600
400
200
0
population
gross farm income
1994 1996 1998 2000 2002 2004 2006 2008 2010
(year)
(gross farm income: per household)
Fodder supply and demand
(ton)
4000
3000
2000
1000
0
demand
supply
1994 1996 1998 2000 2002 2004 2006 2008 2010
(year)
Food supply and demand
(ton)
800
600
400
200
0
demand
supply
1994 1996 1998 2000 2002 2004 2006 2008 2010
(year)
Firewood supply and demand
(M^3)
2500
2000
1500
1000
500
0
demand
supply
1994 1996 1998 2000 2002 2004 2006 2008 2010
(year)

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Environmental Impacts of Land Degradation in Pakistan

Zahid HUSSAIN* and Qurban HUSSAIN**

Abstract- Out of the 79.6 million hectares (Mha) area of the country , only 20.5 Mha. are available for agriculture (16 Mha. for irrigated and 4.0 Mha for rainfed agriculture). A sizeable chunk of land mass about 31 Mha. is under forests and the remaining areas remained untapped or culturable waste. Pakistan can be divided into some broad based land resources regions; Northern Mountains, Barani lands (Rainfed), irrigated plains, sandy deserts, Sulaiman Rod Kohi, Western Dry Mountains and coastal areas. Land degradation, resulting from salinity and waterlogging, soil, water and wind erosion and combinations of these , is a major impediment to land utilization in Pakistan. These problems, particularly irrigation induced salinity and soil erosion have led to the development of unproductive marginal lands in the country. A strategy for the conservation and management of land resources has been described to contain land degradation in Pakistan.

1. Introduction

Pakistan has a total cultivable land area of 20.5 Mha, out of which 16.0 Mha is irrigated through one of the largest irrigation systems of the world. The snowfall and resulting glacier melt during the summer, while the country received 80% of the annual rainfall in the Monsoon season (July-September) Excessively high water available for shorter periods during the late summer season are not handled by our irrigation system, resulting in salinity, water logging, soil and water erosion and other environmental problems in the high productive lands. Therefore we have a situation of excessive water for short periods during summer and water scarcity in other part of the year. Thus Pakistan has more than 45 Mha. designated as rangeland desert. The major problems of the land degradation are;

1. Soil, water and wind erosion.
2. Abandoned villages through traditional irrigation systems and cultivation of marginal lands thus accelerating the process of desertification.
3. Salinity and waterlogging
4. Shortage of good quality of irrigation water and unplanned brackish water use.
5. Flash floods and heavy sediment load thus siltation of rivers, irrigation systems and reservoirs.

The main environmental impacts of land degradation in Pakistan area vegetative degradation primarily due to soil, water and wind erosion, salinity and waterlogging. A strategy for the conservation and management of land resources has been described in the paper to sustain the process of land degradation in Pakistan.

2. Environmental Problems of Pakistan

The major land resources regions are shown in Fig.1 Accordingly the main land resources degradation problems have been grouped in the following;

2.1 Soil and water erosion Soil and water erosion affects 9.7 Mha area in Northern Mountains, 4.29 Mha in Barani Lands; affecting altogether about 16-18 million peoples. The relief ranges from highly mountainous and rugged from 300 m in the south to more than 8600 m high in the north. Geologic erosion on these mountainous areas is substantial and at places very deep gorges have been formed while at other locations sharp bluffs and peaks (e.g. K2, Nanga Parbat,Takaposhi) stand out. At the foot of the mountains, rock debris is commonly found with thick soil cover where arable farming is practiced.

The soils generally occur on sloping surfaces , therefore these soil are most unstable and subject to greater water erosion. The organic matter of the surface horizons ranges from 1-9% while the subsoils are dominantly subangular blocky. The pH range form 5.5 to 7.3. Because of the vast difference in the ecology, the most important soils formed are; Piedmont plain soils, Loess plain soils, and alluvial plain soils. The Northern mountains make the

* Land and Water Resources, Pak. Agri. Res. Council, P.O. Box, 1031, Islamabad, Pakistan (Fax-92-51-812136)
** Land and Water Resources, Pak. Agri. Res. Council, P.O. Box. 1031, Islamabad Pakistan (Fax:92-51-812136)

most important catchment of the two vital dams Tarbela and Mangla with a total catchment are of 27.69 Mha in Pakistan. The catchment is drained by two mighty rivers Indus and Jhelum which receive heavy precipitation during the monsoon season.

Due to deforestation, overgrazing and excessive runoff, soil erosion is the most dominant land degradation problem in the region. The ecological balance of this tract is seriously upset and is posing a wide spread environmental degradation and resources depletion. The following is proposed:

* A comprehensive afforestation for soil and water conservation may be launched. This programme may be associated with management plans for the protected areas where soil erosion has determental effects on environment.

* Conversion of marginal lands where agricultural productivity is definitely economic to agroforestry, rangelands pastures to promote low cost environmentally sound technologies to conserve land and water resources.

* Training the land users in integrated farming systems may be encouraged so as to popularize the sustained agricultural production concept in the local communities. Participatory approach involving local community leaders for the transfer of technology may be institutionalized.

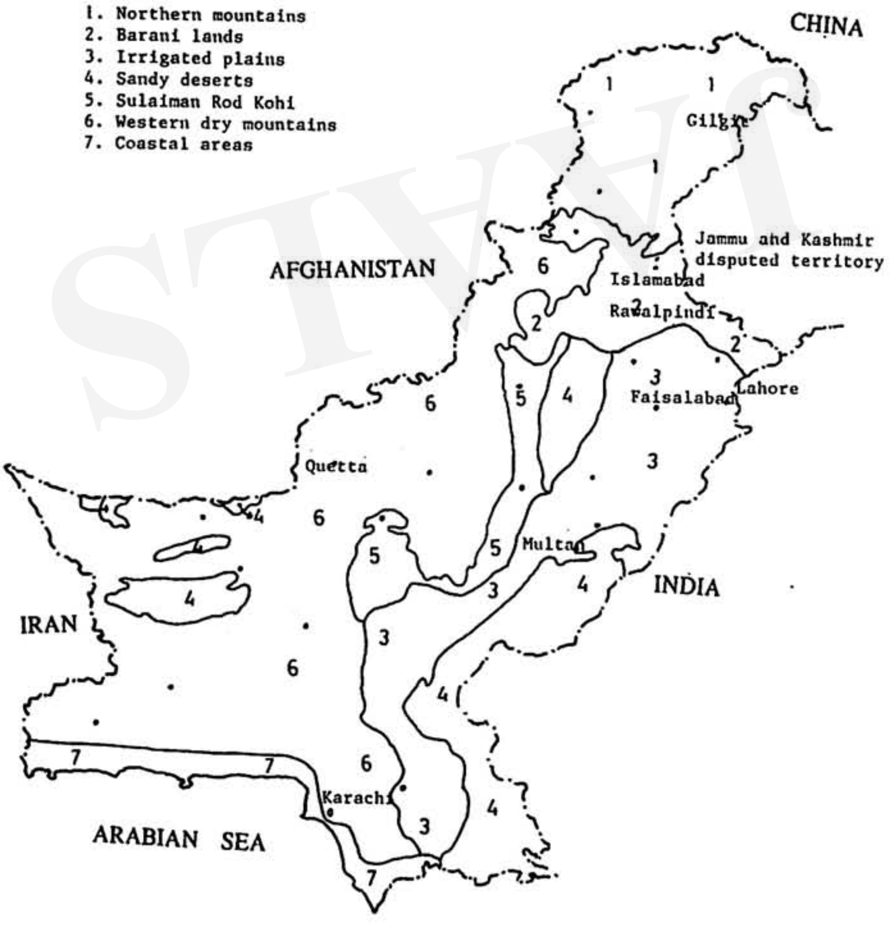

Figure 1. Land Resources Regions of Pakistan.

2.2 Wind erosion Thal and Cholistan in Punjab, Thar in Sindh and Chagai Kharan in Balochistan are the main desert of Pakistan which cover an area of 11.5 Mha (Mohammad, 1994). The climate of the area is arid to semi arid and subtropical characterised by summer temperature (July) 43 C with winter (January) temperature of 3-7 C. The soils in the regions are made from parent material of clayey alluvium and wind resorted fine sand or loamy sands. The deserts constitute sand dunes. slopes or ridges and flat lands. About 30% Cholistan desert is reputed to have underground water resource at depth 20-60 m or more with salts in the range of 9000-25000 ppm. However deserts of Thal, Thar or Chagai have only isolated pockets of brackish water unfit for human consumption or agricultural use.

Soil erosion by wind is a major component of the land degradation in the sandy deserts. The proximate physical causes of the erosion are aridity over exploitation of fuelwood and overgrazing The loose sand in these vicinities has accumulated to from 0.5 to 4 m high moving sand dunes posing on ever present danger of burial of cultivated land around. Accordingly to soil survey of Pakistan, about 4.8 Mha undergo soil degradation through wind erosion in Pakistan. The momentum of sand storm depends on the nature of soil material, wind velocities and soil moisture conditions. For example in the Thar desert dust storms are a general characteristic of the area. They blow from southwest to northeast in the summer with velocities of 65 km /hour being harsh in day but less violent at night. Prolonged dry conditions with fast winds degrade the land by burial of good agricultural land in the vicinity of moving sands, choking or burial of irrigation channels by sand, increasing their maintenance costs and blockade or disturbance of communications systems besides being a constant menance to the communities living in the vicinity.

By and large droughts, wind erosion and shifting sand dunes are the main problems responsible for the land degradation and subsistent economy of the local inhabitant. The involvement of local farmers right from the planning and formulation of the project, whether the individual level or through farmers associations or cooperative is essential. The people in the area are illiterate therefore basic education facilities together with financial incentives are needed to protect their lands from wind erosion. Species like Cenchrus ciliaris Lasiurus sindices, Panicum antidotale have been identified to grow under scarce water conditions with water quality of 12000-20000 ppm salts. Sand dunes fixation techniques, trench irrigation techniques, plastic mulching and saline agriculture are some of the measures which can greatly control the wind erosion in the deserts of Pakistan.

2.3 Salinity and waterlogging Salinity and waterlogging persists in irrigated plains of Punjab and Sindh provinces, Peshawar-Mardan Valley which collectively cover together an area of 13.78 Mha unknown value affecting 68 million inhabitants in Pakistan. The area is characterized by severe aridity and prolonged hot summer. The irrigated plains are formed by alluvium deposited by the Indus river system. In Pakistan only 26% of the total area is under cultivation(80% under irrigation and 20% rainfed agriculture). Due to leakage of canals and inappropriate irrigation practices, there is a net loss of nearly 50% of 17.5 million hectares meters of water available through network of Indus Basin irrigation system. As a result, more than 40,000 ha of land every year is said to losing fertility as a result of salinity and waterlogging (World Bank/UNDP 1993). At present more than 6.8 Mha are affected by twin problems of salinity and water-logging. In order to contain this menance through lowering of watertable in the irrigated areas, the WAPDA (Water and Power Development Authority) initiated in 1960's SCARP(Salinity control and Reclamation Projects) projects which effectively cover at present about 5 Mha. at a cost of 3.0 billion US$ The annual flow of salts through the irrigation system is estimated at 50 MT/ annum while the out flow below Kotri (in Sindh) is only 10-15 MT/annum). Thus about 35-40 MT are being added regularly in the Indus Basin through river flows alone. This would mean that this engineering approach may not be a sustainable one due to socio-economic conditions.

Simple leaching of salts through the drainage system to reclaim salt affected lands was proved to be least cost effective, very inefficient, and deteriorated the soil by converting saline sodic soils into sodic soils. Chemical amendments, especially gypsum are very cost effective, efficient, but the initial investment is high. Therefore the bio-saline approach to contain land degradation was found popular among farmers in Pakistan. The strategy is the profitable use of salt affected lands and saline water on sustain basis using an optimum combination of the genetic approach and agronomic manipulation is known as saline agriculture approach. It includes:

* Moderately salt affected areas are planted with salt tolerant varieties of crops already grown by the farmers coupled with improved agronomic practiced for the success of crops.

