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"Biovillage Concept"
- A Plan of Sustainable Development in Semi-Arid Lands to Prevent Desertification -

Tadashi Nagahama*

Abstract - The "Biovillage Concept" is a proposal to achieve ecological harmony of human activity with nature and to prevent desertification. Various sciences and technologies should be used in cooperation with nature to realize a clean and green Biovillage system where a few hundred to a few tens of thousand people can live through recycling and utilizing the features of the land. Primary ,secondary and tertiary industries will be included in the Biovillage and managed on a permanent basis so that the people can be autonomous.

Key Words:Semi-Arid Lands,Sustainable Development,Biovillage Concept ,Prevention of Desertification ,ecosystem

1.Introduction

A small "Settlement" area with a population between several hundreds and several tens of thousands will be built in Semi-Arid area. This "Populated" area will not form naturally as has been the case in the past. Rather the number of people who settle in the area will be carefully considered from the start.The features of the land will be used effectively, and agriculture and industries will be conducted on a scale large enough to sustain the population. The system will be comprehensive and the energy will be used effectively.

This "Settlement" will be a small to medium sized urban deliberately constructed to maintain a life style incorporating recycling for its population,and named as "Biovillage".

In the Biovillage, there will be agriculture, fisheries,stockbreeding, industry, etc. which will provide the inhabitants with self-sustaining livelihoods. Production, fabrication, utilization, treatment and other secondary and tertiary industries will be managed on a permanent basis, so that a recycling system society can be maintained.

2.Concepts for Sustainable Development "Biovillage Concept"

It's my intention to introduce a plan for sustainable development in semi-arid lands to prevent desertification.As is well know, in the area surrounding the true desert, desertification is steadily progressing due to medium-term dry weather and human activity. To prevent further desertification, a great variety of aids ranging from small-scale assistance to large subsidies have been granted to encourage development of effective measures. In the long run, however, some of these aids have contributed to desertification rather than preventing it.

To give an example of small-scale assistance: Measures based on good intentions to dig wells in pastures have resulted in grazing too many animals, which has triggered further desertification.

Examples of large-scale assistance can be found in large, capital-intensive projects such as large-scale development of water resources, large farm lands and large pastures. These projects benefit only a limited number of people. The majority of the tribesmen and farmers have long been forced off the lands, and soil has been destroyed and deserts created by the growing of cash crops, using machinery on vulnerable soils. Furthermore, this kind of development encourages the import of products from developed countries. This has deprived the native people of their jobs, with the result that a great number of local people have been turned into environmental refugees living in the slums of urban areas.

There are many difficult aspects concerning development aids. Then, are development aids unnecessary after all? Definitely not! Human intelligence and management competence has built today's civilization. I firmly believe that there are solutions to the problem.

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There are two different concepts behind the development aids; (1) Ecocentrism which aims at coexistence between humans and nature, placing importance on the laws of nature,
and (2) Technocentrism which attempts to solve natural and environmental problems by science, technology and human efforts.
Both are excellent concepts, but it seems unrealistic to expect solutions to come from only one of the two.
Fig.1 shows truly valid and feasible sustainable development.

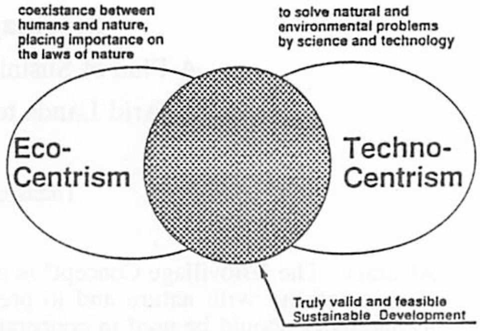


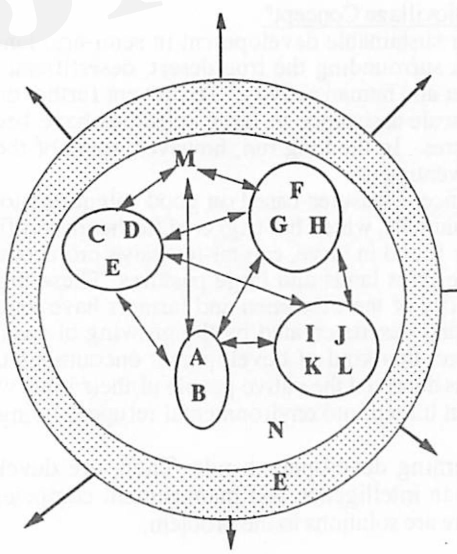
Fig-1 Sustainable development

I believe that truly valid and feasible "sustainable development" can be achieved by a combination of ecocentrism and technocentrism, that is, by man's creative efforts in harmony with nature and the ecosystem. I summarized my ideas on this standpoint and named it as "Biovillage concept".

3.Configuration of a Biovillage

The configuration of a Biovillage is shown in Fig. 2, A Model Biovillage.
A Biovillage will be made up of 14 areas.
The Central Functions area, indicated by "**A**"will have the control functions for all activities in the Bio-village. The Residential area, indicated by "**B**" will be an important part of the daily lives of the inhabitants. The Agricultural area "**C**",Stock Raising area "**D**",Forestry area "**E**" and "**F** "Fisheries area will maintain the lives of the population. The Water Source area "**G** "is the mainstay of life. And Water Treatment area "**H**". The Energy Production area "**I**" will supply electricity, gas and other forms of energy. The Recycle Processing area "**J**", Simple Factory area "**K**" and Storage Facilities area "**L**" are also included. The Recreational area "**M**"will help to enrich the lives of the inhabitants.The Other Infrastructures "**N**", will provide the other basic facilities which are necessary for social life, such as roads, bridges,waterworks etc.

In the first phase, the concrete requirements and specifications for each area must be determined by the site conditions and the population size. Because the areas are interrelated in complex ways, the main point of concern is thorough consideration of material, energy and ecological balance.



A: Central function area
B: Residential area
C: Agricultural area
D: Stock raising area
E: Forestry area
F: Fisheries area
G: Water source area
H: Water treatment area
I: Energy production area
J: Recycle processing area
K: Simple factory area
L: Storage facilities area
M: Recreational area
N: Other infrastructures

Fig-2 A Model Biovillage

4.Basic concept for some components

4.1 The central function area A This erea will act as the control center for the management of the entire Biovillage. It will be made up of the simple facilities to provide the minimum functions in administration, education, medicine, sanitation, culture, communications, distribution, etc.
This area will also have research facilities for studying desertification, and facilities to receive outside volunteers and aid materials. It will also have facilities to expedite academic exchange and reception of aid. It will be necessary to make the management system simple; at the initial stage, specialists in various fields will have to be dispatched from developed nations.
The goal, however, is gradual transfer of such activities to the residents of the area.

4.2 The residential area B Some groups of concentrated residences will be built. Technologies for zero-energy houses , passive solar houses(for example, combined system of solar and underground heat storage) , energy conservation, etc. will be adopted, so that little energy will be consumed. Greenery will be planted around the residences and ivy will cover the walls so that the heat can be reduced, and the residents will have a more relaxing environment.
It is hoped that the eating habits of the residents will also be changed to make lunch the main meal of the day, so that solar cookers and the like can be used. Some examples of cooking by a solar cooker are roasted meat,fish,vegetables, noodles,sunny side up eggs (in only 3 minutes) and various boiled dishes , etc.The morning and the evening meal should use as little energy as possible. Garbage and waste water collection systems should be installed in all of the residences,so that they can be recycled.

4.3 The energy production area I This erea will produce and supply all the electricity, heat, fuel etc. which are necessary in the Biovillage.It is very important to establish facilities for local manufacture of simple and efficient equipment without any pollution.
The following equipment could be recommended:Solar energy generators, water heaters, water desalinators, coolers and wind energy generators. Alcohol and methane production, charcoal production, and the other natural energies will be produced.

Fig. 3 shows "A View of a Completed Biovillage." A clean and green settlement is created.

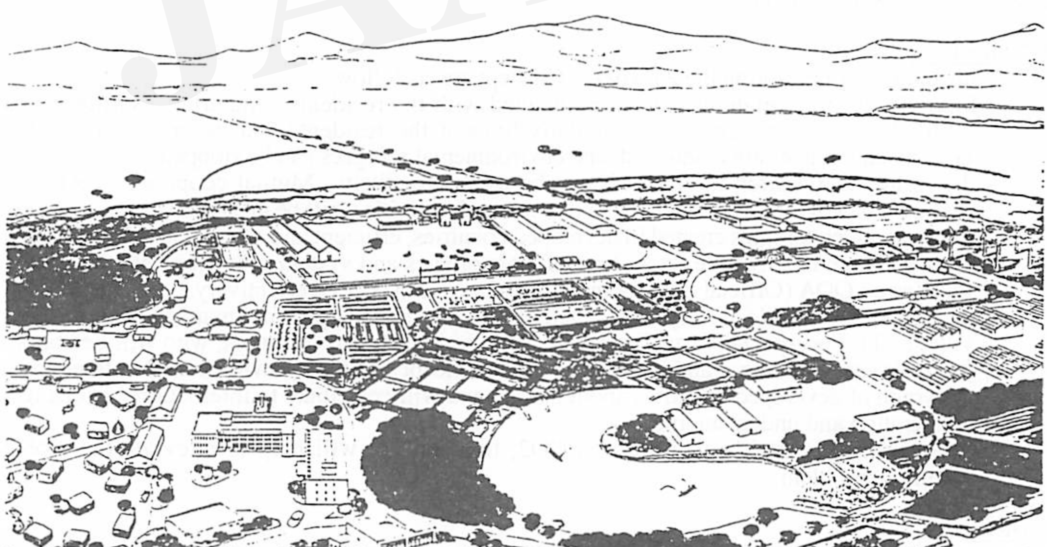


Fig-3 A View of a Completed Biovillage

5.Biovillage Network Concept

In the second phase, another Biovillage is constructed about 50 kilometers from the first. The Biovillages are connected by green belts. Trees will be planted along the green belts with widths of about 30 meters, and the green belts will also contain water piping, and electrical and communications cables. In this manner, Biovillages will be constructed and connected. The green belts can be secured by fixing the dunes so that they do not move.

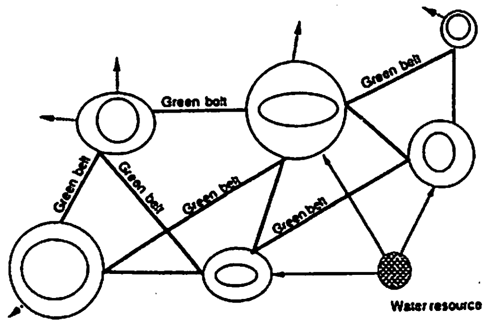


Fig-4 The Biovillage Network Concept

By planning and constructing Biovillage so that they form a network, there will be mutual exchange of the materials necessary for life, exchange of culture, and other interrelations. These will help to create a healthy and new cultural area, and, at the same time, prevent desertification over a wide area.

This concept does not require the latest advanced technology. The first thing is to fully utilize traditional agriculture, fisheries, stock-breeding, industries and the other technologies which are applicable to the region. Technologies which have already been developed in the United States, Japan and the other developed nations must be used. In addition, bio-relation, soft energy , recycling,energy conservation , and other technologies which are being developed should also be combined to a certain extent.By reorganizing simple technologies, the various technologies can be effectively used, and greater results can be achieved. These results can lead to the creation of permanent small to medium size urban which do not produce pollution.

In addition, the lives of the residents will be stabilized, and by promoting greenery in the Biovillage and reforestation in surrounding areas, clean and green urban can be created. I believe that desertification can be prevented and reforestation can be achieved by designing and constructing many Biovillages in this manner.

6.Conclusion

The advantages of promoting the Biovillage Concept are as follows:

1. Friendly, trusting relations can be maintained with the residents. Material, facilities, and cultural aspects necessary for the daily lives of the residents can be provided, so that poverty and hunger are eradicated, and environmental refugees can be stopped.
2. The results of research in all fields can be used effectively. Mutual cooperation between researchers will be easier to attain, so that research activities will be promoted.
3. Combining technologies created in developed countries, efficient and coordinated development can be attained. Effective know-how of technologies and system management can also be transferred.ODA (Official Development Assistance) can be used effectively.
4. Volunteers will be able to fully utilize their abilities in construction and management of Bio-village. This is especially true for the elderly from developed countries, who will be able to use their vast experience and knowledge. This concept will also provide a chance to educate the youth of developed countries about nature, and will contribute to international exchange, cooperation and understanding.
5. By increasing plant life that absorbs CO_2, this concept will help to alleviate the global warming problem.