* Much deteriorated land with marginal water quality and quantity may be planted with salt tolerant trees (Eucalyptus, Acacias, Tamarisks) and in between the rows of trees salt tolerant forage shrubs like Atriplex species or selected grasses could be planted. Small animals may be introduced after 2-3 years and large animals after 3 years for controlled grazing.

* Salt tolerant fruits and apiculture can be successfully added to the set up depending upon the interests of the farmers. Other agronomic practices commensurate with the soil characteristics and the species are introduced.

* The user of this technology should be considered the most important element and without his participation this option cannot be exercised. The farmer should start getting economic returns after 2 years from crops and forage species, and 5-7 years from trees grown in degraded lands.

The social impact of the bio-saline approach is due to improvement of economic conditions of the farming community. The current annual consumption of fire wood is 19.70 M^3 which will rise to 30.66M^3 by the year 2000. In rural Pakistan, about 80% of households use wood for cooking and heating and lands affected by salinity and waterlogging could be 30-50% of the rural lands (Qureshi, 1993). Therefore the bio-saline approach to reclaim salt affected land has added advantages for social improvement. The overall improvement in the environment by providing a green cover to the degraded land presently covered with salt puffs only, will have a salutary effect on the health and humor of inhabitants. It will also greatly improve the conservation of the natural flora of the severely affected salt affected lands and thus help in the conservation of biodiversity for further exploitation through genetic improvement and natural selection.

3. Conclusions

Salinity and waterlogging are the most persistent land degradation problems in the rural Pakistan, where 62% of the country population resides. Due to socio-economic reason the bio-saline approach to reclaim such lands has proven to contain land degradation problem in Pakistan. Soil water and wind erosion need to be contained since both land and water resources of the country are limited. There is no limitation to the socio-economic problem of the growing population. Affordable solutions of the environmental problems of land degradation are essential to sustained growth and development of agriculture in Pakistan.

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Optimum Arrangements of Parabolic Mirrors as Collective Concentrators in Solar-cookers

Y. Nakajo*

Department of Mechanical Engineering,
Ashikaga Institute of Technology,
268 Omae-cho, Ashikaga, Tochigi, JAPAN

ABSTRACT - Most solar cookers are classified into two categories. One is reflecting type and the other is heating box type (or solar oven). The reflecting type solar cookers are ideal for the use in the areas where the sun height angle is not very large because they can concentrate the light densely with simple configuration of reflectors and cooking portion. The purpose of the present study is to find the best configuration of a set of ready-made reflectors which are not designed for dedicated reflecting type solar-cookers. Mathematical analyses are performed for single, combined two, and also combined four reflectors adopting the sequential unconstrained minimization technique.

1. INTRODUCTION

As one of the simplest applications of solar energy, cooking with focused sunlight is popular in deserts where fuel is not obtained easily, and even in industrialized districts where people have a better opinion of clean energy. Although it is not very easy even in town to build an ideal reflector for its dedicated use, it is not difficult to find a parabolic surface among existing appliances. For example, receivers of the satellite communications can be found everywhere nowadays.

While performance of a solar-cooker directly depends on dimensions of the reflector (or reflectors) used, this is not the only design variable in optimizing its performance especially when some of the other design variables are restricted.

Even for a single reflector, directing the axis of the parabolic mirror to the sun and setting the pot at its focal point is not optimal at all when the area of the shadow cast by the cooking portion is comparable to the size of the reflector.

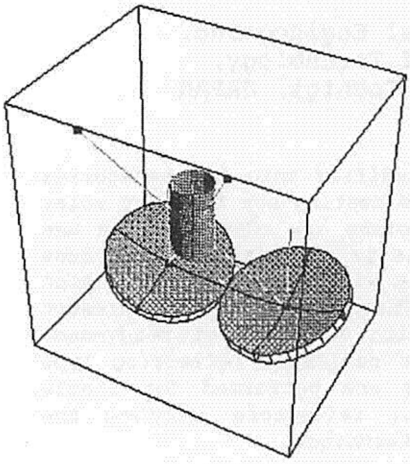
The purpose of the present study is to find the best configuration of a set of ready-made reflectors by a rational method for arbitrary incident ray angles.

2. OPTIMIZATION

The optimization is performed for three different configurations of the reflectors, i.e., the case of single reflector, combined two reflectors and combined four reflectors. (See Fig. 1(a) and (b).) The sequential unconstrained minimization technique (SUMT) is adopted to account for the constrained conditions automatically. The design variables are position of the cooking pot and directions of the reflectors in tree dimensional space. Any of the design variables can be fixed or restricted. The object function is a calculated convergence

* Dept. Mech. Eng., Ashikaga Inst. Tech., Tochigi 326, Japan

rate of the sunlight flux at the bottom of the cooking pot. The effect of the shadow of the cylindrically shaped cooking pot is taken into account. The optimization technique is performed to obtain the maximum convergence rate at the bottom of the pot. In the actual calculation, x and y positions which give the highest convergence rate are 'combed' out by calculating the convergence rate at each selective point to determine initial values for the iteration.


(a)

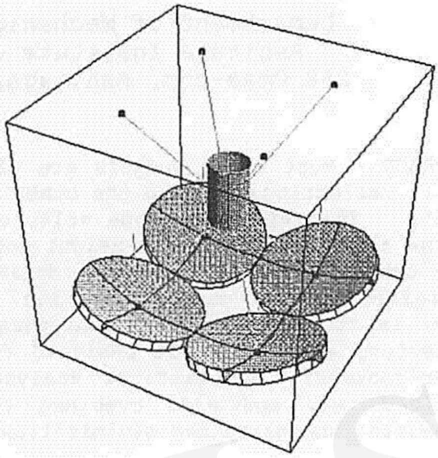

(b)

Fig. 1 Configuration of combined two (a) and combined four (b) reflectors.

3. RESULTS OF THE CALCULATION

In the case of single reflector, the optimized direction of the reflector is almost same with the direction of the incident ray. The deviation is caused by the existence of the cooking pot which casts a shadow on the reflector and it increases when a larger pot is used. However, when the axis of the reflector is deviated from the direction of the sunlight, total efficient area of the mirror which can reflect the sunlight decreases. Hence, we must consider these two contrary conditions. The calculated results are shown in Table 1. In the case of a combined parabolic mirrors, the optimization has a significant effect. Because the pot is located among the mirrors, depending on the dimensions of the reflectors and their focal point, sometimes it is impossible to focus all the reflected sunlight at the bottom of the pot. It is also quite difficult to find the most effective directions of the mirrors by inspection for the rays can be diverged even near the most densely converged positions. The results for combined reflectors are shown in Table 2 and Table 3. In the demonstrated calculations, all of the dimentions are normalized by the diameter of each circle reflector, and consequently, they are represented in nondimentional units. The combined mirrors have the same diameters (1.0) and focal points (0.5). The diameter of the pot is 0.2 and the depth is 0.2. By changing the constraint conditions, optimum configurations for any combinations of different types of reflectors with a cooking pot of any shape can be obtained with the present scheme.

Table 1. Optimal position and directiron of the single reflector.

Hs	90	80	70	60	50	40
Rx	-1.39	-9.36	-19.4	-30.8	-35.3	-41.9
Ry	-0.40	-1.97	-0.192	-0.978	-0.595	0.427
Mx	-3.21×10^{-3}	1.00×10^{-1}	-1.59×10^{-6}	-7.96×10^{-4}	-1.94×10^{-4}	-8.55×10^{-4}
My	-4.65×10^{-3}	-0.149	-0.349	-0.549	-0.550	-0.549
Md	0.999	0.996	1.001	1.003	1.007	1.008
P	87.3	86.3	86.7	94.4	98.3	98.0

[Note] Hs: Height of the sun in degree; Rx and Ry: Rotational angle of the mirror around x- and y-axis respectively; Mx and My: Position of the center of the mirror in x and y coodinate respectively; Md: Depth of the center of the mirror measured from the bottom of the pot; P: Percentage of the effective sunlight concentrated at the bottom of the pot.

Table 2. Optimal position and directiron of the combined two reflectors.

Hs	90	80	70	60	50	40
Rx	-9.76	-17.5	-21.6	-29.3	-34.9	-40.7
Ry	±9.15	±8.38	±10.2	±9.45	±8.76	±10.4
Mx	±0.45	±0.45	±0.45	±0.45	±0.45	±0.45
My	-0.449	0.500	0.430	0.550	0.490	0.520
Md	1.007	0.998	1.001	1.002	1.005	1.006
P	82.4	84.4	85.9	92.3	97.3	95.8

Table 3. Optimal position and directiron of the combined four reflectors.

Hs	90	80	70	60	50	40
Rxf	9.02	5.05	1.48	-4.94	-10.3	-12.4
Rxr	-9.76	-17.5	-22.1	-29.3	-34.9	-40.7
Ryf	±9.70	±10.4	±10.9	±11.2	±12.4	±13.1
Ryr	±9.15	±8.38	±9.85	±9.45	±8.76	±10.4
Mxf	±0.447	±0.449	±0.450	±0.449	±0.449	±0.449
Mxr	±0.449	±0.449	±0.449	±0.450	±0.450	±0.450
Myf	0.445	0.459	0.590	0.540	0.540	0.641
Myr	-0.449	-0.500	-0.449	-0.550	-0.490	-0.519
Mdf	1.030	0.999	0.996	0.998	0.995	0.998
Mdr	1.007	0.997	1.003	1.002	1.005	1.006
Pf	82.5	82.5	79.6	83.1	81.2	65.9
Pr	82.4	84.4	86.0	92.3	97.3	95.8

[Note] The subscripts f and r denote front and rear mirrors respectively.

4. DISCUSSIONS

Combining two mirrors does not simply double the performance of a single mirror because a combined reflector has difficulty in convergence of the rays. However, combined reflectors do increase the density of light flux at the bottom of a pot. In Table 2, convergence rates are larger than 0.5 and this means two mirrors are better than one. Table 3 shows that the convergence rates are larger than half of those of combined two reflectors and this means four reflectors are better than two. One of the most significant merits of using the present scheme is that one can find an optimal arrangement of plural mirrors collected from his own junk. Adjusting plural mirrors according to the calculated results is quite difficult but the experiments using the actual solar cookers showed that once the optimal arrangement was determined, it was not very difficult to adjust them tracing the sun. However, it would be impossible to find the best arrangement of the mirrors if no knowledge is given at the beginning. As for combined four mirrors, it will be possible to use this combined reflector to cook foods when it is not possible if only one of the four mirrors is used as a reflector. In an demonstration, the experimental solar-cooker with the combined four reflectors boiled 1.8 kg of rice in an hour. These results show clearly that practical applications of combined reflectors are possible and also that the optimization technique is a must in obtaining the maximum performance.

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OFADEC experience on desert control and measures taken locally to tackle it.

Mamadou Ndiaye *

Abstract.- desert control is a major problem in Senegal, many actions are launched with poor results. This paper will focus on grassroots actions where communities are involved in planning, leadership and execution. This presentation shows the capacities of local communities as far as they are concerned and have control on their work and final results.

Key Words : reforestation, community actions

1 Introduction :

Desertification is a progressive and an irreversible deterioration of ecosystems, transforming an environment where life was possible, into a hostile environment.

When it happens the survival of human beings ,animals and plants is compromised. Land can no longer nourish populations and animals.

Desertification is not only an external phenomenon like climate change, it's also caused by degradation provoked by the pressure of human beings and animals on nature.

Many explanations are given on the causes of this phenomenon among which, climatic changes and man's actions on nature.

Although it is clear that climatic conditions are a cause of desertification, the over exploitation of nature, tree cut for fuel, overgrazing and agriculture provoke destruction of soils and leave the land unprotected against erosion and drying out.

The increase of population in recent decades has also accelerated this situation and unbalanced in some areas the use of land (agriculture, cattle raising, housing)

Every year new lands are cleared and brought to agricultural production. This situation brings many negative impacts and most of the time changes are irreversible, soil erosion, declining soil productivity, loss of wildlife.

Poor livestock management, overstocking and overgrazing, have negative impacts on soils (erosion, loss of fertility and structure change).

Forest fires, burning to manipulate grassland cause irreparable damages on trees, soil fertility and moisture retention.

Senegal is under desert stroke since 1977, the main reasons are : the overuse of land for agriculture, forest fires, overgrazing, fuelwood production.

According to 1991 statistics released by the forestry department, 48,124 hectares of forest are destroyed by fire. Reforestation conducted by forestry department is 20,640 hectares with 17,942 hectares planted by communities.

In the same time 135,595 tons of coal and 58,963 cubic meters of wood are taken from forests, about 70 % of this production is for city use.To measure the pressure of coal production on forest ; 100 kilos of wood produce 18 to 25 kilos of coal.

Increased population takes more land from forest for agricultural use ; in 1960 agriculture used 17 % of land in 1991 : 52%.

Further heavy pressure on the land is livestock, in Senegal overgrazing is the cause of 50 % of land degradation, in Sahelian countries the level is 49 %.

Fall of prices for agricultural products on international markets force communities to use more land and work harder to cover their basic needs.

All these phenomena accentuate the vulnerability of the naked soil to winds and erosion and open the way to desertification.

* OFADEC Director BP. 1887 Dakar Senegal Fax : + 221 21 87 59

2 Belel experience

Belel is a village of 350 inhabitants, 75 % of the population live on cattle raising and 25 % are living on agriculture, forest exploitation or are traders.
In the area the average cows per inhabitant is 0.9 and the density is 450 cows on a square kilometre (C. Santoir ORSTOM Sud quotidian No 643 mai 1995).
Belel is in a dry tropical area with a degraded forest, which receives every year around 15 inches of rain. With this quantity of rain agriculture is difficult and uncertain.

2.1 The objectives of the project were : Short term economic actions to generate revenues for the local community to help stop emigration, in long term provide self sufficiency in food and a good management of livestock.

- Elimination of overgrazing and overstocking by training and education and the lessons we learn on local strategies to maintain cattle.
- Irrigation project for food production (vegetable and forage) with pumping stations, protected by wind breakers.
- A reforestation program with the creation of a nursery to produce 1,000,000 fast growing trees a year.
- Production of fuelwood from plantations made by the community around the village was among the actions to save the nearby forest and reduce the time spent to gather wood and the possibility to sell the surplus.
- Re-establishing and increasing tree cover in the area by organizing the protection of the remaining trees against winds, animals and cutting.

The realisations were :

A well of 230 meters depth
A farm of 10 hectares
3 hectares of wood plantation around the village
A watching committee created to protect local trees.
A local committee to manage the project.

2.2 Social actions : Amelioration of living conditions for the local community in health and education through school and health center building, these facilities were not accessible. Training and education for leaders to help organise and make decisions on their environment.
Diffusion of cookers made with local materials to use less wood.

3. Main lessons

These are the main results and lessons we learn through this project :
Community participation is the main key to reach autonomy, it must appear at all levels : (planning, control; decision making).
Community participation and planning tend to increase the access to results, to ownership and encourage self reliance, it also increases local capacities and ensure that the project benefits will go directly to beneficiaries and help cut the project costs, once the community knows that they work for themselves.
We spent 2 years implanting full participation at all levels. We cannot say that we have had full success because we were in special conditionsamong which a high level of illiteracy of about 70%.
The main difficulties appear in handling funds and using them according to budgets and procedures.
It was not a 100% success but this option helped to reach the goals in reforestation and cattle management and leave the project in the community's hands.

ORSTOM ; French Institute for Scientific Research and Co-operation.

3.1 Reforestation and nursery : We haven't had a lot of difficulties with new varieties of trees. We use fast growing trees, Native species were difficult to produce in nursery.
Some technical difficulties appear in handling these fast growing trees, solutions were found easily
Difficulties were : unsuitable site conditions or ecological tolerance (rain fall, temperature...).
Also some problems arise in accepting some species, it is important to test species before introduction
It is also important to use many species in a plantation to have a variety of forage, and varying resistance to drought and diseases.
Our work was mainly in upgrading degraded areas around the village (cultivated lands, grassland).
The species we use are :

Acacia senegal
Prosopis juliflora (wind breaker).
Leucaena leucocephala (for fuelwood nitrogen fixation).
Acacia tortilis (fuelwood).
Balanite aegyptiea
Parkinsonia acuelata (wind breaker).
Eucalyptus camaldulensis (wind breaker, wood).
Neem azadirachta indica (Shade, wood).
Acacia nilotica (Tomentosa).

In the nursery we also develop trees for fruit production. This aspect was a success, even if the result in terms of fruit production did not reach the normal average.

3.2 Agriculture :We cannot say it was an economic success. Profit was low because of the fuel cost and the difficulties to reach other markets.
This program did help families to have fresh vegetables for food and local market, to have forage for animals and helped to pay for the well costs.
The agriculture program was also helped by money paid by cattle raisers to water their animals.

3.3 Wind breakers : Wind breakers are very important in tackling dune progress and increasing agriculture yield.
The use of wind breakers in tomato plantations increased the yield by 50% compared to a plantation in the same area without wind breakers.
Curtains of wind breakers of different species of trees is a good protection against dune movement.
Wind breaker of different species and sizes are necessary to stop the wind at all levels, and when they are used to protect agricultural land, a line planted every 150 meters gives good results.
Green belts of trees are a good way to stop dune formation and movement.

3.4 Cattle Raising : We experimented rangeland management but it failed because of a non adequate study on the land capacity. The gain of weight was not substantial, and the price of meat could not cover the extra cost. The rate of the forage production was lower than the animals' consumption.
Our experience shows that the local cattle raisers did not destroy the land and the ecology as we thought before of their traditional system, they destock and restock according to climate. This method is a severe lesson learnt after the 1977 drought where more than 70 % of livestock was lost.
This method did not make irreversible damage on soils and must be taken into account when trying to improve livestock management.

3.5 Reforestation : It was not a success in trying to regenerate the forest on a large scale, but it was an achievement to implant trees around the village for fuel, housing purposes or wind breakers.
We also save indirectly the remaining forest through protection and by stopping the cut of trees and branches for cattle.Fuelwood production was a success for local use and it helped to increase revenues.
We haven't used agroforestry in Belel. We cannot comment on its results on desert control in this area.

3.6 Education and training : In this area we met good results on tree plantation and forest management training. Training and education must use local language to reach communities.
More actions must be taken to promote school building for children who, most of the time, cannot go to school.
Diffusion of cookers was not accepted, because of the difficulty to have a clay of good quality in the area.

4. General considerations :

At the end of the project more than 100,000 trees were planted with success, 50 tons of vegetable are produced every year, forage and water were available for cattle at a reasonable cost.
These activities need support and commitment from local governments, they must take action, NGO's can also support and act locally.
These actions must be among their priorities in desert control :
A campaign to promote the use of gas for cooking in the country.
Gas must be tax exempted for better access to all communities.
New cookers have to be developped to fit local cooking tools.
A campaign for new gas users to know the security measures.
Same actions are to be taken on solar energy use for : fish dryers, pumping water, cookers, electric fences powered by solar energy.
This energy is available all year long in the country, some positive experimentations are already available and have to be popularised.
Local communities must have control over local resources provided by forest. Servicing local needs are important steps to preserve forests.
Both policing and reforestation programs cannot be assumed by forestry department, changes are to be made on their status.
The Belel, experience was used in Mauritania two years later to organise its strategy to fight desertification (Integrated program to fight desert in river Senegal basin and in Trarza Brakna and Ferlo region).

5. Conclusion

We understand development as a compromise between what is technically possible, what is socially desirable, what is economically profitable and what is ecologically acceptable. During all this process we had these criteria in mind and try to use them as guidelines, sometimes they conflict but the goal is to put them together to meet these objectives. The results show that we can put them in an equal way if we take the necessary time and steps.
Putting all actors together in decision making, actions and experience sharing was the best way to reach our goal.
We cannot say we have stopped the desert in the north region. This was not our goal, but in the area we worked on, clear steps were made to reduce or stop the desert spreading. We had expectations that new life possibilities will encourage valid hands to come back and make decisive actions against desert spreading.
We think that those local actions with large scale action conducted by NGO's and government are the only way to stop the desert spreading, and reverse this situation.
Desert control should not be taken as a local problem, it is a nation wide dilemma, any carelessness can lead to disaster.
Finally, desert control is not a dilemma for Sahelian countries only, it is also an issue for the world. Any change in Sahel area will have an impact world-wide.
Shall we accept being witness to this tragedy without acting ?

NGO : Non Governmental Organisation

Land use & soil management

L1: Chaired by A. Lauchli & K. Satake
L2: Chaired by L. Aylmore & V. Raghavan

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The Importance of Soil Structure in the Management of Semi arid Lands of Western Australia.

L.A.G. AYLMORE* and H.R. COCHRANE

Abstract - Soils throughout much of the semi arid cropping and rangeland areas of Western Australia are poorly structured and highly susceptible to further structural degradation. Under inappropriate management, soil physical properties may deteriorate rapidly to the point where soils become incapable of supporting plant life under prevailing environmental conditions. Sustainable agricultural and pastoral land use in this area requires that maintenance of soil structure should be a major consideration. This paper examines some aspects of the physical properties of the region's soils that need to be taken into account in designing sustainable land management practices.

Key Words: Soil structure, Western Australia, Hardsetting, Compaction, Crusting.

1. Introduction

Western Australia covers just over 2.5 million km^2; almost one third of the Australian continent. The majority of this area has an arid or semi-arid climate (Fig.1). The desert region (zone 6, fig.1) has a low, sporadic and unreliable rainfall and does not support agricultural production. The semi-arid rangelands (zone 3, fig.1) support a pastoral industry along with isolated, very small areas of horticultural production. Cleared land to the south and west of the rangelands, where mean annual rainfall exceeds approximately 275mm, is used for arable farming, predominantly cereal cropping combined with sheep production (zone 4, fig 1). In the semi arid agricultural and pastoral areas climate, particularly rainfall, is the major determinant of biological productivity but soil physical conditions also have a substantial influence on both native vegetation and the productivity of agricultural land. Poor soil structure constitutes the major limitation to plant growth on a significant proportion of this land and is thus also a major determinant of desertification processes in the region.

2. Soils

Soils throughout the area are predominantly highly weathered, have low nutrient status and poor physical properties, Sandy surfaced soils dominate but there is a great diversity of soil types; including deep sands, duplex soils which are dominant in the agricultural regions, and fine textured soils common in lower parts of the landscape. In the context of the region, soils are classed as being either coarse (sand to loamy sand) or fine textured (sandy loam to clay). Kaolinite and illite are the dominant clay minerals and their susceptibility to slaking, ready dispersivity and relatively small swell-shrink characteristics contribute to poor aggregate formation. The distribution of soils is poorly defined and for a large proportion of the area very little data is available on soil chemical or physical status, thus it is not possible to give accurate estimates of the areal extent of particular soil physical problems encountered in the region. Figure 1 indicates the distribution of dominant soil types along with their associated major degradation hazards.

3. Effects of land management practice on soil physical conditions.

The effect of agricultural and pastoral activities on soil physical fertility has generally been deleterious and in some cases catastrophic. Causes of soil structural degradation vary from loss of vegetative cover following overgrazing in pastoral areas, to excessive cultivation and traffic on agricultural land. Effects of inappropriate management range from complete removal of topsoil by wind or water erosion to the ubiquitous but less visually striking soil compaction and structural deterioration. Given the unreliability of rainfall and fragility of soils in the region, land use should be limited to activities that will maintain or improve soil physical, chemical and biological fertility. The impact of land management practices on soil physical properties is determined both by the disruptive forces imposed and by soil susceptibility to structural change. In turn susceptibility to structural change depends on inherent soil characteristics such as particle size distribution and the position of soil in the profile. The following is a brief account of some common soil physical problems known to affect land productivity in the region.