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Wind Tunnel Modelling of Shifting Sand Control for Oil Field Developmint in Desert Area of China[1]

Zhang Kebin[2] Kawai Eiji[3] Hikaru Kitahara[4]

Abstract—Based on this experiment for shifting sand—proof, we can find that for sand—fixation, denser fence in form of type A could be used(for example sand fixtion along highway in desert area). But if only for windproof and avoid shifting sand deposition, type B and type C could be adopted(for example type C can be used around the oil tower while drilling)

Key Words: Wind Tunnel, Shifting Sand, Oil Field, Desert.

1. Introduction:

As the economy develops, desert oil production becomes one of the important factors in China to meet the fuel demand. But oil field development such as drilling and piping are very hard because of the strong sandstorms ans shifting sand. Of course biological methods such as tree and shrub, even grass, can be used to set shelterbelt and vegetation cover to reduce wind velocity and fix the shifting sand. But there is almost no ground water in desert areas with low rainfall. Mechanical measures are becoming one of the most important methods instead of the biological measures to reduce wind velocity and control sandstorm.

2. Model design:

12 types of the models (fence)had been made for velocity distribution measuring experiments and for erosion and shifting sand distribution experiments.

3. Experiment condition:

3.1 Wind tunnel used for experiment:

Wind tunnels at the Forestry and Forest Products Research Institute of Japan in Tsukuba Science City were used for experiment. Their specifications are as follows: closed—rectangular working section of 1.2m width x1.6m height x 10.0m length (wind velocity measuring experiment), and 0.6m width x 1.0m height x 4.0m length (erosion and shifting sand distribution experiment). The wind velocity ranged from 2.7 to 40.0m/s by 150 kw axial—flow fan(the former) and 1.5 to 15.0m/s by 10 kw axial—fan(the latter)

3.2 Experiment conditions:

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① This research work had been done when the first author studied at Forestry and Forest Products Resaerch Insititute of Japan, special thanks go to Dr. Mashima, Dr. Takeuti, Dr Yoshitake, Dr. Sanmori. Dr. Okura, Dr. Yamanoi Dr. Mizokuti and researchers of the institute.

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L1/L2 is the similarity proportion, V1 and V2 are the wind velocity related to them based on $V1/V2=(L1/L2)^{1/3}$ by Dr. Nemoto. Wind velocity of 7.4m/s (it is related to about 20m/s in natural condition) was adopted in wind velocity distribution measuring experiment. For the erosion and shifting sand distribution experinent, wind velocity of 10.2m/s, 7.4m/s, 6.3m/s and 4.6m/s were adopted.

3.3 Sand texture:

Experiments used sand from Japan's beach and Arab Desert. Their texture are as follows:

Tab. 1 For wind velocity distribution measuring experinent:

species	ventilating coefficient (%)	dimension(cm) width x height	type *
I	55	120x20	55A 55B 55C
II	40	120x20	40A 40B 40C
III	30	120x20	30A 30B 30C
IV	20	120x20	20A 20B 20C

* Type A was in origial shape and for type B, 25mm had been take off from the bottom of the model (i.e. ventilating coefficient here is about 100%), for type C, 50 mm had been take off from the bottom. Models used for erosion and shifting sand distribution experiment are same except widths were 60mm.

Tab. 2. Experiment—used sand's texture

diameter(mm)	Japan's beach sand(%)	Arab desert sand
>0.25	19.7	7.9
0.25—0.105	76.7	85.0
0.105—0.704	1.9	4.1
<0.704	2.7	3.0

4. Results and discussion:

4.1 Wind velocity distribution and windbreak affect

Fig. 1 shows the wind velocity distribution at height of 4cm (2mm in wind tunnel), 200cm (100mm) and 400cm (200mm). Table 3 shows the min. wind speed, location which it took place, and windbreak affect at height of 4cm (landsurface). For species I, the min. wind speed at height of 4cm occussed at 14H (A) 20H(B) and >25H(C). i.e. A<B<C it

almost as same in other species, it also tell us the denser the windbreak the shorter distance at which the min. wind speed takes place.

Table 3. The min wind velocity at 4cm/2mm

type / species		A location H	A velocity m/s	A windbreak affect %	B location H	B velocity m/s	B windbreak affect %	C location H	C velocity m/s	C windbreak affect %
I	55	14	4.1	79.5	20	7.4	63.2	>25		
II	40	10	1.8	90.1	14	5.5	72.3	18	9.6	51.9
III	30	4	1.3	93.3	12	3.7	81.5	12	7.3	63.6
IV	20				10	2.6	86.8	10	4.8	76.2

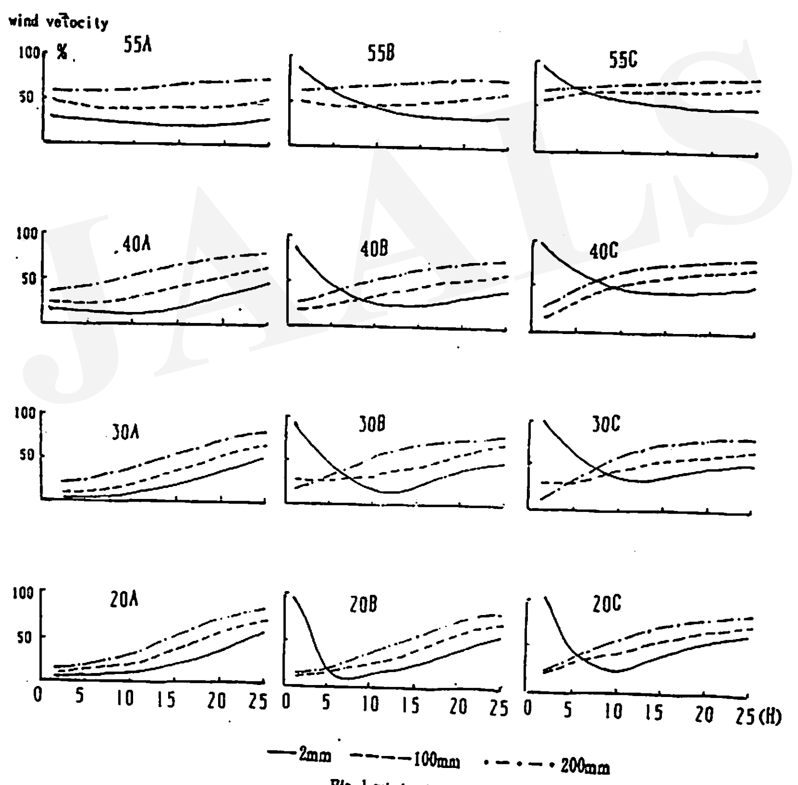

Fig. 1 wind velocity distribution

4.2 Shifting sand distribution and sand fixation affect.

For the shifting sand distribution behind the fence, in view of density, the quantity of deposing sand is Ⅳ > Ⅲ > Ⅱ > Ⅰ. i. e. the denser the fence, the greater quantity sand deposited behind the fence. In view of types and deposited location (H) it shows that, take species Ⅲ as an example, all the sand was deposited before 10H for type A, from 6H—16H for type B and from 13H to more back for type C, i. e. in view of distance behind the fence A <B<C. for species I. Only type A had some deposited sand before 16H, with the other two types deposited sand was all far from 16H.

5. Conclusion

Based on this experiment of shifting sand control for oil field development in desert area, denser fence in form of type A conld be used (for example sand fixation along highway in desert area). But if only for windproof and avoid shifting sand deposition, type B and type C could be adopted (for example type C can be used around the oil tower while drilling).

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沙漠研究 5S, 279-281(1995)
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The Socio—economic Factors in Desertification and It's control

Zhang Kebin[①] Zheng Guozhong[②] Meng Xinhua

Abstract — In this paper , the author gave the global desertification servey and it's causes, then point out some socio—economic factors in desc tification and finally pio-nt out the problems that should be solved at present.

Key words: Desertification, Socio—economic factors

1. Introduction

1.1 Global desertification servey

Desertification is one of the most serious global environmental problems which mainly exists in developing regions in Asia, Africa and Latin America. According to the definition provided by UN Convention to Combat Desertification in Those Countries Experiencing Serious Drought and /or Desertification Particularly in Africa, desertifcation means land degradation in arid, semiarid and dry sub—humid areas resulting from various factors, including climatic variations and human activities. Here land degradation means reduction or loss, in arid, semi—arid and dry sub—humid areas, of the biological or economic productivity and complexity of rainfed cropland, irrigated cropland, or range, pasture, forests, and woodlands resulting from a process or combination of processes, including processes arising from human activities and habitation patterns. The world's desertified land has now reached 35.92 million square kilometers, almost equal to the area of Russia, China and United State put together. Moreover, desertification is expanding at an annual rate of 5000—7000 km^2 which is equivalent to the area of Ireland or that of Belgium plus Denmark.

Based on UNEP's date (1991), the global dry—land * area is about 5159.66 million ha. of which 3562.19 million ha. was affected by desertification(i. e. 69% of the dry —land area) in which 900 million people are living in these region, annual average economic loss is about $42.31 billion, and about 100 countries and regions are affected by desertifucation, especially Africa and Asia.

1.2 Desertification causes worldwide

Drought, over—speed increment of population and land misuses are the main causes of land desertification worldwide. Drought is one of the main causes in land desertification. It was the serions drought in Africa in 1970's that lead to UN 3337 resolution in 1975 and United Nation Conference on Desertification (UNCOD 1977) in Nairobi, Kenya. But the mankind almost could do nothing for climate, especiailly in large scale. Over—speed increment of population with undeveloped social economy is also one of the important cause in desertification, but it is a complex problem at the lower productivity level, in order to feed the increasing population, it leads to over—cultivated, over—grazing, hunting, over—cropping and deforestation, etc.

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2. The socio—economic factors in desertification

2.1 Population growth and economy development.

At present, the world population is over 5.5 billion, double that of 50 years ago. But of which developing countries increased over 1.5 time, developed countries increased only 0.6 time. Based on UN population data, during 1970—1975, there were 50 countries that his population birth rate are over 44.7% and the max. 52.2%, all of them are developing countries, of which 7 were in Asia, one in Oceania, 2 in North America and others were all in Africa. Maybe that is why Africa are the most serious desertification area in the world, let's take China as example, from 1949 to 1989. the mean population increment was 14 million every years, and as the Australia's population , and it was this year on Feb. 15 (1995), China's population reached 1.2 billion. It was a terrible data. The rapid increment of population exert greater and greater impact on land, under very undevelped economic condition, those cause serious desertification. Based on Zhu Zhenda's (1994) research, in north part of China before 1970's, the desertified land expansion 1560 km^2 every year, but since 1980's desertified land expansion are 2100 km^2 annual and annual increment rate is 1.47%, it is also a terrible data. If China's economy deveopment is in high speed, maybe we have some funds and as somebody said that for the 21 century China will be the No. 1 food imported country in the world. But if we have no money, what could happen!

2.2 Educational level

Eduational level is very important for one nation to use science and technology to develop his economy. But if the people have lower educational level and know little about advance science and technology, they can do nothing because all the advanvced science and technology need educated people to use them. For most of developing countries, most of people have little education and it's hard in those countries to popularize advanced technology, let's take China as example, the whole nation's mean education level is only about six years now, in remote rural area, about 44% local people are illiterate and semi—illiterate persons, for some reasons in rural China, young girls have little chance to go to school, for example, green house technology and plastic film cover technology have longer history in Japan, but it was recent years that these technology popularized in rural regions of China.

2.3 Law and regulation

Law and regulation are very important in desertification and environment protection. Because of historic reasons, for most of developing countries, they have no perfect law system to protect environment. Sometimes the un—rational regulations may lead to desertification. In north part pasture area of China, a large area of desertified land were because of un—rational agricultural regulation from later 1960's to early 1970's, at that time policy maker ask local people in these pasture area to cultivate land and cropping as rainfed agriculture, and those cause serious desertification in these region during that time.

3. The problem that should be solved at present

3.1 Family planning and control population

Althoughit it is hard problem for mankind, family planning and control population are very important for developing countries, maybe last year (1994) UN Conference on Population, which held in Cairo, Egypt, was important step to control population. Athough it have little progress because of the difference of religion, conviction, custom. etc. Measures in economy, law, regulation and someothers should be used in developing countries to educate high birth rate region's people to control population. Maybe foreign friend don't understand our country's family planning policy. We can tell you here, that if there no family planning during past 30 years, the total number of population in China could reach 1.3 or 1.4 billion. It means that if there have no family planning, we need 10 Australia to feed increased population at present.

3.2 Develop economy and protect environment.

For historic reasons, in some dveloping countries, they pay little attention to develop economy. fighting and disputes between nations, sometimes religions are very common in past years, all these cause poor, refugee and environment disaster, Maybe we all remember Rwanda refugee in 1994 and Gulf Fighting in 1990, they are human disasters. We should pay more and more attention in developing economies to feed our people and protect the environment.

3.3 Law and regulation making

For these countries, if they have no perfect law and regulation system to protect environment. Some law and regulation making are very important. For these countries, have laws and regulation, all the laws and regulation should be strictly adhere to.

3.4 Education

We should pay much attention on education, especially in rural regions, all measures should be adopted to let young children go to school; Only in this way maybe 30 years later our globe will be more beautiful.

3.5 International cooperation

At present the difference between South and North are becoming greater and greater. If the developed countries can do somethings, for example economy or technological assistance for developing countrics, the world should become better and better. For example, if Japan provide money for developing countries, use advanced technology to assist these countries to develop economy, the developing countries, in turn, have money to buy some good from Japan. Maybe it is one of main purpose of the conference.

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* dry—land includs arid,sub—arid and dry—subhumid area,but not including hyper—arid area such as Taklamakan in northwest of China.

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Application of Supper Absorbent Polymers ForArid-Farming in Southeast Region of Shanxi Province, China

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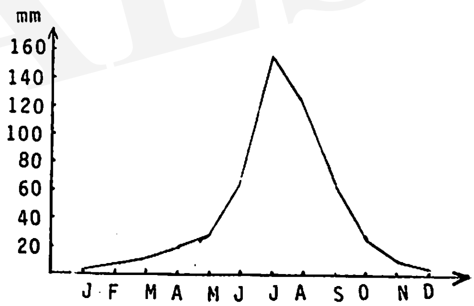
Abstract - This paper summarized the suitable cope, tech niques and effects of Supper Absorbent Polymers application. the wide-suitability on arid-farming was identified. The effects of SAP on promoting seed germination and seedling growth/develop ment, delaying the wilting stage of seedlings, increasing striking date of transplanted crop and upgrading crop yields and income were emphasized. Finally, the extension acheivements on field crops were also reported.

Key Words: Supper Absorbent Polymers, Arid Farming Region

1. Introduction

Southeast region of Shanxi Province is one of the typical semi-arid farming region in China, where the elevation is about 800-1,500 meters over the sea level. The annual temperature averaged 8.7-10.8 C, annual precipitation is about 550 mm which can meet the demands for crops on the whole. But it varies greatly from year to year, and its distribution is uneven within a year (Fig. 1), the spring drought occurs more often and autumn drought is severe. Water run-off isserious in rainy season, yearly water deficit is about 1,500 m3/ha. Upland fields occupies above 90% of the total arable land. Because of almost no water coming from out of the region and the poor underground water resources, irrigation area in this region is very limited, drought plays the main obstacle to agricultural production in this region.

Fig. 1. The average monthly rainfall of Tunliu, 1971-1985



In Shanxi Province, an experimental region of a national key project, "Studies on the kit of crop yield-increasing techniques on arid farming region (1986-1990)", was established at Tunliu County, the application of SAP (Supper Absorbent Polymers) on arid farming is one component of above mentioned project. A large number of field and lab testing were conducted with the aspect of identifying suitable scope, techniques and effects of SAP application. Research acheivements have been extended in Shanxi Province and across the country.

2. The Suitable Scope of SAP

SAP is a kind of new-developed products of chemical industry.
It has a high water-absorbing and water-holding capacity. In Tunliu Experimental Rigion, the experiments and demonstrations of suitable scope of SAP aplication were conducted in multilocation and on multiple crops. 27 kinds of crops covering grain, oil bearing and pasture crops, fruit trees, melons and vegetables were tested. The wide-suitability of SAP application on arid farming was identified on more than 60 kinds of crops in 25 provinces, municipalities and sutonomous regions in China.

3. Application Method of SAP

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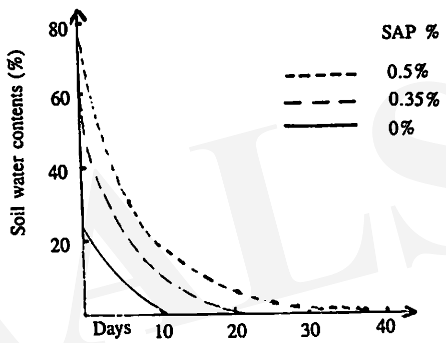
Seed coating, seed granulation, root-staining, fluid-drilling and furrow-application were adopted and tested. Results indicated the promising rate of SAP seed coating is 1-2% of seed rate for wheat, 0.5-1.0% for corn and 0.5-2.0% for millet and peanut. Seed granulation not only performed saving labour for seedling-thining, but also performed further effectiveness of fertilizing and relaxed the pollution, if it was co-applicated with fertilizer and pesticides. Fluid-drilling advenced 1-2 days of seedling emergency in general, 4-6 days of emergency of cucamber, tomato, rape, cauliflowers, furrow-application needed high application rate as high as 22.5 kg/ha, and it was recognized low economic efficiency and less adaptability.

4. Effects of SAP Application

4.1 Improving the soil water regime SAP can absorbed not only the irrigation water, but also the moisture from air. It preserve the water in the soil, release and supply water to crop roots continuously as a small reservoir when drought occurs. It plays an important role in reserving the water and preventing the drought.

The lab experimental results showed that the saturated water content of a sandy soil sample containing 0.5% SAP mounted 74%, and two weeks after, the water content decreased to 12% and all-evaporated completely at about 40 days after; On other hand, sandy soil sample without SAP content, the saturated water content was 27% only, and it evaporated completly after 12 days (Fig.2). The results of experiments with different concentration of HSR-1 showed that water contents after one month varied in same trend, the water holding capacity of soil was correlated significantly (r=0.9165**) with the content of HSR-1 in soil.

Fig. 2. Changes of soil water contents after SAP application



Sweet potato root-staining with SAP saved 60% of irrigation water, cutting striking rate reached 94%, or 26% higher than the cutting without root-staining. Fruit tree transplanted with SAP root-staining saved 30 tons/ha of irrigation water, the striking rate reach 98%. Results showed also, in rainfed condition, 15.9-18.1% were the best water contents at 0-5 cm soil layer for corn emergence as its seeds were coated with 1% SAP; 16% was suitable for emergence of soybean seeds coated with SAP, and 12% was the lowest limitation of water content for soybean and corn emergence as well.

4.2 Promoting the growth and development of crops

4.2.1 Promoting seed germination The soil water content is low during spring seeding dates in Tunliu because of the drought and windy weather, as the seeds were treated with SAP, its capacity of water-absorbing and drought tolerance were in creased, seedlings emerged earlier and emergence rate was higher than traditional practice. Results in 1987-1989 indicated that the emergence of spring grain crops was 1-3 days advanced and the emergence rates was 10-33.4% increased by SAP seed-coating (Table 1). Same effects were observed on emergence of cash crops, such as: peanut, water melon, etc.

4.2.2 Delaying the waiting stage of seedlings In experiment of Rice dry-seeded in the soil mixed with 0.1-0.8% of SAP, rice seedlings wilted after 26 days and withered out after 33 days except the seedling growing at the soil mixed with 0.8% of SAP, it still kept green.

Table 1. SAP's effects on emergence of corn

Dosages (% of seed wt.)	Days of emergence stage*				Rates of establishment (%)
	Sowing-SE	SE-E	E-FE	Sowing-FE	
0.0	14	14	--	--	43.3
0.5	10	5	15	30	73.3
1.0	10	5	6	21	76.7
2.0	14	8	--	--	53.3
3.0	12	9	--	--	60.0

* SE-start emergence, E-Emergence, FE-Full emergence

4.2.3 Promoting the growth and development of seedlings

Experiment and dmonstration of SAP application on wheat in rainfed fields were carried out 3 years (1986-1988), 165 wheat samples from 26 parcels were collected, measured and summarized. Results (Table 2) indicated that SAP-coated seeds performed promising effects on increasing stem number per meter, tiller and root number per plant and leaf-age advancement, and the increasing was further more in serious drought year (1987). Same results were observed also on corn, millet and dry-seeded rice. seed-coating advanced the peanut's flowering stage for 5-7 days, and increased fodder yield of triticale for 8.1-23.4% of the check.

Table 2. Effects of SAP seed-coating on growth of rainfed wheat plant before winter

Items		1986		1987		1988	
		SAP	CK	SAP	CK	SAP	CK
Total stems/meter		292.2	273.0	90.3	79.8	198.9	172.5
Tillers/plant		2:08	1.81	1.60	0.70	1.49	1.36
Plant height(cm)		14.4	14.1	14.3	13.0	16.0	15.4
Leaf-age		--	--	4.6	3.6	5.5	5.4
Root no./plant		1.88	1.44	3.10	1,42	1.91	1.57
Water content	at sowing	10.3%		10.9%		16.7%	
(5-10cm)	at emerg.	14.8		9.3		16.3	

4.2.4 Increasing the striking rate of transplanted crops

It is always suffered from windy and dry weather while the sweet potato cuttings were transplanted in Tunliu Site. the experimental results indicated, when the cuttings were stained with SAP, the striking rate of sweet potato cuttings mounted about 90% and more, or 10-30% higher than that of cuttings without staining. the SAP's effects on apple and grape were same as that on sweet potato. Root-staining with SAP increased the seedling survival rates of cypress, yellow locust, chinese pine and poplar after transplanting.

4.3 Increasing crop yield and income

Results of experiments and demonstrations showed, SAP application increased the yields and incomes per unit land of wheat, millet, corn, triticale and sweet potato. Taking wheat for instance, the fields per ha were 5-31% higher in general as compared with the wheat without SAP application; and it performed further high increasing, 47.7-72.6% in sloping fields at high mountains in poor soil moiture condition. The yielding components of spike mumber per meter and 1,000 grain weight were significantly improved (Table 3).

Table 3. Effects of SAP application on wheat yield/ha and yielding components (1987)

Items*		Plant height (cm)	Spike length (cm)	Grains/ spike	Spikes/ meter	1,000 grain wt.(g)	Yields kg/ha	Yields %
WAC	SAP	74.7	5.5	18.8	119.3	32.1	1,678.5	148
	ck	59.0	4.8	11.8	106.0	28.4	1,136.3	100
WAF	SAP	74.6	5.7	20.2	91.0	34.4	3,747.8	173
	ck	61.8	5.4	21.3	64.0	28.7	2,172.0	100

*WAC - wheat after corn, WAF - wheat after fallow, ck-without SAP

5. The extension of SAP application techniques

The areas of demonstration and extension of SAP application techniques accumulated 5,580 ha, and increased 5,045.6 tons of grain production according to the imcompleted statistics in Tunliu, Licheng and Lucheng counties of Shanxi Province in 1986-1989. SAP application techniques spearded 20 counties and municipalities of Shanxi and other 24 provinces across the country, it covered 33,000 ha of farmland in total in 1990.

6. Conclusion

SAP improved the soil water regime and upgrded the crop's drought tolerance, it performed siginificant effects on improving seed germination and striking rate after transplanting, and resulted yield-increasing of many field crops and fruit trees. It showed a wide adaptable prospect in arid farming in China.

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WATER RESOURCES MANAGEMENT IN ARID ZONES

Gideon ORON*

Abstract - A management model is presented for the optimal development of marginal water sources in arid zones in conjunction with minimizing the dependence on high quality water. The marginal sources include saline ground water, treated wastewater and runoff water and are required to augment a limited supply from regional high quality local sources. The objective is to minimize operational and capital costs while simultaneously allocating a conventional regional supply in a best way among a set of local sites. A novel aspect is the consideration of water quality as an additional constraint in the decision model. In this way an optimal investment strategy for marginal water sources development and use is obtained while satisfying quality requirements at the individual sites.