* Soil Science, The University of Western Australia, Nedlands 6907, W. Australia. (Fax +61-9-3801050).

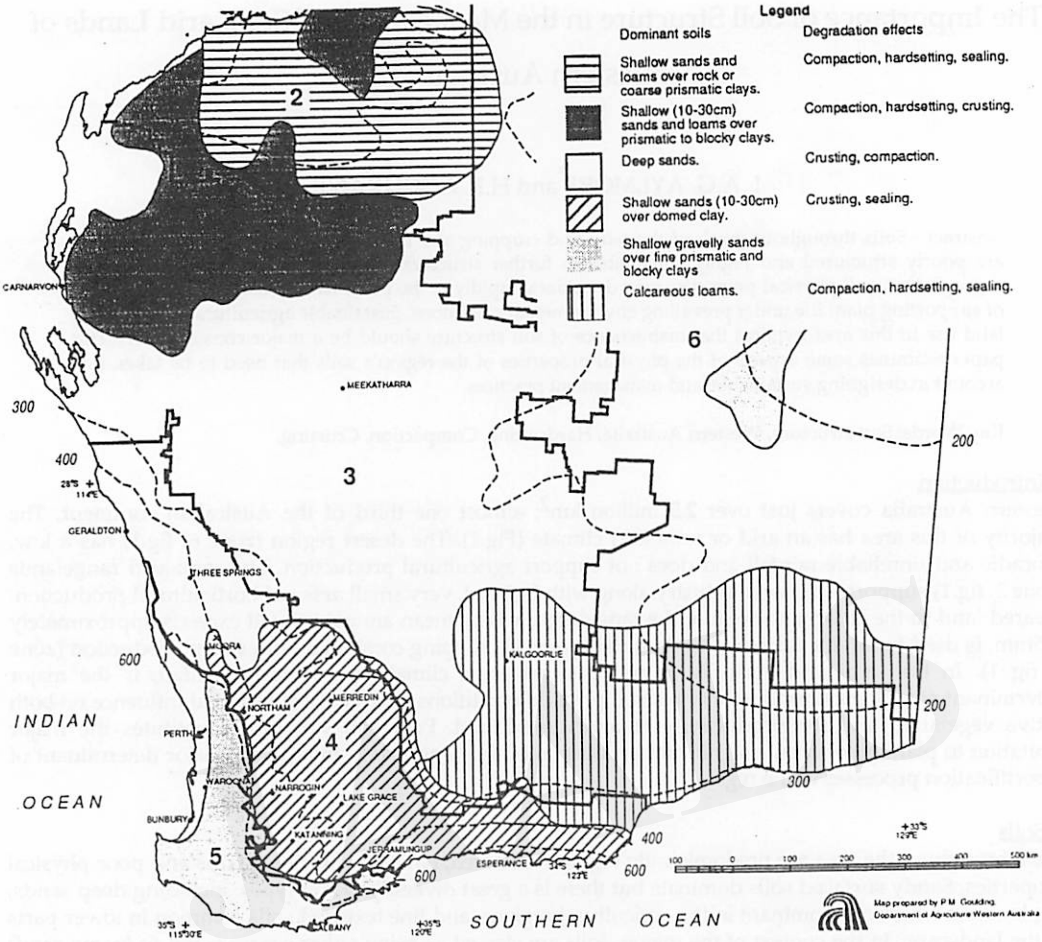

Figure 1. Soils and climatic zones in the south of Western Australia

4. Common Soil Physical Problems

4..1 Soil structural instability. The fine textured soils are most severely affected by structural instability. They were originally the most productive soils in the region, providing preferred grazing under pastoral management and being the first brought into cultivation following European settlement. Almost invariably soil structural quality has deteriorated since grazing or clearing and has been accompanied by a significant drop in soil organic matter content, especially in the surface soil. Fine textured surface soils of the region tend to become hardsetting as structure deteriorates under poor management. Characteristically hardsetting soils are apedal, have low permeability and bearing capacity when wet, and on drying develop sufficient strength to inhibit plant emergence and root growth. Soils of the region vary greatly in their potential to set hard depending on factors such as particle size composition, exchangeable and soluble cation composition and organic carbon (Aylmore and Sills 1982). The extent to which the potential for hardsetting is expressed depends on soil susceptibility to slaking and clay dipersion, factors which are influenced by the management regime imposed. Cochrane and Aylmore (1991) measured the impact of a range of management practices on the severity of hardsetting in agricultural soils. A sample of results obtained is illustrated in fig. 2. Figure 2a shows the effects of three levels of tillage intensity (3, 1 and 0 cultivations annually) and gypsum application on the structural stability of soil collected from a trial in it's tenth season of continuous wheat production (gypsum was applied in the seventh season at 5 T ha^{-1}). Structural instability was assessed by modulus of rupture (MOR) measurements performed under conditions which allowed separate assessment of the contributions made by dispersion and slaking to structural instability. The third component of structural instability shown (residual) is associated with inherent soil characteristics not dependant on soil management. Increasing MOR indicates decreasing structural stability.

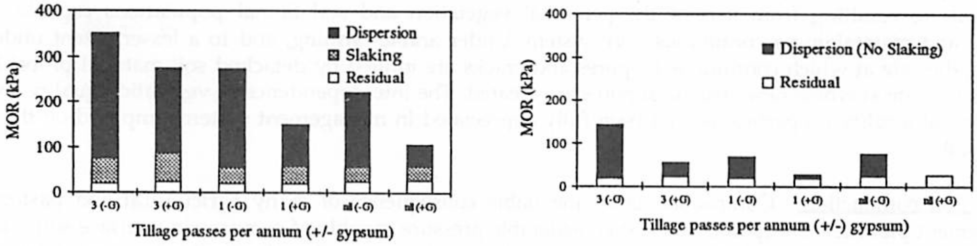

Fig 2a Slaking permitted

Fig 2b Slaking inhibited

Figure 2 Effects of tillage intensity and gypsum application on soil structural stability

As with most severely hardsetting soils, dispersive failure was the dominant mechanism contributing to structural instability. Increasing tillage intensity significantly increased dispersive failure and to a lesser extent slaking failure. Gypsum application reduced dispersive failure but had no significant impact on slaking. Although the slaking component of structural instability is small relative to dispersion the expression of dispersive failure is highly dependant on the severity of slaking, this is demonstrated in figure 2b which shows the level of dispersive failure when slaking is minimised in the same set of soils. Dispersive failure is reduced by a factor varying from 55% to 100% of the level found in soil tested under conditions which allow full expression of slaking. This analysis indicates that for these soils adoption of management practices that improve soil resistance to slaking (ie. reducing soil disturbance and improving soil organic matter content), have the potential to be as effective in ameliorating hardsetting as direct manipulation of dispersive failure through gypsum application.

Although hardsetting is probably more widespread in agricultural than in pastoral regions, farmers have a wide range of management options available (altering tillage and traffic intensity, rotation, amendment application, stubble and grazing management to suit soil conditions) to effect soil structural stabilisation.

The most severely hardsetting soils in the region have been found in the pastoral areas, on scalds created by overgrazing. Some soils attain tensile strengths twice as high as any encountered in the most degraded agricultural soils and are extremely sensitive to small changes in soil solution electrolyte concentration. Management options for structural amelioration on rangeland soils are limited to grazing control and a variety of soil preparation techniques suitable for initiating revegetation on small areas of degraded land.

4.2. Soil crusting Crusting occurs on arable clayey and loamy sands but neither the significance of the problem nor specific ameliorative practices have yet been investigated. Such crusting reduces rainfall acceptance and inhibits seedling emergence but is of minor significance in comparison with hardsetting. Much uncleared land throughout both agricultural and pastoral areas has a thin crusted surface layer. Surface sealing can occur quickly following rainfall or run-on, particularly on finer textured soils but the significance of these layers is unclear: Nulsen et.al. (1986) noted no runoff from an uncleared catchment within the agricultural area, although crusted soil within the catchment produced runoff at low rainfall intensities; water was redistributed and infiltrated elsewhere within the catchment.. Graetz and Tongway (1986) found cryptogam-soil surface crusts from semi arid rangeland sites in South Australia to be much less permeable than uncrusted soil at the same site but considered that the impermeability of these crusts was a desirable feature for the rangeland ecosystem as it facilitated concentration of water and nutrients at the soil surface where they would be most accessible to plant seedlings. If this is the case more generally throughout the region, management should aim to avoid destruction of these crusts.

4.3. Subsoil structural deterioration. There is virtually no information on the structural condition of subsoils in the rangelands. Fine textured subsoils in the agricultural areas however can exhibit very undesirable structural characteristics. Bulk densities in excess of 1.7 are common, the majority are sodic and have impermeable layers which cause temporary waterlogging, low water entry and storage and poor root penetration. Relative to topsoils, structural degradation in subsoils is an insidious process which is not only more difficult to detect but is much more difficult and expensive to remedy. The physical fertility of many fine textured subsoils is dependant on structural features developed under native vegetation. These features include networks of cracks and channels created by numerous wet/dry cycles, plant root and soil faunal activity. Although there is evidence that subsoil structure was generally poor prior to grazing and clearing, agricultural and pastoral land management practices have undoubtedly caused further structural deterioration; resulting from loss of the perennial vegetation and soil faunal populations capable of creating and maintaining a continuous pore system. Under arable farming, and to a lesser extent under grazing, the rate at which continuous biopores and cracks are infilled by detached soil material probably exceeds the rate at which new structural pores are created. The interdependence of vegetation quality and soil physical fertility properties has not been fully appreciated in management systems imposed on these fragile soils.

4.4. Soil compaction. Compaction is an inevitable consequence of many agricultural and pastoral management practices. Sheep hooves exert considerable pressure capable of compressing surface soils and significantly reducing permeability and aggregate stability while increasing the mechanical impedance of fine textured soils of then region (Proffitt et al 1993).. Agricultural traffic causes compaction to a greater depth in the profile and many coarse textured soils are very susceptible to development of traffic induced hardpans with a maximum mechanical impedance at depths in the profile from 10 to 30 cm depending on particle size distribution and stresses imposed. For soils with little stable aggregation and low organic matter contents susceptibility to compaction can be predicted on the basis of primary particle size distribution. (Daniel et.. al. 1992). Sandy soils with a well graded range of particle sizes, pack naturally to high densities and are easily further compressed by traffic. Mechanical ripping to disrupt hardpans has been used successfully on sand to loamy sands throughout the agricultural areas but on susceptible soils pans reform quickly if heavy vehicle traffic is not kept to a minimum

4.5. Soil erosion. Every conceivable form of soil erosion is represented in the region and significant land areas are affected. Wind erosion has removed the entire A horizon of some overgrazed rangeland soils, exposing massive, sodic B horizons incapable of supporting plant life. Revegetation of such areas is slow, expensive and uncertain of success, requiring extensive earthworks to improve water detention, and possibly chemical and/or physical amendments to overcome specific soil deficiencies. Water erosion can be equally devastating and land use planning on a catchment scale is required to minimise this hazard. Many soil, management and environmental factors combine to create an erosion risk. One particularly widespread condition which can predispose soil to both wind and water erosion is water repellence. This is caused by hydrophobic organic coatings on soil particles and the presence of fungal hyphae. Water repellent sands may shed a very high proportion of incident rainfall, creating a water erosion hazard and once cleared lack the cohesion and vegetative cover required to provide resistance to wind erosion.

5. Conclusion

Resistance to desertification processes in the semi arid regions of south western Australia is highly dependant on maintenance of adequate soil physical fertility. Soils of the region are structurally fragile and susceptible to a wide range of degradation hazards. Development of land management practices aimed at minimising the impact of these hazards requires improved knowledge of soil distribution, physical behaviour and improved techniques for assessing soil structural status and it's susceptibility to change.