The model formulated takes the form of a mixed binary integer linear problem. The main purpose of the presented model is to delineate a methodology for marginal water considerations and development in arid zones. Water qualities, supply and demand for diverse uses and related costs are of primary importance. Several simplifying assumptions are made, such as aggregation on an annual basis, in order to cope with the essential features of the problem at a reasonable level of complexity. These assumptions may be relaxed at a later, more-detailed stage of analysis.

Key Words: Marginal water sources, Management modeling, Arid-zones.

1. Introduction

1.1 Marginal Water in Arid Zones Escalating demand for high quality water, linked with natural shortage and quality deterioration in arid zones, has resulted in intensive utilization of conventional sources. The gap between supply and demand can primarily be satisfied when marginal sources such as saline, waste and runoff waters, are put to use and regional considerations are taken into account. Regional water planning, development and management has therefore become an important uncertainty in arid zones with limited high quality sources. Development of the various sources must be implemented gradually by taking sequential steps, subject to factors such as stability of supply, quality of water, environmental pollution risks, future development, agricultural cultivation potential, and related economic aspects (Oron et al., 1991).

Water scarcity in arid zones can be expelled by implementing two major routes: (a)transporting water from external sources, using large conveying systems; (b)gradual development of local marginal water sources, subject to regional needs, economic and environmental considerations, and future prospects.

Water supply to the southern parts of the state of California (USA) is maintained *via* the California Aqueduct, receiving water from the Sierra mountains. Similarly, water supply to the Negev Desert region in southern part of Israel is maintained *via* the National Water Carrier (NWC). Water is pumped from the Sea of Galilee and merged with the coastal and mountain aquifers waters in the northern and central areas of the country. Blending water from various sources allows to expand available quantities for diverse usages (Vieira and Lijklema, 1989). However, several

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drought events, akin with increasing demand in all sectors of the economy have resulted in over-pumpage of water from all sources. This is exemplified by a decrease in the water tables of the coastal and mountain aquifers, as well as a decline in the levels of the Sea of Galilee and the Dead Sea downstream. In previous works (Schwarz et al., 1985; Nativ and Issar, 1988) it was concluded that current system is not capable of expanding much further to supply the expected water demands toward the end of the century, not to speak beyond the year 2000.

In order to reduce the dependence of water supply on external sources such as the NWC and alleviate the problems associated with over-pumpage, it has become necessary to develop the non-conventional and not yet fully exploited water sources existing in the Negev Desert. These marginal water sources have the following characteristics:

i) *Treated wastewater* (TWW). Treated wastewater, and primarily domestic treated sewage. can be reused for a large pattern of possibilities, primarily for agricultural irrigation (Asano et al., 1992). The major drawbacks of TWW use are the high capital investment in the treatment facilities and equipment, the dual piping system required to distribute it separately from potable water, effluent quality control and requirements. Treatment level as related to the purpose of reuse is of extra concern. The nutrients contained in the TWW are, however, beneficial for agricultural use (Oron et al., 1991).

ii) *Runoff water* (ROW). Runoff water is generated during sparse rainfalls events in the wet (winter) season. Due to low soil surface permeability the flood water can be diverted to special facilities and stored for future needs. Relatively high capital investments are required for the collection, storage and distribution of the water to the consumption sites. The stochastic nature of runoff water supply raises additional reliability difficulties to use this water efficiently. Although the low stability, the high-quality of the water, and the potential to retain large volumes are advantageous in regions with scarce conventional waters.

iii) *Saline ground water* (SGW). Saline water can be found in deep aquifers (approximately 1000 m) throughout the Negev and Sinai Deserts (Issar and Adar, 1992). The high variable expenses for pumpage and the lower quality of the water generate extra difficulties. The main advantage stems from the huge available volumes stored in the Negev Desert (billions of cubic meters) and the possibility of utilizing the water for further desalination for a broad pattern of purposes. Advanced application techniques are frequently implemented to use the SGW for irrigation.

2. The Purpose of The Work

A management model was developed for optimal water sources development in arid zones. The aim is to use gradual educated development phases for implementation of the non-conventional sources (Yeh, 1985). The implementation is simultaneously subject to a series of technological and environmental constraints and financial considerations. The objective of the model is to determine the optimal distribution in time and location of the marginal water sources as related to alternative water supply from external sources, such as the NWC.

3. A Model for Regional Water Development

3.1 General Structure of the Model In regional planning local and overall aspects ought to be integrated in order to obtain an optimal distribution of the limited water supply from external sources (the NWC), while simultaneously choosing the best local marginal sources to develop in order to make up the deficit. Actually, the purpose is to determine, with minimal expenses, the two main decision variables. In the model, these are denoted by q_{ij}, representing actual supply (m^3/year) to demand site i from source j, and by y_{ij}, which is a boolean variable to flag new capacity at site i from marginal source j ($y_{ij} = 1$, if new capacity is added, $y_{ij} = 0$ otherwise). The model is based on a mixed integer linear mode. Although most akin processes are nonlinear, it is anticipated that a mixed integer linear model will yield reasonable results and extra directions for further water resources development. Some simplifying assumptions regarding the water status in the system entitle as concise mathematical formulation of the problem.

3.2 Model Formulation The regional multi-quality water supply system is described by an objective (cost) function to be minimized. Capital investments at the sites are discounted assuming perpetual life for the new assets.

$$\text{Minimize} \quad Z = \sum_{i,j} c_{ij}\, q_{ij} + \tau \sum_{i,j\neq 1} b_{ij}\, y_{ij}, \qquad (1)$$

where c_{ij} is the variable cost coefficient (\$/m^3) for satisfying the demand at site i from source j, q_{ij} is the unknown supply (m^3/year) to demand site i from source j, τ is the applicable rate of interest for discounting purposes, b_{ij} is the capital investment (\$) at demand site i for new capacity from marginal source j and y_{ij} is an directive variable ($y_{ij}=1$, if a new capacity is added, and $y_{ij}=0$ otherwise).

The objective function to be minimized is subject to a series of constraints::

(i) Regional constraint (maximal allowed supply from an external source, the NWC):

$$\sum_i q_{ij} \le S \qquad (2)$$

(ii) Local constraints:

$$\sum_j q_{ij} \le d_i, \quad \forall i \qquad \text{(demand)} \qquad (3)$$

$$\sum_j \rho_{ij} q_{ij} \le \gamma_i d_i, \quad \forall i \qquad \text{(quality)} \qquad (4)$$

$$q_{ij} - M y_{ij} \le s_{ij}, \quad \forall i, j \neq 1 \qquad \text{(fixed cost)} \qquad (5)$$

$$q_{ij} \le s_{ij} + v_{ij}, \quad \forall i, j \neq 1 \qquad \text{(capacity)} \qquad (6)$$

(iii) Non-negativity and integrally constraints:

$$q_{ij} \ge 0,\ y_{ij} = 0,1, \quad \forall i, j \qquad (7)$$

where $i = 1,\ldots,N_d$, and N_d is the number of water consumption sites in the system (i≠j). Here S denotes the maximum total volume (m^3/year) supplied to the region by the NWC, is the total annual demand (m^3/year) at site i, γ_i is the mean quality [measured in units of electrical conductivity (EC), dS/m] required at site i, ρ_{ij} is the quality (EC) of the water at demand site i supplied from source j, M is a very large number, s_{ij} is the existing capacity (m^3/year) at site i from marginal source j (j=2,3,4), v_{ij} is the new capacity (m^3/year) added at site i from marginal source j (j=2,3,4).

Subject to the model structure, the fixed cost constraint ensures a capital investment b_{ij} is incurred in the objective function whenever the supply at site i from marginal source j exceeds its current capacity. The value assigned to M must be sufficiently large so that,

$$M \ge \max_{i,j} \{v_{ij}\}, \quad \forall i, j \neq 1 \qquad (8)$$

The capacity constraints at site i ensure that the total annual capacities of the marginal sources here are not exceeded. However, the on-site storage and handling facilities may be adequate if seasonal use of these capacities is uneven, resulting in an infeasible solution. This typically is not a problem and in any case, can be remedied by replacing annual constraints by seasonal ones.

4. Preliminary Results

The most consequential outcome obtained from the case study for the Negev Desert with six potential development sites is the feasibility and economic viability of SGW over a wide range of energy prices and required quality levels (Fig. 1). Based on the findings of the case study, it can be concluded that utilization of SGW in a dry region such as the Negev Desert should be increased enormously, through immediate investments in new capacities. Based on current prices, consuming water from the NWC or TWW is also an economical option. Even without restrictions on external water supply such as : the NWC, development of large regional treatment plants, operated at relatively augmented capacities adjacent to urban areas (e.g., an approximate capacity of $6.6x10^6$ m^3/year close to the city of Beer-Sheva, Israel) is recommended.

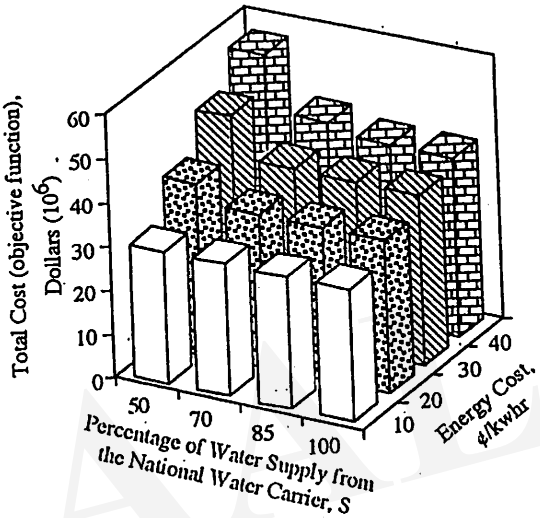

Fig. 1. Effect of water supply from the national carrier, quality (σ factor) and energy cost on optimal cost (objective function)

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Feasibility Study And Technological Requirements For Development Of Arid And Semi-Arid Lands In Australia

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Abstract - Development of arid lands requires careful consideration of terrain characteristics, natural habitat and socio-economic conditions of the given region. The present paper is based on our investigations in Australia. In this study we have proposed a Development Feasability Zonation Scheme (DFZS) using annual precipitation, landuse map and vegetation production for classfying areas according to their relative feasibility for future development. Further, we have discussed the technological requirements for effective management and utilization of water resources with particular reference to problems of salinization, conservation of soil quality and re-vegetation.

Keywords: Arid land, Development Feasability Zonation Scheme, Appropriate Technology, Australia.

1. Introduction

In formulating development strategy for arid and semi-arid lands, it is essential to evolve a suitable classification scheme using the terrain characteristics and categorize areas according to their relative feasibility for development. In this study we have used the annual precipitation, landuse information and vegetation production as individual parameters and developed a DFZS. The DFZS is used to categorize the Australian arid land into five zones based on their relative feasibility for sustainable development. In addition, we have discussed about the appropriate technological requirements that can be used in the different development feasibility zones in Australia.

2. Development Feasibility Zonation Scheme For Arid and Semi-Arid Land

This section describes the details of the DFZS. The Australian region was categorized into three zones based on the annual precipitation data (Abe and Kano, 1994). Each zone was assigned a score as shown in Table 1. Further, the landuse information (Takenaka and Uchijima, 1993) were classified into three classes and each class was assigned respective scores (Table 1). Finally, the vegetation production map derived from NOAA imagery (USACERL, 1992) was categorized into 3 units and each type was assigned their respective scale (Table 1). The weighted scores shown in Table 1 were arbitrarily determined and each map layer was assumed to be of equal importance. It is observed that the arid or semi region do not contain any area with vegetation production scores of 2.

In order to prepare the DFZS, the weights assigned to different classes of the three primary map layers mentioned were added to obtain the *feasibility scores*. The *feasibility score* map was reclassified

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Table 1: Feasibility evaluation for development & classification of arid & semi-arid lands.

Average Annual Precipitation	Landuse	Vegetation Production	Feasibility Score & Type
500~400 mm (2)	Stock farming & crop cultivation. (2)	Medium (1)	(5) A
	Stock farming. (1)	Low (0)	(3) C
	Unused. (0)	Low (0)	(2) D
400~200 mm (1)	Stock farming & crop cultivation. (2)	Medium (1)	(4) B
	Stock farming. (1)	Low (0)	(2) D
	Unused. (0)	Low (0)	(1) E
Less than 200 mm (0)	Stock farming. (1)	Low (0)	(1) E
	Unused (0)	Low (0)	(0) E

Numbers in bracket ( ) represent weighted scores

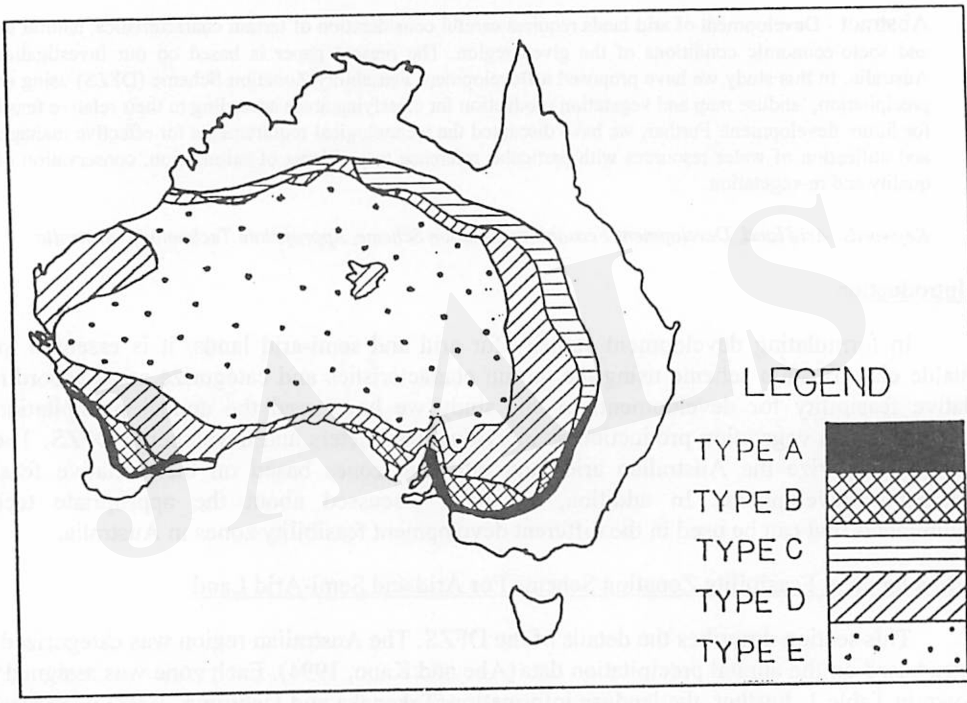

Figure 1. Development Feasibility Zonation map of Australia.

into five categories (A-E). The types A corresponds to areas with scores greater than 4 and represent areas that have high developmental feasibility. On the other hand, type E represents the lowest scores (less than 2) and corresponds to areas of very low developmental feasibility. The weights assigned to different classes of the map layers and corresponding feasibility scores are shown in Table 1. The Development Feasibility Zonation map is shown in Figure 1. In the feasibility type A and B , semi-arid land type of agricultural activity is presently being carried out. It is suggested that in types A-B preventing desertification must be the most important and immediate concern. In type C, although vegetative production is low, there would be some possibility of increasing production depending on precipitation and prudent water management. Type D, which is widely distributed, suffers from severe environmental stress and in these areas technological considerations for upgrading land suitability is the most serious concern. On the other hand, in type E which covers most part of Australia, development feasibility is quite low. Based on technological and logistical considerations, it is suggested that development of type D which surrounds type E should receive preference in future development planning.

3. Technological Requirements for Development

In considering the development of arid lands in Australia, it is firstly necessary to determine the kind of enterprise that need to be introduced or activated in these regions. Field investigations in a type D area in western Australia was investigated in order to access the technological requirements for stimulating agricultural activity and increase vegetation production. The field survey was carried out around Kalgoorlie and Merredin in Western Australia.

Kalgoorlie is a major gold mining city where stock farming is another major activity. Cereal and grain production is a major agricultural activity in Merredin. These areas depend on low annual precipitation and fresh water routed through a pipeline from the suburbs of Perth City. The conditions for developmental activities are quite severe. Technological requirements in this region relate to efficient stocking of water resources and its effective utilization, methods for mitigating the salinization problem, soil preservation and revegetation. These problems are discussed below.

3.1 Stocking water resources and its effective utilization

Available water resource in this area depends on the amount that is physically transportable through the pipeline and the total volume available at source. In order to stimulate developmental activity it is urgently required that new water sources are explored and effectively exploited. Groundwater is difficult to use due to its high salt content. In the stock farm, water harvesting and storage system are being developed in order to use rain water efficiently (Addison *et al.*, 1994). In the case water harvesting, efforts need to be focused on developing technology for maximizing the input the meager annual precipitation into the stock pond. Water loss for evaporation, percolation and surface run-off causes not only the loss of water resources but also has adverse effect on the soil. Techniques for preventing water percolation by spreading a vinyl sheet to cover the bottom of the intake ditch during rainy season can also be considered. The problem of storage systems is minimizing evaporation loss. Construction of water tanks with smaller surface area is being considered to reduce evaporation loss. In addition, use of evaporation preventing agents such thin film coating over water surfaces needs to be urgently investigated. Underground storage is another promising area that needs to be studied. Drain water or sewage can be a major source of water supply. Especially, drain water from domestic source contain few toxic elements and low density of salt, and it is quite possible to recycle it by sewage treatment. In Kalgoorlie, a recycling system has been executed wherein treated water is sprinkled to lawns in the city. However, this system uses an *Oxidation Pond Process* and evaporation loss is quite high. The use of *Activated Sludge Process* will help prevent vapor loss since treatment time is very short. In this regard, *Oxidation Ditch Process* using surface cover or underground method is especially very effective. The purification process for water treatment needs to be carefully considered depending on the ultimate use of the recycled water.

3.2 Treatment for salinization and soil preservation

Developmental activities in these area are hindered by salinization caused by water logging. Lack of proper drainage causes water logging and salinization of soil. This problem is mainly induced by indiscriminate land development and other human activities. Long term solutions for lowering the water table include revegetaion using deep rooted plants. However, some short term solutions such as improving surface drainage etc. need to be considered in order to lower the water table. Due to the almost flat topography of the region, the drain ditches have no slope. Therefore, techniques for lowering water table using renewable or non-renewable energy source need to be carefully considered. Another area of research would be to finds ways to exploit the high evaporation rate in arid lands and device techniques to reconvert water from its vapor form.

With regards to the problem of soil preservation, erosion control requires foremost priority. Erosion by surface run-off need to be considered together with water harvesting. Prevention of wind erosion can also be considered as a part of the problem concerning revegetation.

3.3. Rapid revegetation of plants

It is required to restore vegetation rapidly in order to stimulate agricultural development. Revegetation technology must be considered together with storage of water and soil preservation. Revegetation is the most effective way for erosion control and the appropriate choice of plant species may also help in lowering the water table and prevent water-logging. In deciding the species suited for revegetation, it is necessary to chose plants that are well adapted to dry and saline conditions. Plantation must proceed before the rainy season and adequate steps must be taken to improve water retention capacity of soil and allow germination. The technology for introducing grassy sod because it is highly tolerant to salt and also helps in retaining water in the soil. Improving soil characteristics by using high polymer absorbents is also effective but involves high cost. Research on revegetation technology is being actively carried out in the gold mining city of Kalgoorlie. Technology developed in this region can be applied to other areas in order to stimulate agriculture development.

4. Conclusions

In considering the feasibility of arid land development, we need to have a clear understanding of the regional characteristics and socio-economic. In this paper we have presented an example of arid land development in Australia. Further, using the annual precipitation, landuse and vegetation production as the basic data, we have applied the DFZS to the region. The area was classified in to 5 zones based on the relative feasibility for development and examined the technological requirements. The results obtained in the present study can be considered as a generalized approach for a broad based zonation. Detailed studies on development feasibility for each zone needs to be taken up. Future investigations need to include data from other sources and detailed statistical analysis to determine their relative importance. We consider that the basic technique discussed in this paper would be useful for planning land development.

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Behavior of Water and Salt in Beds with and without SAP

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Abstract – Understanding the behavior of water and salt is important to the prevention of desertification. Water and salt content profiles in soil were experimentally measured in a one-dimensional apparatus filled with glass beads or standard sand with and without SAP (super absorbent polymer) under controlled temperature and humidity conditions. Differences in water and salt content profiles were also found between standard sand and glass beads with similar particle size distributions, suggesting that the difference was caused by the difference in particle shape. The beds with SAP restrained salt accumulation on its surface when water evaporation was promoted by infrared lamps. In conclusion, SAP prevents water and salt from moving in the bed, leading to a reduction in evaporation and salt accumulation.
Key words : super absorbent polymer, salt, evaporation, accumulation

1. Introduction

Desertified areas are now expanding and this issue is one of the most important global environmental problems. It is caused not only by the climate change, but also by artificial destruction of the ecosystem such as overgrazing, inadequate cultivation, deforestation and inappropriate irrigation. Inappropriate irrigation may often cause salinization at the soil surface through salt accumulation resulting from the mixing of the surface irrigation water with underground salt water. This effect is also caused by deforestation. Furthermore, excessive irrigation also enhances the accumulation if salt is present in the irrigation water used (Matumoto, 1988). Thus farmland induced by deforestation is easily turned to desert (Abe et al., 1994). Countermeasures against salinization have been proposed and carried out, such as leaching and drip irrigation. But there have been few studies which estimate and describe quantitatively water and salt movement in the soil, especially in soils containing the SAP (super absorbent polymer) which has recently been employed for agriculture in dry areas. In irrigated agriculture SAP has been found to increase the harvest sizes (Toyama, 1990). It is necessary to understand the true mechanism in order to propose the most suitable irrigation and leaching methods.

In this paper, the distribution of water in a one-dimensional apparatus filled with glass beads was studied to predict the behavior of water and salt in soil or sand under dry conditions. The effects of SAP on water and salt movement in sand were experimentally investigated under the initial conditions that the bed was filled with (salt) water simulating to the conditions after the rain season. In addition, we compared the behaviors in the sand and the glass bead beds.

2. Experimental

The one-dimensional apparatus used in this study is shown in Fig.1. The experiments were conducted under a constant temperature of 25 °C and a relative humidity of 25 % or 50 %. It was made of eight or fifteen separable 3 cm high acrylic resin tubes filled with spherical glass beads (about 0.4 or 0.2 mm average diameter) or sand (Toyoura standard sand, 0.25 mm average

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diameter) with or without 0.1 wt% SAP (20–145 mesh: 95 %, AP–100 from The Nippon Synthetic Chemical Industry Co., Ltd, Osaka. Japan). SAP can absorb pure water up to 300–500 times its own weight, but the absorptive power is inhibted by salt water. Glass beads of similar particle size distribution as the sand were also employed. The total height of the bed was 270 or 480 mm. To simulate seasonal rain or irrigation, the entire apparatus was initially dipped into water or salt water (0.5wt% NaCl) for twelve hours. After lifting the apparatus up, it was put on a tray filled with water or salt water (0.5wt% NaCl) to a depth of up to 10 mm. Water movement was estimated by the change in local water content in each layer of the bed, which was sampled after 2, 14, and 25 days. The local water content was determined by sample weight loss after drying. Then a known amount of water was added to the dried samples. The local salt content was determined from the electrical conductivity of its filtrate. In some runs, the bed surface was irradiated by infrared radiation lamps. When the bed was irradiated, the temperature of bed surface was kept at about 60 °C.

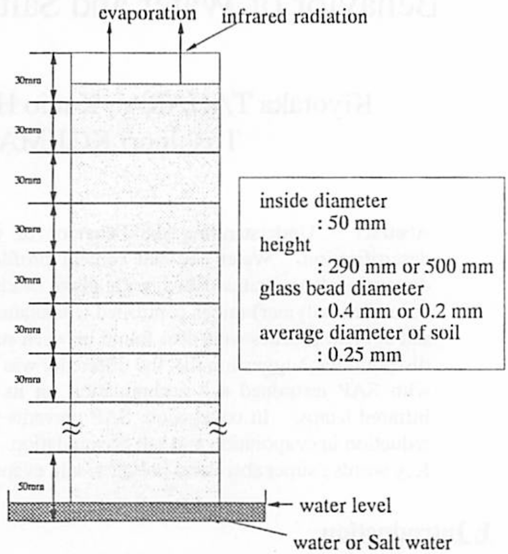

Fig.1 Outline of apparatus

As expected, the SAP swelled due to the absorption of water and consequently clogged the gaps between the glass beads. The effect of swelling on the water permeability through the bed of glass beads was also studied at the appropriate pressure differences.