Acknowledgment

We gratefully acknowledge the assistance of Dr. G. Scholz and Mr. Phil Goulding in preparing the map (figure 1)

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Removal of Salt and Excess Water from Soils Using Evaporative Force

Yukuo Abe*

The accumulation of salts and excess water in soils found in arid environments exacerbates soil degradation. In order to control salt accumulation and excess water, new methods involving the use of evaporative force have been studied. These methods include a salt capturing method which removes salt from the soil surface by using absorbtive materials, a dehydration method which desalinizes the soil surface of accumulated salt and an evaporation drainage method which disposes of water and salt in soil through the use of an artificial tree-like apparatus. These methods are both possible and effective in principle. They are introduced and discussed here based upon various experimental results.

Key Words: Dry environment, Salt accumulation, Evaporative force, Drainage

1. Introduction

In arid environments, the treatment of salt laden soil is a major problem. Though many methods of preventing, reducing and controlling salt accumulation are already in practice, there is not as yet a method which can provide a comprehensive solution to the problem. In view of this, some new techniques have been experimented which may help overcome some of the problems associated with the methods which are currently in use.

Our research group has focused its attention on three methods that use evaporation as a cost effective means for removing salt and solution on or in the soil surface(Abe et al., 1992, Ii et al., 1993). In addition we have also noticed an unexpectedly high incidence of water logging in arid regions. Therefore, developing new methods of removing excess water by countering natural gravitational drainage is necessary. In this paper, we explore some of the concepts, principles, advantages and problems of these methods based on new ideas shown by using the results of basic experiments.

2. Salt circulation in soil and its countermeasure

Salt in soil circulates endlessly accompanied with the flow of soil solution. Fig. 1 shows the sources of salt in soil consisting of existing salt in soil, soluble salt in ground water, salt rock, irrigation water and fertilizer and various phenomena related to the action of salt during circulation. After raining or irrigation occurs, salt moves together with solution downwards transporting existing salt in the soil.

Reversely, when evaporation and transpiration begins, salt changes into an upward flow. At the soil surface, only water evaporates. In order to prevent salt accumulation, many countermeasures are being practiced. These include: irrigation, evaporation control, salt leaching, lowering the ground water table and controlling the capilliary fringe, however a truly effective method has yet to be found. To resolve this problem we must develop technology which can stop salt from endlessly circulating in a closed system and remove it to an outer system. In arid conditions, because the upward flow of salt in solution is more predominant than the downward flow, evaporative force, which is the force behind the salt movement, can be progressively utilized as a natural and powerful energy device.

*Inst. Agr. & Forest Eng., Univ. Tsukuba, Ibaraki 305, Japan (Fax: +81-298-55-2203)

3. Salt capturing method on the soil surface

The method which treats salt on the surface using evaporative force is the most economical and simple because the space to dispose of salt is open and the energy to gather salt is a renewable resource. Therefore we have investigated a simple method of desalinizing the soil surface layer using simple salt capturing materials.

The concept of the salt capturing method is shown in Fig. 2. On bare ground, salt accumulates near the surface layer once all water has evaporated from the soil surface.

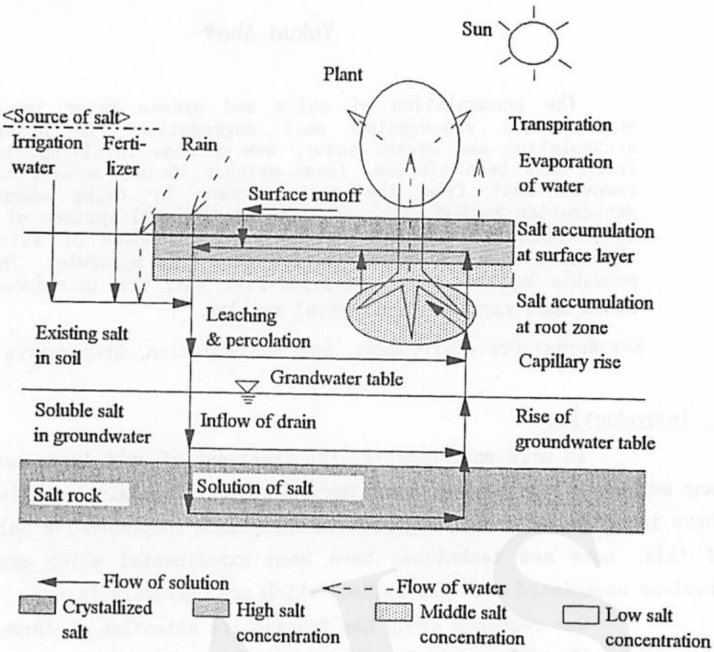

Fig. 1 Salt Circulation in Soil

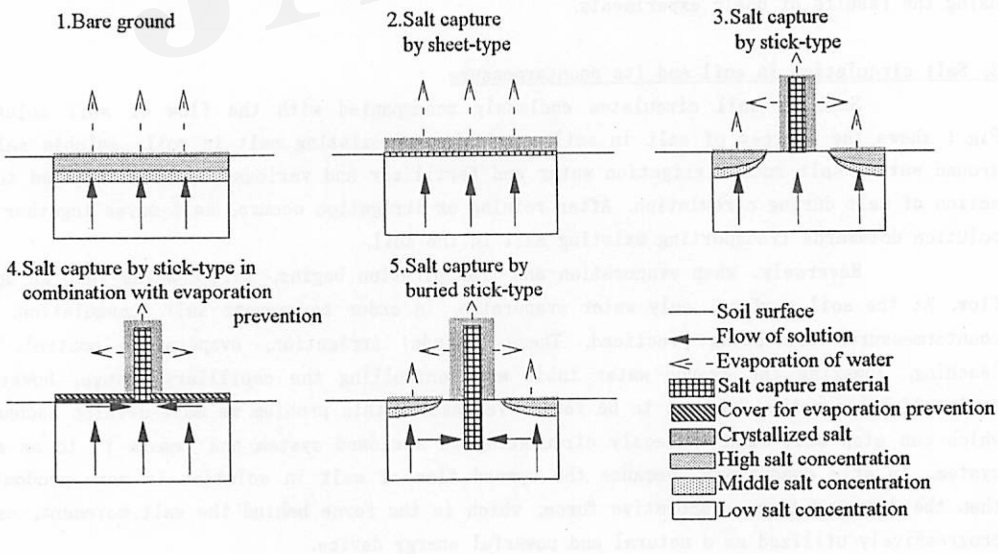

Fig. 2 Type and action of salt capturing materials

The depth of the accumulated salt layer increases along with increasing evaporation. When the soil surface is covered by a salt capturing sheet, salt either accumulates on the surface layer or is absorbed by the sheet. Salt can also be prevented from dispersing into the soil to a large extent. The capturing sheet is made up of a medical guaze-like material. Gauze has good permeability characteristics, a retaining capacity for salt and a large evaporation surface.

In order to facilitate easy handling of captured material, stick-type salt attractors were tested. Buried stick-type attractors which are inserted into the soil show improved performance compared to the previous type of the stick. Salt accumulation does not occur in the soil surrounding the stick surface. Furthermore, the efficiency of salt capture can be improved if the soil surface is covered with a vinyl sheet, then virtually all salt can be captured by the stick. Although some problems exist regarding handling and removal of salt, degree of adherence between the cover sheet and soil, and variability of appropriate weather conditions, this method has added value due to its related advantages such as warmth retention, evaporation prevention, blocking off heat and light and protection against soil erosion.

4. Dehydration method to remove salt from soil

The dehydration method was developed to remove accumulated salt on and inside the soil surface layer in combination with the salt capturing sheet. This can be used to lift up the salt contained in the low mobility solution in the deeper soil layer and to even remove toxic substances in the soil using evaporative force.

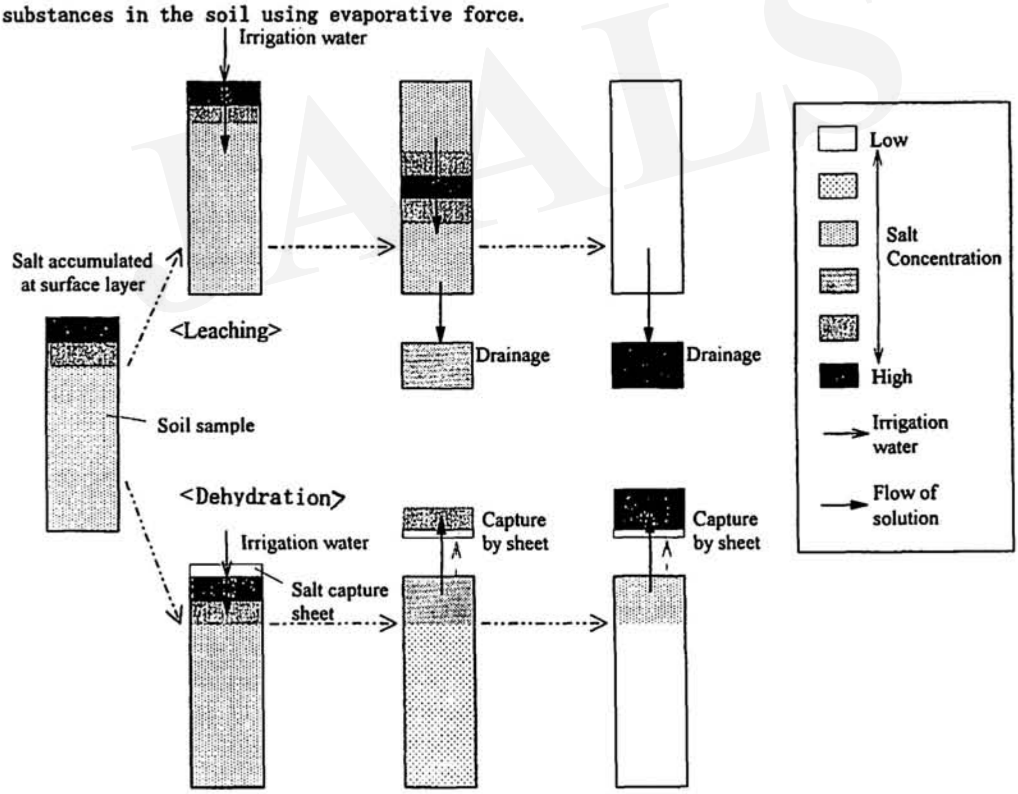

Fig. 3 Comparison of dehydration and leaching methods

Fig. 3 shows the comparison between dehydration and leaching methods. Leaching washes salt away with comparatively clean irrigation water. On the other hand, the dehydration method first dissolves accumulated salt by using a small amount of irrigation water, then solution is uplifted by evaporative force. Salt is finally captured on the surface sheet. Though this method is considered time consuming, it has the important effect of removing solutions with high salt concentrations and preventing underground drainage.

5. Evaporation drainage method for disposal of salt and water from soil

Though preventing evaporation is a critical theme in arid land research, there are many unexpected cases where the groundwater table rises to a very shallow level causing water logging, poor drainage and ponding of waste water. In such cases a drainage channel or system cannot be constructed due to either economic reasons or unsuitable geographical conditions. Therefore an innovative approach to control salt and water is necessary in order to develop and utilize the arid regions. In this regard, we have pursued a new idea which effectively utilizes the strong forces of evaporation which are prevalent in arid regions.

Fig. 4 shows a sketch of the proposed methodology. The process consists of three sections that perform functions including water evaporation, solution transportation and absorption of soil solution. Each process consists of different items that must be examined experimentally and theoretically in order to achieve an amicable balance between the various processes.