3. Results and Discussion

3.1 Water content profiles Typical water content profiles are shown in Fig. 2–4. Water content was defined as follows:

$$\text{water content} = \text{volume of (salt) water} / \text{volume of solid} \quad [\text{cm}^3/\text{cm}^3]$$

The bed heights were measured from bottom of apparatus. The water level of the apparatus was 10 mm. Figures 2 and 3 show that the column containing 0.4 mm beads was almost completely filled with water in the lower 150 mm of the bed due to capillary forces (saturated capillary zone).

3.1.1 Fresh water experiments (Figure 2) The water content in the glass beads bed with SAP within the saturated capillary zone was larger than that without SAP. This result is explained by the porosity increase caused by the expansion of SAP. The water content in the glass bead bed with SAP at bed heights above the saturated capillary zone was also higher than that without SAP, because the SAP the swelled near the surface of the bed could easily expand.

Water content profiles of beds without SAP attained steady state within 2 days, while those with SAP did not reach steady state even after 25 days. This may be explained by water release by SAP as time elapsed.

Under irradiation conditions, the water content profiles were compared in beds with and without SAP. Drying of the bed surface was promoted by an infrared radiation lamp. The water content profile reached steady state after about 10 days even without SAP. The bed without SAP was easily dried to depths far below the surface because water movement was more facile than in beds with SAP.

<u>3.1.2 Comparison between standard sand and glass beads experiments (Figure 4)</u> Differences in water content profiles were found between standard sand and glass beads of comparable particle size distribution. This result suggests that the difference was caused by the difference in shape of particles since the theoretical maximum water content as calculated by $\varepsilon / (1-\varepsilon)$ was observed at the capillary zone of the bed. It was found that behavior of water in sand and glass bead beds was essentially the same.

<u>3.1.3 Salt water experiments (Figure 3)</u> Under the salt water conditions with radiation without SAP, the water content profile was almost same as that under fresh water conditions. The salt water content in beds with SAP was slightly larger than those without SAP. The effect of SAP under salt water conditions was not as remarkable as in the fresh water experiments. This may be due to a decrease in absorption potential of SAP caused by the presence of salt. The present result strongly suggests that SAP obstructed water movement even in salt water conditions.

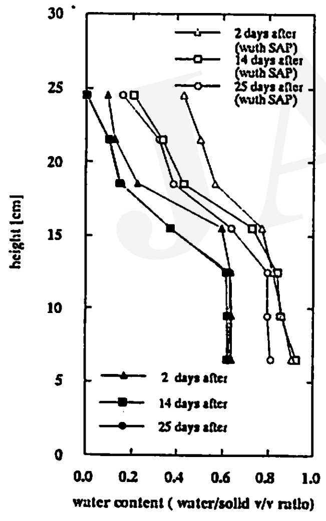

Fig.2 Profile of water content (with infrared lamp, water)

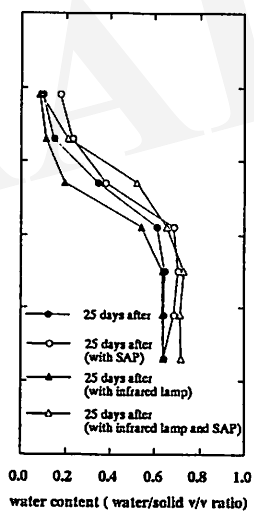

Fig.3 Profile of salt water content (with/without infrared lamp/SAP)

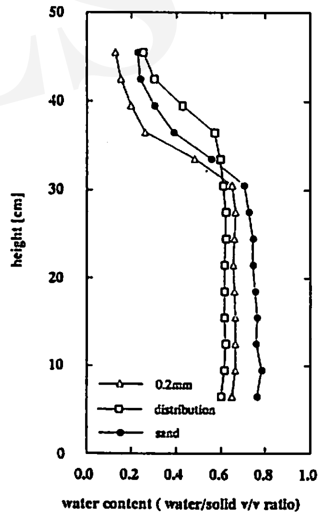

Fig.4 Profile of water content (sand and glass beads of similar part. size distribution)

<u>3.2 Salt content profiles</u> Profiles of salt content are shown in Figs.5 and 6. Salt content was calculated as:

salt content = volume of salt water equivalent to salt in sample / volume of solid [cm^3/cm^3]

Even in experiments without infrared radiation lamps, salt accumulation near the bed surface was observed in experiments without SAP, while slight accumulation was observed in runs with SAP. Salt content profiles except near the surface were almost same as the fresh water content profiles, indicating that no concentration occurred (Figure 5).

Under irradiation conditions, strong salt accumulation was confirmed near the bed surface in beds without SAP. Salt accumulation was also found near the surface in beds containing SAP, but not the same extent. It is clearly evident that SAP prevented surface salt accumulation by obstructing water movement (Figure 6).

In some salt accumulation experiments, the apparatus was initially dipped into fresh water before being dipped in salt water. Under these conditions for the case without SAP, the salt content after 25 days fell to values between those after 14 and 25 days in the conventional salt water experiments. On the other hand, no accumulation was found with SAP. This result indicates the strong obstructive effect of SAP swelled with fresh water on salt water movement.

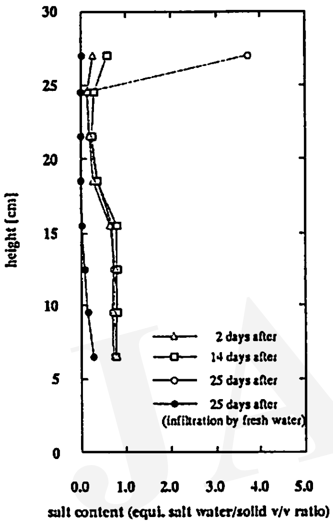

Fig.5 Profile of salt content
(without infrared lamp, with SAP)

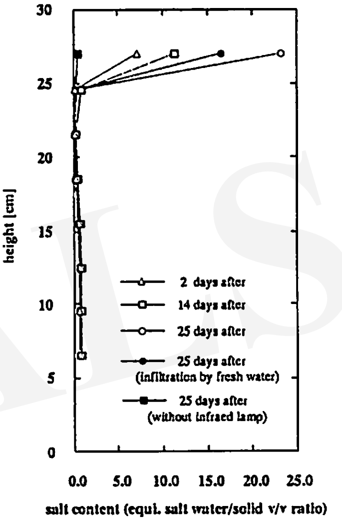

Fig.6 Profile of salt content
(with/without infrared lamp, without SAP)

4. Conclusion

The water content of the glass bead bed with SAP was larger than that without SAP. Differences in water and salt content profiles were also found between standard sand and glass beads of similar particle size distribution, suggesting that the difference was caused by the difference in particle shape. Salt accumulation was also found at the bed surface in beds with SAP, however not to same extent as those without SAP. It was clearly shown that SAP prevented salt accumulation at the bed surface by obstructing water movement. When the bed with SAP was dipped into fresh water prior to exposure to salt water, a remarkable obstruction of salt water movement was observed due to SAP swelled with fresh water.

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Study on the Capture Method of Salt Accumulated on the Soil Surface Using the Sheet and Stick Materials.
– Some Baisic Experiments in the Soiltron –

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Yoshiyuki OHTSUKA** and Hiroyuki II**

Abstract–A new method of capturing accumulated salt from the soil surface has been developed. Salt–capturing–devices, composed of layered gauzes, a vinyl sheet and/or towel wrapped sticks, are placed on or inserted into soil surface and functioned to collect salt during the drying process. This paper reports the basic characteristics for evaporation and solute transport displayed by the salt–capturing–devices in soiltron experiments.

Key Words: Salt accumulation, Evaporation, Salt–capturing–device

1. Introduction

Soil and water salinity decreases the availability of soil water and retards germination, growth and yields of crops (Tanji,1990). Indeed, salt accumulation in soils is one of the most serious problems facing agricultural production in arid and semi–arid regions of the world. As a countermeasure to such salinization in soil, we have developed and examined a new method of capturing salt which was accumulated on the soil surface, by using "salt–capturing–devices" placed on or inserted into the soil surface (Abe et al.,1992 and Ii et al.,1993). The capture–devices are composed of multiple layerd medical gauzes, a vinyl sheet, and/or a towel wrapped sticks. Some basic experiments were performed in an experimental glasshouse, soiltron. This paper discusses the characteristics of evaporation, salt solute tranport, and the amount of salts captured by the devices.

2. Materials and Methods

<u>2.1 Soil</u> A sandy soil was used for the experiments. The particle density of the sand was 2.690g/cm ^{3}. The initial salt content in the sand was negligible. Wagner pots (1/2000a and diameter of 25 cm) were filled to the depth of 24 cm with the sand, as the bulk density needed to be adjusted to about 1.70 g/cm ^{3}. Then a measured amount of salt (NaCl) solution, 0.5 % in solute concentration was added to the sand in each pot.

<u>2.2 Salt–capturing–devices</u> Immediately after preparing the soil and solution in the pots, three kind of the salt–capturing–devices, as shown in Fig.1, were placed on or inserted into the soil surface. The first one was composed of five–layered gauzes on the soil surface (denoted type–G), the second one was made of only a rolled towel stick (denoted type–S), and the last one being composed of two layerd gauzes with a vinyl sheet around them and with a towel stick (denoted type–GVS). The towel stick had a diameter of 3.8 cm and a length of 35 cm, half of which was set above the soil surface and the other half was inserted into the ground.

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In addition to the above settings, the reference pots having a bare soil surface were included in the experiments. Six pots were prepared in each experimental lot. These pots are shown in Fig.1.

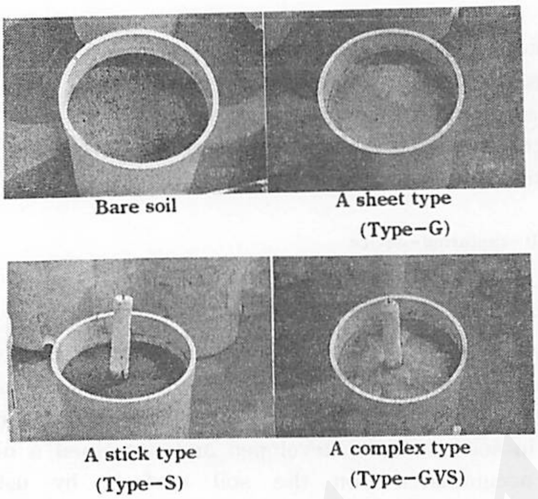

Fig.1 Experimental salt−capturing−devices set on the soil in the pots.

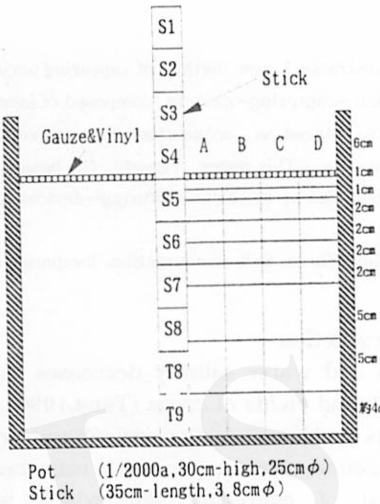

Fig.2 Sampling divisions in the soil and devices.

<u>2.3 Apparatus</u> A soiltron, a controlled glasshouse used for soil environmental research on a farm in the University of Tsukuba, was used to hold the pots. The atmospheric environment within the soiltron could be conditioned with an air−conditioner, but during the experimental period, the soiltron was being naturally ventilated by opening the top and side windows.

<u>2.4 Measurement</u> After setting the salt−capture−devices to the pots, the evaporation started on August 23rd, 1994 and continued until October 30th, 1994. A pyranometer was used to measure the total intensity of solar radiation inside the soiltron. Thermo−couple thermometers were set to measure the ambient dry−bulb temperature outside and inside the soiltron as well as the soil temperature. A high polymer film hygrometer was used to measure the relative humidity inside the soiltron. All signals concerning the environmental factors were taken every10 min. and recorded on static memory in the datalogger.

The soil from points at depths and radius as shown in Fig.2 was sampled to measure water content and salt content at the six drying−levels during the experimental period. The water content was measured with the 105 ℃, 24hr. oven dry method. A diluted solution of the sampled soil was prepared by adding pure water and stirred for an hour with an oscilator, and then the ionic concentration of chlorine (Cl^-), representing the salt content, was measured using ion chromatography.

3. Results and Discussions

<u>3.1 Environmental conditions</u> During the experimental period, the maximal and minimal dry−bulb temperature outside and inside the soiltron were 35.9 and 8.4 ℃ , and 61.4 and 12.4 ℃ , respectively. The relative humuidity in the soiltron changed within a range between 15.7 to 93.9 %. The humidity ratios (absolute humidity) were calculated from psychrometric relationships. These ranged from 0.005 to 0.0401 kg/kg' during the period. As known, the daily changes of the humidity ratio were not so much.

<u>3.2 Evaporation</u> The relationships between the cumulative solar radiation flux and the cumulative amounts of evaporation were shown in Fig.3. If there was a sufficient water in the soil, the evaporation from the soil could increase with the cumulative solar radiation especially in bare soil as shown by Hara et al.(1993). However,the rates of evaporation were decreased at the later period of drying, because the amount of water in the pots was limited and was not irrigated during the period.

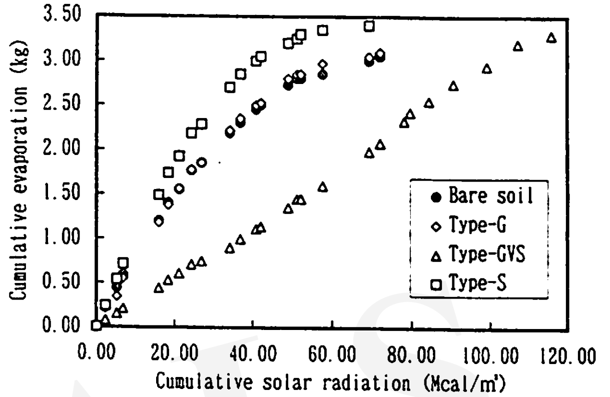

Fig.3 Changes of cumulative evaporation with the cumulative solar radiation.

The stick type had the greatest amount of evaporation because of the largest evaporating surface area which was composed of both bare soil and a towel stick. But the evapoation from only a stick surface used to capture salt was found to be as little as 13% compared to bare soil when the cumulative radiation was about 70 Mcal/ ㎡ . The cumulative evaporation for type−GVS increased at a nearly constan rate with the cumulative solar radiation.

<u>3.3 Captured Salt on the Devices</u>

Salt accumulates near the soil surface with evaporation of water at the soil surface. If the capture−device is placed on the soil surface, some of the salt accumulated on the surface then transports to the capture−device. In Fig.4, changes in the amount of salt captured by the devices are shown with increaing cumulative solar radiation.

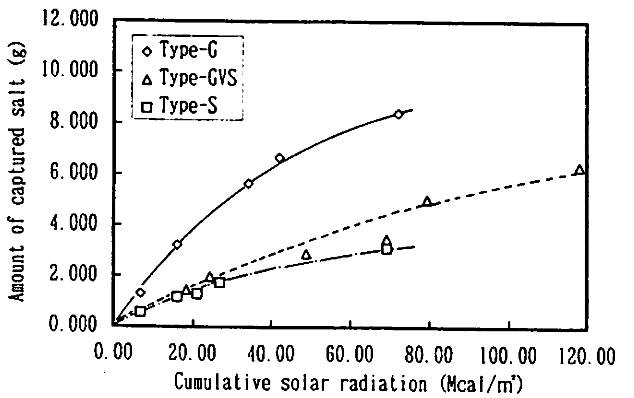

Fig.4 Amount of captured salt on the devices with the cumulative solar radiation.

Fig.5 also shows the ratio of the amount of captured salt to the total dissolved salt in the soil. The Rate of evaporation in Fig.5 is defined as the ratio of the amount of evaporated water to the innitial amount of water in the soil. At the last stage of drying, the type−G device, being composed of five gauzes, could capture the most amount of salt, about 8 g which is approximately eqivalent to 80% of the dissolved salts in the initial solution of soil. This is because the type−G has larger efective areas for evaporation and collecting salt. The type−S device has the largest total area for evaporation. But the the surface of the stick only is not effective to capture the salt, therefore, the amount of captured salt is only about 3g. The amount of salt captured on the type−GVS is increasing at a nearly constant rate as the same in the case of the evaporation.

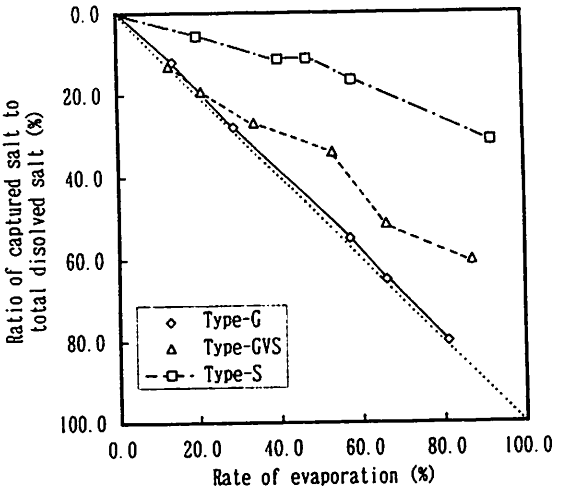

Fig.5 Changes of the ratio of captured salt to the total disolved salt in soil with increaing evaporation.

4. Conclusion

Basic characteristics for evaporation and the amount of salts collected on the developed "salt−capturing−devices" were discussed. Using the definition for the caputuring effectiveness, as the ratio of the captured salt to the amount of salt transported to the soil surface during evaporation, the averaged effectivness of three kind of capture−devices are 95% for the type−G, 80% for the type−GVS, and 30% for the type−S, respectively.

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Structural Peculiarity of the Ephemers Leaf Organs from Kyzylkum Desert.

Gulnora BEGBAEVA*

Abstract - The structure of leaf organs in 30 species from 24 genus and 7 families the South-west Kyzylkum desert area were studied. Mesophyll of cotyledon is dorsiventral, leaf - dorsiventral, isolateral-palisade and central, i.e. xeromorphic features become stronger in ontogenesis. In consequence of xeromorphic and mesomorphic features combination in the leaf structure, the ephemers are related to ecological group of mesoxerophytes by us.

Key Words : cotyledons, leaves, structure, adaptation

1. Introduction.

The adaptive evolution in the arid climate condition occurs in 2 direction: in structural specialization and in specialization of the rhithmogenesis (Krylova, Beljanina, 1988). Adaptation of ephemers occurs on the way of intensive use of short favourable time in sufficient moisture conditions. As a result of this fact some authors include ephemers to mesophytes (Morozova, 1941). Another investigators consider them as the original xerophytes "running away from drought" (Shtoker, 1928; Markova, 1966). The places of their habitat are various: from deserts to middle zone of mountains.

The cotyledons .and leaves are the most sensetive organs to condition of environment. The study of their structure in ontogenesis defines the plant strategy of adaptation, i.e. the ways of their adaptation during the transition from cotyledons to leaves.

There are few data about leaf structure of ephemers growing in Karakum, foothills of West Tien Shan and Kopet-Dag (Nechaeva & others, 1973; Ubajdullaev, 1959; Volkova, 1960).

Our investigations were carried out on 30 species of 24 genus from 7 families (Ranunculaceae, Chenopodiaceae, Brassicaceae, Umbelliferae, Plantaginaceae, Asteraceae, Valerianaceae) to reveal the ways of ephemers structure adaptation and determination of their ecological types. The ephemers leaf organs structure was compared with the structure of xerophytes from Kyzylkum (Butnik & others, 1991) and mesophytes from other habitats (Baranov, 1925; Vasiljev, 1988).

2. The leaf organs structure

The following features dominate: the amphystomatic cotyledons and leaves, monostichous epidermis with the tortuous walls, the unsubmersed stomata of anomocytic and the anisocytic types, the dorsiventral type of mesophyll (cotyledons) and isolateral- palisade (leaves).

2.1 Cotyledons They are very small, 3-9 mm length, 1-4 mm width, different shape: from oblong-spatulate (Brassicaceae) to thready (Cuminum setifolium). The pubescence is absent, the stellate or grandular trichomes (g.Alyssum) in single or moderate quantity are present, (Fig. 1 a, b). The epidermal cells with tortuous walls are predominant, A.desertorum has the straight-lined ones (Fig. 2 a, b). The stomata number is rather great (130-200 per sq. mm), sometimes it comes to 285 on the lower side of A.marginatum but A.desertorum has it only 80 per sq. mm.

Dorsiventral mesophyll (typical for mesophytes) consists of 1-5 the palisade and 3-10 the spongy parenchyma layers (Fig. 3 a). But the isolateral-palisade and the kranz types are typical for xerophytes. The mesophyll thickness is within 200-300 mkm, sometimes - above 365 mkm. The palisade coefficient (the palisade tissue to the thickness of mesophyll in per cent) is mainly below 50 %. The palisade index (the correlation between height & width of palisade cells) varies from 1.7 (A.marginatum) to 3.1 (A.dasycarpum, Isatis minima).

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2.2 Leaves Microphyllia is being in xerophytes, peculiar for ephemers too. The leaf size is within 6-80 mm length, 2-20 mm width. Laminate leaves are predominated but there are cylindrical ones (Ceratocephala falcata, Leptaleum filifolium, Cyminum setifolium, Microcephala lamellata, Koelpinia turanica). Trichomes are simple, branchy, stellate (Fig. 1 a,c,d). The present species on pubescence degree are divided into unpubescent or thin-pubescent (g.Isatis, Tauscheria lasiocarpa, Goldbachia laevigata, Valerianella dufresnia, Senecio subdentatus), mid-pubescent, 3-10 per sq. mm (g.Alyssum, g.Strigozella) and strong-pubescent, above 10 per sq. mm (Lachnoloma lehmannii, Londesia eriantha).

Epidermis with tortuous and wavy walls is prevailed and only L.eriantha has straight-lined ones (Fig. 2 c, d). Stomata being mainly in moderate number, from 70 (Senecio subdentatus, Epilasia hemilasia) to 290 per sq. mm (Goldbachia laevigata).

All presented species are divided into isolateral-palisade (53 %), dorsiventral (40 %) and kranz (7 %) mesophyll types (Fig. 3 b-d). Xerophytes have specialized kranz mesophyll type and it's palisade coefficient is above 50 %. This per cent is typical for ephemers too exept G.laevigata, Isatis violascens, g.Strigozella, Senecio subdentatus but it grows to 75-78 % in some species (g.Alyssum). The palisade index varies from 2.6 (A.dasycarpum) up to 4 (Isatis minima), i.e. generally it is higher in leaves than in cotyledons as the palisade coefficient.

2.3 Structural analysis Xeromorphic features are found to increase in ontogenesis of South-west Kyzylkum ephemers which appears in transition of mesophyll type from dorsiventral cotyledons to isolateral-palisade and specialized leaves. The formation of palisade tissue in the cotyledons, probably, connects with geliofactor because their life-cycle relates moist period and high insolation.

Thus the general features of ephemer and mesophyte leaf organs are tortuous walls of epidermis cells, unsubmersed stomata and some species are naked. However mesophyte leaves are usually gipostomatic or stomata dominate on the lower surface of epidermis. But ephemers have amphystomatic leaf organs, the number of stomata can be more both on the upper and lower sides.

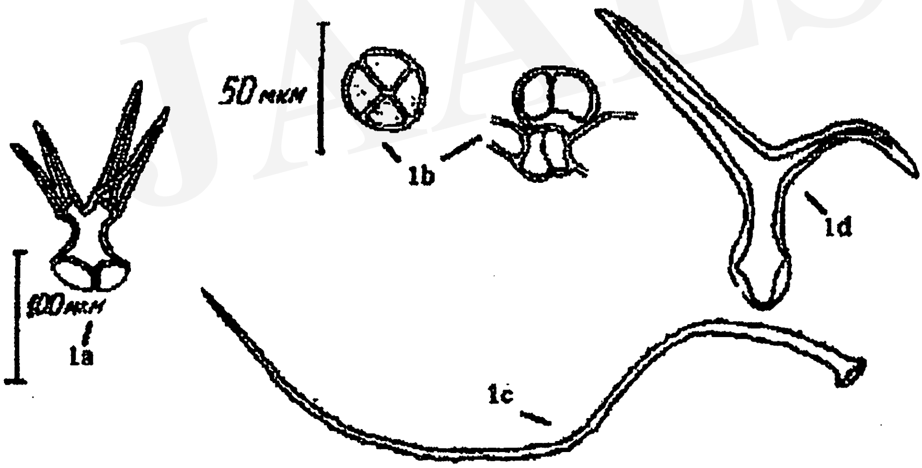

Fig. 1. Trichomes of the cotyledons: a - Alyssum dasycarpum (stellate), b - A.desertorum (glandular); of the leaf: c -Londesia eriantha (simple), d - Strigozella scorpioides (branchy).