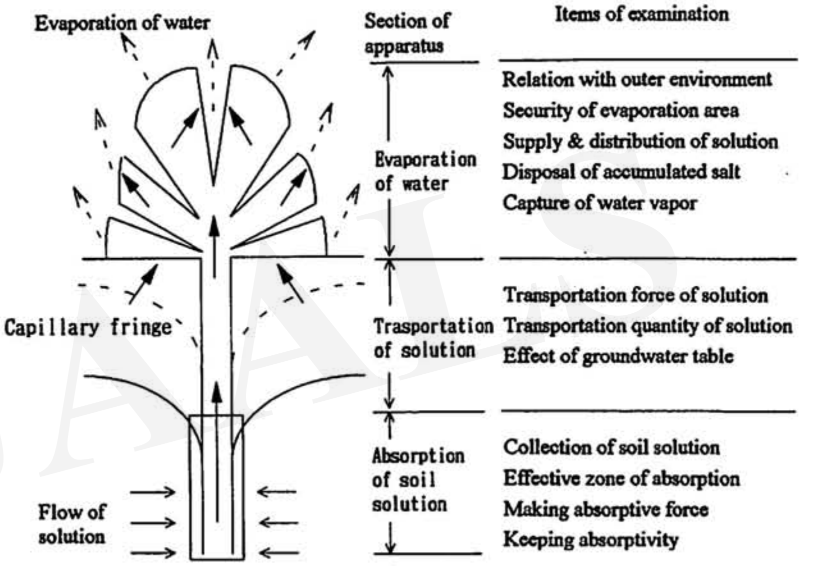

Fig. 4 A sketch showing the apparatus for evaporative drainage

The process outlined in Fig. 4 aims at developing a technology for making distilled water from water vapor evaporating at the surface.

6. Conclusion

Agricultural lands which are potentially threatened by salt accumulation can be more productive. Such lands must be protected and sustained to ensure future food supplies. It was confirmed in our basic experiments that these salt accumulation prevention and removal methods are feasible in principle, and further study is necessary to effectively utilize potentially productive arid lands.

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Rangeland Management For Stability and Production
A joint venture of insitu training and research

Adrian WILLIAMS* and Robert SVENDSEN**

Abstract - The paper outlines reasons for the degradation and subsequent recovery of rangelands in the Kalgoorlie region of Western Australia and describes how these rangelands and their management have become a teaching resource.

Keywords: Rangeland regeneration, Kalgoorlie, Education.

1 Introduction

The rangelands of the Kalgoorlie region of Western Australia have changed from an area exhibiting very little human impact to an area of intense human activity and rangeland degradation, and then to an area of rangeland recovery where production is now bordering on being ecologically sustainable. What makes this unique is that it has all happened within 100 years. This provides a novel opportunity to review the processes at work, and to identify why recovery to a productive state has been possible.

The area is part of a gently undulating plain 300 - 500 m above sea level. Drainage is internal, flowing into seasonal salt lakes and claypans.

The climate is classed as semi-desert. Mean annual rainfall across the region varies from 200-250 mm. Seasonality and annual totals are highly variable. Extremes of temperature range from a -3°C winter night time minimum to a summer day time maximum of 47°C.

Vegetation consists of four distinct zones (Beard 1990). The south and west of the region supports tall eucalyptus woodland. This grades into low acacia woodland in the north, and into open chenopod shrublands in the south east. Beyond pastoral country to the drier north east the vegetation becomes dominated by tussock (spinifex) grassland.

Ground water resources in the region are highly variable, ranging from fresh to 100,000 ppm TDS. Generally groundwater quality is reflected in the vegetation. Eucalyptus woodland tends to delineate the areas of saline to hypersaline groundwater.

2 History of rangeland degradation

A number of factors contributed to the degradation in the Kalgoorlie Region.

- Pastoralism commenced in the region in the 1870's at a few isolated locations. However, the main thrust of animal rearing was in answer to the demand for meat and milk in the early mining towns. Animal rearers brought European ideas of stocking rates to bear on the rangelands which led to rangeland degradation and urban dust problems (Burnside, 1993).
- The growing gold mining industry required vast quantities of timber. Timber was used in underground workings; it provided firewood and fuelwood for condensers to produce potable water; it supplied building materials, fuel for power generation, and fuelwood to power the pumping stations of the Goldfields water pipeline, opened in 1903. These uses consumed up to 500,000 t annually (Kealley, 1991). By the time fuelwood harvesting ceased in 1960, some 30 million t had been harvested from 3.4 million ha, generally using clearfelling techniques.
- Progressively, pastoral production changed to wool (Faithful, 1994). Wool production boomed first in the 1920's in the North East Goldfields, in the north of the region. Here underground water was of suitable quality for stock. Stock were not removed in dry times, so that vegetation growing close to watering points was grazed to the point of rangeland degradation.

* District Leader, Agriculture Western Australia, Kalgoorlie, W.A. Australia 6430. Fax - 0015 61 90 912 199.
** Head of Department Applied Science, Kalgoorlie University College, Kalgoorlie, W.A. Australia 6430.

- Stock management in the early years was based either on a paddocking or shepherding system. Paddocks were commonly in excess of 4000 ha. It was a legal requirement that fences around paddocks had to be erected running either north-south or east-west. This rule made no allowance for geomorphology or changes in soil or vegetation type. Degradation of areas of preferred grazing resulted.
- The provision of manmade water points allowed native animals and feral animals to increase in numbers. This placed even higher grazing pressure on the rangelands, a problem that became particularly apparent in years of low rainfall, and little pasture growth.

Today the condition of rangelands is highly variable Australia wide. However, Goss et al., (1995) states that rangelands used wisely are a renewable resource which can continue to produce export income with minimal inputs. The area of Western Australian rangelands that are considered to be severely degraded and eroded is less than 2%. The North East Goldfields and Nullarbor have the lowest recorded percentages of severely degraded and eroded areas (0.4% and 0.0% respectively). Pringle (1994) states that the North East Goldfields are in above average condition compared with other surveyed areas. This then begs the question why are the rangelands of this area in relatively good shape. Exploration of this may reveal clues to methods to address improvement, and sustainability of rangelands in Australia and other countries.

3 Factors leading to rangeland recovery

3.1 Administration The rangelands of Western Australia belong to the State. Pastoralists have leasehold tenure under the Land Act (1933). Lease tenure is administered by the Pastoral Board, which relies on the Department of Agriculture to furnish reports on each lease every five years. This provides the opportunity to set lease conditions to mitigate land use problems. The Land Act is supported by the Soil and Land Conservation Act (1945-1982). The Conservation and Land Management Act (1984) and the Wildlife Conservation Act (1976) control the use of native flora and fauna, and allow for the creation of reserves for the conservation of specific species.

The sizes of pastoral properties in Western Australia rangelands are larger than in many other areas. The average pastoral property size in the Kalgoorlie region is some 200 000 ha (range = 13 000 - 2 000 000 ha). The State has resisted the temptation for smaller properties and closer settlement. Alternative land uses are being investigated with a view to diversify pastoral stations away from a single enterprise system. The messages here are that property sizes need to appropriately reflect the productive potential of the land and that diversification of income sources on individual properties will become an increasingly important weapon in the fight to prevent over use and degradation of rangeland resources.

3.2 Attitude Appropriate attitudes towards rangeland resources are essential for their conservation. This was considered so important by a group of experienced Goldfields pastoralists that they devoted the first chapter of their book to it (Robinson et al., 1993).

The formation of Land Conservation Districts (LCD) in the rangelands of Western Australia, started in 1983 as a government initiative to place more of the decision making power for the conservative use of rangelands in the hands of the land users. This has been an important catalyst for change in attitude towards land management, as well as providing a forum in which to exchange knowledge and experience. LCD activities include education programmes for school children and urban dwellers, publication of advisory material, input into State and National initiatives, research, rangeland rehabilitation and total grazing control. LCDs are supported by local government and State government departments.

Rangelands occupy about three quarters of the Australian continent, and the condition of the rangelands could have a profound influence on Australia's future climate. Rangeland users are therefore becoming obliged to justify their use of the rangelands, and to educate the general public that the rangeland managers of today are sensitive to the conservation requirements of the land they manage.

3.3 Technology Five technological advances within the last 20 years have aided the recovery of rangelands in the Goldfields to their present condition.

- The advent of using small aircraft to assist in the mustering of stock.
- The development of improved, perennial stock watering dams, which can hold water for up to three years following one filling. (Addison, Law and Eliot, 1994).
- Stock numbers are only allocated to those parts of paddocks that are adequately watered (Burnside, Williams and Curry, 1990).
- The development of systems for total grazing control.
- Rangeland monitoring techniques for Western Australia (Holm, Burnside and Mitchell, 1987) have been developed for pastoralists to use in their management decision making.

4 Current challenges

- Further control of water loss from dams by advances in evaporation and seepage control
- Development of fodder conservation systems to minimise drought risk
- Reliable long range weather forecasting to minimise drought risk and to take advantage of forecast good seasons
- Development of rangeland monitoring systems based on satellite imagery for use by land users and administrators alike
- Development of cost effective rangeland rehabilitation techniques
- Development of renewable energy technologies to provide, amongst other things, remote power and water desalination.

There is an increasing desire to meet the challenges and to pool knowledge by sharing with others in the arid and semi-arid world (Funston, 1993). Maybe this is the greatest challenge of all.

5 Education/training aspects

5.1 History In 1993 at the International Conference on Arid Landcare there were several papers that prompted action in the Kalgoorlie region, to develop a centre for continuing research and training.

A local pastoralist, Funston (1993) expressed his surprise that arid land management training was presented in Wales and other temperate countries. Burnside (1993) argued for establishment of a centre in Western Australia which would focus on Rangeland Science. Svendsen, et al, 1993 detailed a course in Environmental Technology that emphasises arid/semiarid land rehabilitation, particularly as it relates to mining and other land uses.

The melding of these ideas, initially as separate interests, led to continuing discussions between the Kalgoorlie College and Agriculture Western Australia.

5.2 Direction A Memorandum of Agreement was drawn up between Agriculture Western Australia and Kalgoorlie College. This agreement amalgamates two (2) infrastructures. It would then be centred in a comparatively well managed arid environment that incorporates mining and pastoral interests in a region that has overseas and other governmental associations.

The initial program implemented under the Agreement involved ten experts from the Forest and Range Organisation of the Islamic Republic of Iran. The program was presented in two phases over three months. The training, Range Management for Stability and Production, was developed with an emphasis on applied techniques supported by appropriate academic aspects. College lecturers and Agriculture Department staff coordinated various segments of the training that included:

- Water control, storage, catchments (qualitative and quantitative)
- Land use planning within catchments
- Rangeland rehabilitation and conservation
- Production from rangelands

The program was successful in meeting its objectives. Participants strongly supported the use of actual land users as presenters and guides. They also gave strong support for the practical and field aspects of the training.

Late in 1994 the Minister of Primary Industry and the Minister of Education for Western Australia jointly announced the establishment of a Centre for Rangeland Science at Kalgoorlie.

6. Conclusion

As one examines the management of arid areas in the world it becomes clear that a predatory scheme is in operation. Government agencies, industry, and the public generally operate independently and seldom are they mutually accountable. Use leads to abuse of the land and degradation toward desertification results. The alarm bells are ringing and the arid/semiarid regions of the world must respond or be assisted to respond to the impending disaster.

Sustainability and productivity are the planned outcomes in overcoming degradation and desertification in arid areas. Like any other area of the world there is a tenuous relationship among the biotic and abiotic aspects of the ecosystem. The tenuous nature of arid areas is more pronounced than in other areas as there is growing human predation on both aspects of the ecosystem.

Plans for the future of the *Centre for Rangeland Science* in Kalgoorlie include increased flexibility in training programs and expanding the number of applied research projects.

Short training programs will be of one week to three months in duration, tailored to participant requirements. The current higher education Diploma in Environmental Technology (Arid/Semiarid) will be augmented with a degree in Environmental Engineering in 1997.

Research to promote ecological and economic sustainability amongst arid land uses is a major focus of the research efforts of the partners in Kalgoorlie. Collaborative research is welcome.

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Sustainable Construction & Desert Technology

Kohsuke YAMASHITA* and Fumito TAKAGI**

Abstract - The 21st century being just around the corner, world business communities are posed an inescapable challenge by the term "sustainability" in the context of environments. In the construction industry, efforts to face this challenge by establishing and realizing a new concept, namely "sustainable construction" has begun recently. This paper reviews the recent efforts of defining "sustainable construction" and tries to present comprehensive concepts. It also describes examples of practices of the Japanese construction industry in achieving sustainable construction including desert technology in the context of sustainable construction.

Key Words: Environments, Sustainability, Cyclic Process, Restoration, Improvement

1. Introduction

Business activities of all kinds are major causes of direct and indirect environmental impacts. Nevertheless the world's businesses have given too little thoughts to environmental impacts, and their own sustainability, until only recently. The concept of "sustainability" in the context of environments was defined by leading advocates during the 1980s as "leaving sufficient resources for future generations to have a quality of life similar to ours", and was firmly recognized by the world in 1992 at the "Rio Earth Summit" when the term "Sustainable Development" was incorporated in the official documents as a common target to be achieved by the world community. The concept "sustainable construction" is created based on this widely acknowledged term. In November '94, the First World Conference for Sustainable Construction (CIB, TG 16) was held in Tampa, Florida, where the future of construction in the context of "sustainability" were seriously discussed.

Making business operations "sustainable" is not an easy task for any industry. It is particularly difficult for the construction industry because of its unique characteristics. One difficulty arises from the fact that the construction process involves many different parties in different stages from planning through construction to maintenance, and finally to demolition of buildings and structures. Another difficulty is that the life-span of a building and structure is usually several decades, and in some cases, centuries. This life-span is much longer than that of any other industrial product. These characteristics impose additional difficulties on the construction industry in realizing sustainability.

However, since the estimated amount of carbon dioxide emission from construction activities represents nearly 30 % of the entire carbon dioxide emission (estimated ratio in Japan), parties involved in the construction industry must cooperate and seriously reconsider their activities from a broad and long-term perspective to realize "sustainable construction".

2. Definition and approaches of sustainable construction

2.1 What is sustainable construction In the aforementioned conference in Tampa, Florida, many attempts were made to define "sustainable construction". A keynote speaker defined it in a broad sense as "construction of the time and space effects of construction

* Gen. Mangr., Shimizu Corp., Tokyo 105-07, Japan (Fax:+81-3-5441-0358)
** Mangr., Shimizu Corp, Tokyo 105-07, Japan

on the environment in a new non-traditional paradigm". (Y. Miyatake, Shimizu Corporation)

Another presentation proposed six principles of sustainable construction (Kibert, 1994), namely; 1. Minimize resource consumption (Conserve), 2. Maximize resource reuse (Reuse), 3. Use renewable or recyclable resources (Renew/Recycle), 4. Protect natural environment (Protect Nature), 5. Create a healthy, non-toxic environment (Non-Toxic), and 6. Pursue quality in creating the built environment (Quality)

These were attempts to define the term from different view points. With due consideration to these discussions, this paper proposes two distinct approaches toward realizing sustainable construction that will apply to two different arenas of construction activities, namely:-

- Creation of built environments through cyclic processes, and
- Restoration and improvement of (natural) environments.

2.2 Creation of built environments through cyclic processes The first approach concerns the core business of construction, i.e., creation of built environments. Since the dawn of history, creation of built environments for human life has been a main mission of construction. This mission remains unchanged even in the present era of global environments when all human activities are facing serious challenges from environmental sustainability. Today, the construction industry must plan, design and construct built environments not only for the good of human life but also in environmentally sustainable manners. In order to steer the construction processes to environmental sustainability, "Cyclic Construction Processes" must be achieved.

Current construction processes, similar to most industrial processes, are linear. They use energy and materials that are resources from environments, converts them into built environments, i.e., buildings and structures, and discharges waste. Huge volume of debris left after demolition at the end of the building's life is also mostly waste. By achieving cyclical construction processes, however, optimum conservation of energy and resources, and maximum reuse, renewal and/or recycling of resources would be realized whereby sustainability would be achieved.

This paper proposes that this approach of changing linear construction processes to cyclical ones to the maximum extent possible in all stages is an essential approach to realize truely sustainable construction.

2.3 Restoration and improvement of (natural) environments While the first approach effectively lessens impacts on environments, the process of achieving cyclical construction is time-consuming, whose effects are mostly indirect and often invisible. On the other hand the second approach, restoration and improvement of environments, though extensional and subordinate compared to the first one, results in more direct and visible effects upon environments. This approach is further divided into two different categories, one for restoration and the other for improvement, based on the nature of the environment that is to be remedied.

a. Restoration of damaged natural environments Treatments of damaged or contaminated environments, e.g., soil, water and air, are major examples of this category of activities. As the concerns of the world society for environmental issues grow stronger, and as the rules and regulations against contaminated environments become more stringent, needs for rectifying and restoring damaged environments are rapidly increasing everywhere. Needs for a technology break-through to enhance qualities and applicabilities of rectification/purification are also greater than ever. Satisfying these needs by restoring once damaged environments and by bringing them back to viable environments is important in achieving sustainable construction.

b. Improvement of arid environments Construction industry's involvement in developing effective technologies against desertification is a straightforward example of this approach. The activities in this approach are neither everyday affairs nor the day-to-day business of the industry. Nevertheless, positive impacts on environments that these activities could bring about have a significant meaning not only in terms of sustainable construction but also in terms of the world's sustainability at large

3. Examples of efforts of realizing sustainable construction (in case of Japanese construction industry)

In this section, examples of the Japanese construction industry's efforts to realize sustainable construction in each of these three categories are discussed through describing eforts of a Japanese A/E/C Firm.The term "A/E/C (Architects, Engineers & Constructors) Firms" means major Japanese construction companies who are capable of undertaking all stages of construction and engineering processes. Several unique characteristics, including the following two functions clearly distinguish Japanese A/E/C firms from typical general contractors in most countries:

-Strong in-house design and engineering capabilities; and

-Strong and broad in-house Research and Development capabilities.

Experiences and capabilities in these functions are not only competitive advantages of Japanese A/E/C firms but are also a solid basis for activities to realize sustainable construction. The following are activities of Shimizu Corp. in the abovementioned three categories:

3.1 Achieving cyclic processes In the category of creation of built environments (construction), the following efforts are being made to convert the process from the linear to the cyclical:

- Design buildings and structures with optimum energy/resource efficiency and minimum energy/resource consumption,
- Develop construction system with low environmental impacts,
- Use of materials and equipment with low environmental impacts,
- Reuse/recycle residual materials
- Minimize use of tropical timber plywood
- Minimize discharge of waste from job sites
- R & D new materials and construction systems aimed at maximum recyclability.

A wide range of activities are being implemented in all the above fields, from high levels of R & D attempts aiming at realizing evolutional new construction systems, to day-to-day efforts on the job sites. Japanese A/E/C firms are effectively utilizing their comprehensive capabilities in construction so that their identities as organizers to create built environments may be reaffirmed in the era of global environmental sustainability.

3.2 Restoration of damaged environments The second category, restoration of damaged environments, is becoming an important arena of business. The following, too, are examples from Shimizu Corporation:

- Treatment of contaminated soil and hazardous waste
- Water purification and waste water treatment system
- Assessment, simulation and treatment of air pollution
- Bio-remediation, etc.

These activities are becoming important parts of the construction business. Japanese A/E/C firms intend to make direct contributions to realizing a sustainable society in this arena.

3.3 Improvement of arid environments - Desert technology Shimizu began exploring technologies related to improvement of arid lands ten years ago, the first in the industry to do so. Environmental aspects were, in fact, not a key issue at the outset. However, during the decade since then, growing concerns on global environmental issues have shifted the focus of these researches clearly toward environmental sustainability.

Shimizu has implemented many R & D projects directly and indirectly related to desert technology, e.g., Meteorological Simulation, Wind-Blown Sand Simulation, Satellite Observation Technology, Topographical Analysis, Vegetation Cover Improvement, Technology for Selecting Tree Species, Permeation Analysis, Underground Water Simulation, Erosion-control, Ground water Dam Technology, etc.

Shimizu also prepared several conceptual proposals of mega-projects for improvement and development of arid lands. Examples of such proposals are: Construction of several man-made lakes inter-connected by canals in the middle of a desert aiming at moderating arid climate (Desert Aqua-Net Project); Construction of a city in a desert employing technologies to achieve maximum conservation of energy and minimum impacts on environments (Pacifica Project).

Though still conceptual and futuristic, all these proposals are based on solid technical bases. However it is not possible for a private enterprise to implement these projects by itself. Nonetheless, considering two explicit concerns of the present world, i.e., the concerns on global environmental issues and on international cooperation between developed and developing countries, it is the construction industry's hope that some of these projects to improve arid environments will materialize so that direct and really meaningful contributions to the sustainability of our society can be made.

4. Conclusion

Realizing sustainable construction is a difficult and long term challenge for the industry, like any other attempts to achieve sustainability of our society. However, by pursuing the goals in all these arenas continuously into the next century, the author believes that the construction industry will be able to arrive at visible solutions on "sustainable construction".

At the closing of this discussion, the following words, by an advocate of integration of environments and industries, may be recalled: "It is not merely the environment that is at stake. Business itself may well be at stake, if business does not change its strategy (toward sustainabiity). (G. Pauli, 1995)

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Desert and Desertification control Techniques in China

Zhenda ZHU* Shuhong CUI**

Abstract-It is important to control desert and desertification for sustainable development. This paper briefly introduces the techniques how to control desert and desertification in China. These techniques are found to be successful.

Key Words: Control desert and desertification, China

1.Introduction

Desertification or land degradation is one of the most serious global environmental problem. China is one of the countries affected by desertification. The area of desert and sandy desertified land is 1,533,000 km^2, or 15.9% of total land area of China. Desertification has destroyed the ecological system and affected sustainable development. For these reasons, The Chinese government has made a lot of efforts for researching and combating desert and desertification for many years and achieved some success. China government has ratified "Agenda 21 of China", in which Combating Desertification is Chapter 16.

2. Major Techniques for Combating Desert and Sandy Desertification

According to the natural resources and social-economics characteristics in the desert and desertified land in China and on the basis of existing problem during the development and utilization and of the experience gained in the combating desertification in typical areas, the major techniques are as following:

2.1 Engineering and Biological Measures Reduce the speed of sand drift and lower the sand contents in the air current through engineering techniques such as vertical sand barriers, straw checkerboard protection, etc., and biological techniques such as natural regeneration of the vegetation cover, sand control forest, and shelterbelt nets. In the lowland between the dunes, trees and shrubs are planted to split down and isolate dunes.

2.2 Chemical Measures Stabilize the shifting sand surface to prevent wind erosion by mulching such as organic mulches and man-made materials for mulches, and shifting sand dunes by chemical measures (Asphalt emulsion, polyacrylamide, polyvinyl alcohol; polyvinyl acetate, sodium silicate and hydrolytical polyacrylonitrile).

3. Specific Measures Taken to Combat Desert and Sandy Desertification

On the basis of the above mentioned control technology for desert and sandy desertification, the specific measures are adopted for different natural conditions and target objectives of desert and sandy desertification control.

3.1 Equitable Allocation of Available Water and Protection of Oasis in Arid Zone Desertification in arid zone, on the one hand may be caused in the lower reaches because of the misuse of water resources at the upper and middle reaches of inland rivers. On the other hand, the destruction of vegetated dunes at the edge of oasis may cause the reactivation of fixed-dune and encroachment of sand dunes. The following techniques are adopted.
(1) Taking the inland river basin as a whole ecological unit to prepare a master plan for the unified management and utilization of surface and underground water resources, and to establish an irrigated oasis which relies on water supply to sustain a stable and highly efficient artificial ecosystem at the inland river basin.
(2) Taking the oasis as the center to plant sand-blocking belt of grasses (using the surplus water in winter season) at the outskirts of oasis and plant mixture sandbreaks composed of trees and shrubs at the margins of the oasis and farmland protective networks and wind-breaks in the interior of oasis.
3) For the shifting dunes at oasis edge, checkerboard protection should be established and sand-holding species should be planted inside the checkerboard protection and woodlot should be established in the inter-dune areas to form a protective system.After taking these measures, the environment developed soundly (Table 1).

*Institute of Geography, Chinese Academy of Sciences. Beijing, 100101. China.
**Department of Natural Conservation, National Environmental Protection Agency, Beijing 100035, China.

Table 1. The change of landscape before and after control sandy desertification in Linze Hohsi Corridor

Landuse Pattern	Percentage of the area occupied (%)	
	before control	after control
Shifting sand dunes	54.6	9.4
Land affected by desertification	17.8	0.4
Reversed desertification (orchards and woodland)	9.0	52.4
Farmland without desertification	8.9	37.8
Wastelands	9.7	/

3.2 Readjusting Landuse Pattern and Recovering Vegetation in semi-arid zones The techniques of combating desertification is as follows:

(1) Dry-farming landuse system should be readjusted. The landuse proportion for forest and pasture should be enlarged. According to landuse pattern studies in typical areas, the proportions differ with degree of desertification (Table 2). In the areas with more serious degree of desertification and more complex landforms, the proportion of woodland and pasture should be relatively enlarged.

Table 2. Suitable rate of landuse in the dryfarming area affected by sandy desertification

Degree of desertification	Percent of landuse (%)		
	cropping	plantation	pasture
slight	47	27	26
moderate	25	30	45
severe	15	30	55
most severe	10	40	50

(2) For the protection and regeneration of the natural vegetation cover, for example, in the east part of Horqin steppe, the desertified land was conserved for 3-4 years. Because of charcteristics of the potential ability of natural reversing of ecology, vegetation regenerated gradually without other supplementary measures. The vegetation coverage and biomass both increased as shown in Table 3.

Table 3 Changes of vegetation coverage (%) and biomass (g/m^2) since the natural conservation in Zhaohaimiao area of Horqin steppe

Plant community	Without conservation		Conservation for 3-4 years	
	vegetation cover	biomass	vegetation cover	biomass
Astémisia frigida	30	130	65	271
A. holodendron	30	483	45	733
Weed spp.	40	219	70	386
Legmus chinensis	35	183	65	364

(3) The artificial vegetation is established by biological technique which is composed of shrub plantation on dune slopes and shrub-grass plantation in the lowland between the dunes in order to stabilize of shifting sand dune and to control wind erosion. Consequently, Non-desertified land increased sharply (Table 4).

Table 4. The change of landscape before and after the establishment of vegetation in Zhang Wu, Horqin

Various landform and their percentage in the total area (%)	Shifting sand dunes	Wind-eroded lands	Semi-fixed dunes	Non-desertified land
Before control	44	25	9	22
After control	8	4	6	82

3.3 Prevent Railway and Highway From Sand Dune Movement Large areas of shifting sand dunes have been brought under control by the construction of checkerboard protection with the straw in the south-eastern part of Tengri desert, where the Paotow Lanzhou railway passes through. Inside the checkerboard, the shrubs planted were *Salix flavide, Hedysarum scoparium, Caragana korshinskii*. In the front part of windward side, vertical sand barrier were established, and formed combination of blocking and stabilizing system. In the hinterland of Taklimakan desert along the oil-transporting highway, adopted the checkerboard protection by using reed grid, combination with sand barriers to fix the shifting dunes. At present, highway for oil exploration in Takllmakan desert is being constructed.

3.4 Chemical Fixing Sand Dunes In some places especially in extremely dry region where planting vegetation is impossible like along railway (Shapotou) and highway (Xiaotang), chemicals were applied for sand stabilization. Such as Asphalt emulsion, polyacrylamide, polyvinyl alcohol, polyvinyl acetate and hydrolytical polyacrylonitvile is best for sand stabilization. The chemical fixing sand has been successfully applied in Shaopotou by Ms.Hu Yingdi and Mr.Zhou Jixia, 1990 (Table 5). But the cost for shifting dune stabilization with chemical measures are six times higher than with the protection with straw. So, cheaper chemical measure should be explored.

Table 5 The dune fixing effectivenes of polymers in Shapotou.

Condition	Polymer	Sprayed amount g/m^2	Sand dune fixing effectiveness
On the shifting sand dune surface	PAV	125	the layers of suface still in good condition after 9 years
	PAM	250	destroyed after 2 years
	PVAC	125	most part in good condition after 9 years
On a sand dunes where straw check eroded has been laid	PVA	125	in good condition after 9 years
	PVAC	125	most parts in good condition after 5 years
	PAM	250	serious wind erosion after 2 years
On a sand dune planted with vegetation	PVA	125	in good condition after 9 years
	PVAC	125	in good condition after 5 years
	PAM	250	serious wind erosion after 2 years

PVA- polyvinyl alcohol, PVAC-polyvinyl acetate, PAM-polyacrylamide.

4.Conclusion

It is proved that the desert and desertification control techniques tallies with the actual situation of differently desertified regions and also achieves the goal of integrating the ecological, economic and social benefits together. Two example (Table 6) have shown that these techniques are successful.

Table 6. The compassion of some targets before and after the desertified control in Horqin(A) and Mu Us(B) sand land

Comparative Item	Yaoledianzhi (A) Naiman county		Shabianzhi (B) Yanchi County	
	1984	1988	1984	1988
Shifting dune area (ha)	1000	333	1472	1055
Vegetation cover (%)	10	30	7	30
Grain yield (kg)	150000	250000	146000	214000
Average annual Personal income (Yuan/Year)	190	430	400	893

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Land Use and Sandy Desertification — A case study in the North China

Wang Tao*

Abstract - The pattern and intensity of land use play an important role in process of land degradation/sandy desertification in the studied region, Bashang, where the sandy desertified land have been spreading rapidly since 1950's not only in areas, but also in degrees. The inappropriate land use was the main cause, and the unfavourable natural condition and the trends of increased temperature and decreased precipitation also made contributions to the process. But the process could be controlled if land uses were moderate and reasonable.

Key Words: Land use, Sandy desertification, China

1. Introduction

Land degradation is trending accelerated development because of the increasing pressure of human population. Sandy desertification is a main kind of land degradation in the North China (Zhu Zhenda, Liu Shu, 1989), which mainly caused by excessive human impacts through wind erosion (Zhu Zhenda, Wang Tao, 1990). During last four decades the sandy desertification has shown the continued spread in arid and semi-arid region of the North China according to implemented research projects of repeated monitoring and assessing based on remotely sensed data analyzing and investigation of nature and socio-economy (Zhu Zhenda, Wang Tao, 1990, 1992). The sandy desertified land had expanded 1,560 sq.km. annually on an average from the middle of 1950's to the middle of 1970's, and for the last decade it has gone up to 2,100 sq.km., the sandy desertified land has reached 197,000 sq.km.in the late eighties (Zhu Zhenda, Wang Tao, 1990, 1992). The form and intensity of land use determine to a great extent the development of sandy desertification in arid and semi-arid region. This study focuses on land use and sandy desertification based on monitoring and assessing the processes of sandy desertification in Bashang Region of the North China.

2. Environmental background of Bashang Region

Bashang Region, 66,500sq.km. of studied area, is situated in the southeast part of Inner Mongolia Plateau, 1,350–1,600 metres of elevation, undulation of topography distributed hillocks alternate with lakes and lowlands. The area has a semi-arid climate with an average annual temperature from 0 ℃ in west part to 4 ℃ in east, 80–110 frost-free days, 320–450mm of average annual precipitation and 60–70% of the rainfall falls between June and August. 1,500–3,000 mm potential evapotranspiration. The region is controlled by the Mongolian high pressure in winter, cold and windy, but in summer it is continental low pressure and subtropical anticyclone, warm and rainy. The dry season lasts from September to next April, and there are active wind erosion and sandstorms because of the strong wind and surface deposition of sandy-composition. The regional soil is chestnut soil in west and black sandy soil in east. The rivers are continental mainly with short distance and limited flow, and seasonal streams. The natural vegetation is steppe society of temperate zone which mainly composed of *Compositae, Graminae, Rosaceae Leguminosae* and *Ranunclaceae*.

Institute of Desert Research, Chinese Academy of Sciences, Lanzhou 730000, China
(Fax: +86-931-8889950)

* Japan Science and Technology Agency Fellowship (until August,1996) in National Institute of Agro-Environmental Sciences, 3-1-1, Kannondai, Tsukuba, 305, Japan (Fax:+81-298-38-8277)

3. Land use

The environmental background had evolved a fragile ecosystem in Bashang region over thousands of years, mostly in response to climatic changes. Throughout most of history, what humanity has been able to cope with such an evolution by colonizing new and hitherto unaffected areas was nomadic, which become the traditional pattern of land use and was the best natural and social selection. According to the historic records, there were very limited human activities in the region. In 1681, Kanxi emperor (1662 -1722) of the Qing Dynasty (1644-1911) chose east part of the region to be Mulan hunting field, so that from 1681 to 1820 the field was special site for emperors who hunted here nearly every autumn. So one can image that during that period the region was kept a very good environmental condition as the historic books said. Actually, the crop agriculture developed only since a hundred years ago. During the Guangxu emperor period (1875-1908) of the Qing Dynasty the region was encouraged to migrate and to be cultivated resulted from the practice of police of station troops to open up wasteland and garrison the frontiers, the mass population started across the Great Wall to the region. Up to late of 1940's a fair-sized rainfed farmland had been dispersed over south part of the region, and some had reached to the north, so the land use had evolved to be mixed between cultivation and grazing from nomadic grazing. This was the first change of the pattern of land use in the region.

Since 1950's, the pattern of land use have experienced the second change, i.e. from the mixed one to be cultivation dominantly. The intensity of land use has grown, too. Faced to gradual increase of population, up to more than two times in late of 1980 against in early of 1950, and to meet the need of food and development, the region has been determined to be key area of crop cultivation. There were three organized campaigns for cultivating the rangeland by middle of 1970's. For the first some years, after prairie had been cropped, local people had good harvests as expected. But, because of some reasons like the limited of natural condition to crop agriculture, wind erosion and the loss the surface soil, rapid decrease of fertility of soil and the limited of economic base so that nearly no input for land management, the grain yield had declined year by year as from 2,000-2,400 kg. per ha. at the beginning to 600-750 kg. per ha. at the latter. What happen as the consequence was the former farmland had been give up and more prairie had been cultivated, although it met those limited condition again. Such vicious circle took five years normally. By late of 1980's, the crop farmland already occupied more than 50% of total area of the region, and in some county it reached to 80%. Most areas of farmland had degraded in different degree, so the crop production were lower and unsteady, the yield per unit area had sharp declined. Take the Fengning county as example, the average output per ha. yield were 1,335 kg. in 1960, 1,275 kg. in 1970, 900 kg. in 1980 and 600 kg. in 1988. Although the total output had increased more than two times in 1979 as against in 1950, thanked the increase of farmland, the grain ration per person of rural area had decreased from 455 kg. in 1950 to 405 kg. in 1979 because it had been shared by much more population.

The rangeland had reduced 60% of total area since 1950 result from constant reclaim in the region. It was no doubt the severe overgrazing had been practiced since the local resident always tried to keep the amount of livestock as many as possible. Every hectare had have to be roamed by 6 sheep unit in 1988, which was only 2 in 1959. During the same period, according to the statistics, the cover degree of vegetation reduced 40-50%, output of dry forage grass declined 50-70% and the quality of rangeland become poorer and poorer. The supply of forage grass was very far from the need so the domestic animals were landed in the predicament of struggled along on the verge of starvation in every more than half year. There is no more in expectation of good harvest from animal husbandry up to now.

There were small areas of woodland in the region and most of them were shrubs. It was also very difficult to survive because of the gathering firewood and grazing.