Such features as microphyllia, pubescence, amphistomaticity, thickness of leaves within 200-400 mkm, palisade coefficient above 50 % and sclerification of bundles (little in ephemers) are the general for ephemers and xerophytes.

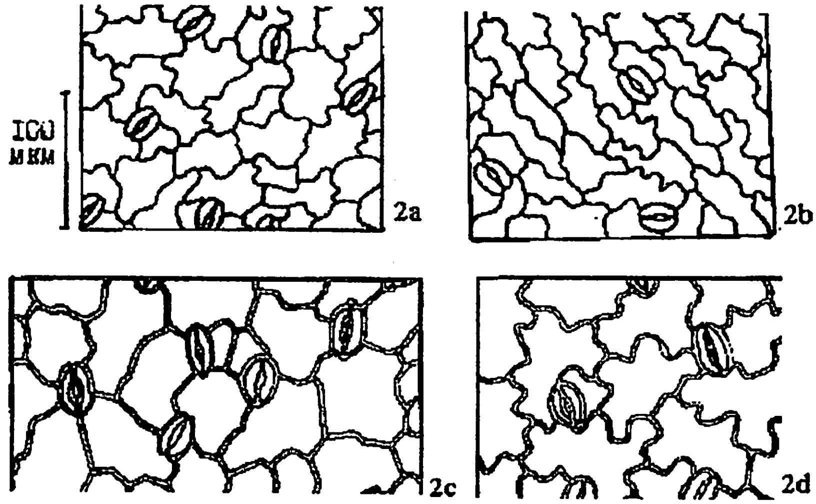

Fig. 2. Epidermis in the surface-view : a - upper, b - lower side of the cotyledon Alyssum dasycarpum; c - upper, d - lower side of the leaf Valerianella Dufresnia

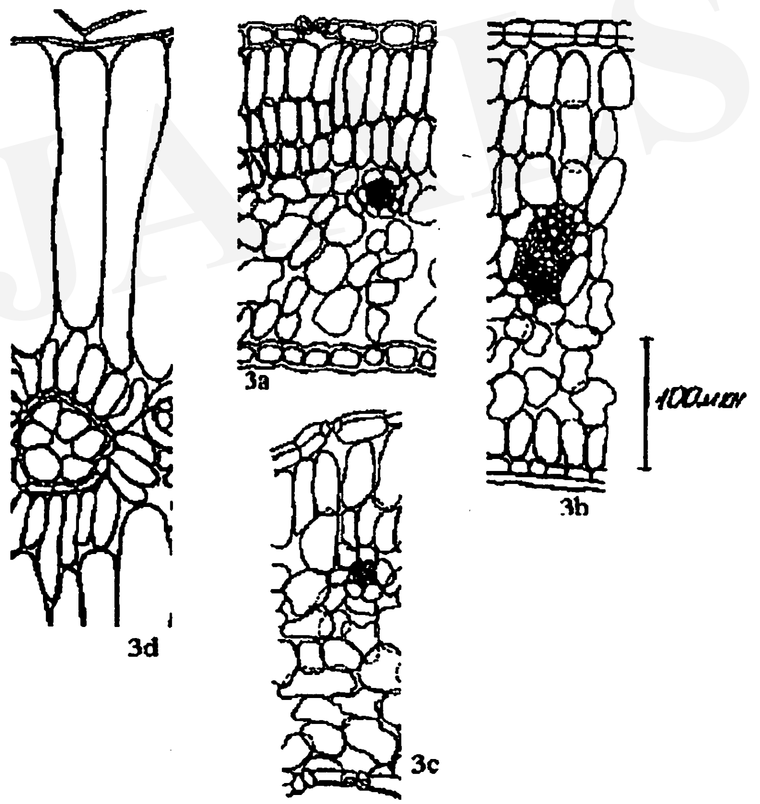

Fig. 3. Portion of a transverse section in : a - Alyssum desertorum (dorsiventral cotyledon), b - Tauscheria lasiocarpa (isolateral - palisade leaf), c - Garhadiolus papposus (dorsiventral leaf), d - Londesia eriantha (cranz leaf)

However xerophytes have straight-lined walls of epidermis and the following types of submersed and unsubmersed stomata: hemiparacytic, paracytic, anomocytic. Stomata are either equably distributed on the whole leaf surface or they are more on the upper side. The isolateral-palisade and kranz types of mesophyll prevail among xerophytes of Kyzylkum desert. Also they have thick pubescence and sclerification of bundles.

3. Conclusion

Since ephemers have as xeromorphic as mesomorphic features they can be related to intermediate type of ecological group - mesoxerophytes. However, this group is unhomogeneous and can be divided into some subgroups on predomination of xeromorphic (for example Londesia eriantha, Alyssum marginatum, Cuminium setifolium et al), mesomorphic (Ceratocephalus falcatus, Isatis violascens, Senecio subdentatus et al), or geliomorphic (Isatis minima, Goldbachia laevigata, Plantago lachnantha et al).

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The Dependens of Desert Plants Seed Germination from Thermofactor

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Abstract - Seed germination of desert plants in Kyzylkum has been in connection with temperature. 3 types of these germination: macrostenothermal, microstenothermal and heurithermal, have been determined. Most desert plants have heurithermal type of germination. Besides their adaptive role among perennials and annuals is examined too.

Key Words: microstenothermal, heurithermal, macrostenothermal

1. Introduction

It is well-known that temperature has a limiting role in plant germination and shows the adaptive reaction of species (Granitova, 1955, Bespalova and other, 1982). However a prevailing type of germination: microstenothermal & macrostenothermal (narrow range of temperature), and heurithermal (wide range of temperature) in definite geographic zone is questionable. Types of 56 species seed germination from 10 families Asteraceae, Brassicaceae, Chenopodiaceae, Caryophyllaceae, Fabaceae, Apiaceae, Lamiaceae, Zygophyllaceae, Peganaceae, Convolvulaceae collected in south-west Kyzylkum were analysed in relation with thermofactor.

2. The germination types

The experimental data taken in laboratory showed different needs of temperature limits for the seed germination. The seeds of some species germinate at +20 +30° C. They belong to the macrostenothermal type of germination. The others germinating in the wide temperature range +4 +30° C belong to the heurithermal one, and the rest - at the reduced temperature +4 +8° C - to the microstenothermal type of germination (Table 1). There is no sharp distinction between the perennials and the annuals in choice of germination type; the heurithermal type dominates in both groups; but the perennials have all three types, annuals - only two - microstenothermal and heurithermal.

2.1. Macrostenothermal type Macrostenothermal type includes only a few perennial species from Zygophyllaceae, Peganaceae, Asteraceae, Convolvulaceae. It is not wide-spread one, probably, due to unsufficient condition in Kyzylkum environment.

2.2. Heurithermal type The majority of studied species have a wide temperature range of germination. The heurithermal species do not have the same reaction to thermofactor. Some species prefer more high positive temperature, others - low on. But some species can have the equal high germination in different temperature conditions (Astragalus flexus, A.kelifi, A.harpilobus, A.remanens, A.ammophilus). It depends on their storage conditions and it is time. Probably, abovementioned species have temperature limits of germination wider than was given during the experiments. After 3-5 years storage Sisimbrium subspinescens, Tauscheria lasiocarpa, Goldbachia laevigata, Astragalus villosissimus have an equal germination in different temperature regimes. The plants with an equal high germination in different temperature regime possess more flexible reaction of germination. Their adaptation degree is very high. The elective temperature conditions are explained by various ecological stages in which the species exist (Tarakanov, 1950). The author distinguishes 3 of such ecological stages: arcto-alpine (when

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the seeds germinate at reduced temperature); steppe, the universal type - at elevated and reduced temperature; tropical, the ancient type - at elevated temperature. On the basis of this classification the most species of Kyzylkum are in different phases of steppe ecological stage. The definition of ecological optimum is necessary for concretization of these phase. According to Poptsov (1960) the ecological optimum is the temperature when definite species seeds have a maximum germination without taken into account of their speed. The following temperature ranges ecological optimum have been determined among the studied species: the elevated temperature +15 +20° C for Alyssum desertorum, A.dasycarpum, Menuartia meyeri, Holosteum polygamum, Climacoptera ferganica and others; the reduced temperature +6 +8° C for Alyssum marginatum, Sisimbrium subspinescens, Scorzonera gageoides, Camphorosma lessingii and others.

Table 1. Species distribution according to types of germination.

Type germination	Species
macrostenothermal +20 +30° C	Mausolea eriocarpa (Bge) P.Pol., Peganum harmala L., Zygophyllum miniatum M.Pop., Z.eichwaldii Bge, Convolvulus fruticosus Pall.
heurithermal +4 +30° C	Alyssum marginatum Steud., Alyssum desertorum Stapf., Alyssum dasycarpum (Steph) CAM, Tauscheria lasiocarpa Fish., Goldbachia laevigata (M.B.) DC, Tetracmidion glochidiatum Botch. et Vved., Sisimbrium subspinescens Bge, Malcolmia scorpioides (Bge) Boiss., Dyptychocarpus strictus (Fisch.) Trautv., Holosteum polygamum C. Koch., Menuartia meyeri (Boiss.) Bornm., Spergularia microspermoides Vved., Climacoptera lanata (Pall.) Botsch., Climacoptera ferganica (Drob.) Botsch., Camphorosma lessingii Litv., Suaeda arcuata Bge, Pulicaria gnaphalodes (Vent.) Boiss., Microcephalla lamellata Bge, Epilasia hemilasia Grossh., Scorzonera gageoides Boiss., Schumania karelinii (Bge) Eug. Kor., Astragalus unifolialatus Bge, A.villosissimus Bge, A.ammotrophus Bge, A.flexus Fisch., A.centralis Sheld., A.subbijugus Ldb., A.kelifi Lipsky., A.turczaninowii K. et K., A.ammophilus K. et K., A.harpilobus K. et K., A.remanens M.Pop., Zygophyllum macrophyllum Regel. et Schmalh., Halimiphyllum atriplicoides (Fisch.et Mey) Boriss.
microstenothermal +4 +8° C	Ferula foetida L., F. varia (Schrenk.) Trautv., F.kyzylkumica Korov., Prangos ammophylla Bge, Lepidium subcordatum Botsch. et Vved., Isatis violascens Bge, I.minima Bge, Hymenolobus procumbens (L.) Nutt., Lallemantia royleana (Wall.) Bnth., Ziziphora tenuior L., Suaeda prostrata Pall., Londesia eriantha F. et M., Scariola orientalis (Boiss.) Sojak., Cymbolaena longifolia (Boiss. et Reut.) Smoljan., Senecio subdentatus Ledeb., Cousinia minima Selena nana K. et K.

The majority of species have constant in some temperature range of their germination for several years. But some Brassicaceae, Lamiaceae, Fabaceae species change it due to seed storage.

2.3. Microstenothermal type Microstenothermal type as the heurithermal one does not have the uniform temperature reaction. There are some species which seeds germinate at the certain given temperature conditions. They are Ferula foetida, F.varia, F.kyzylkumica, Prangos ammophylla. These species seeds do not change their range of germination until their viability within 3-5 years. Other species Isatis minima, Suaeda prostrata, Lallemantia royleana, Senecio subdentatus having sufficient germination at reduced temperature seldom germinate at high temperature too. The transition from microstenothermal type to macrostenothermal one is not determined. While the transition to heurithermal type has been determined in Brassicaceae, Chenopodiaceae, Lamiaceae species due to their seed storage. The seeds with short storage (two months) had zero point germination in +20 +25°C, and maximum point in same temperature after 4-7 years storage (Hymenolobus procumbens, Lepidium subcordatum, Londesia eriantha, Ziziphora tenuior).

3. Conclusion

The determination of temperature limits and germination optimum are necessary for theoretical basis of phytomeliorative works in desert zone. Predominating heurithermal type is as universal for the most studied species as an adaptive peculiarity which helps to survive the species in changing conditions.

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WORKING OUT OF TECHNOLOGY OF CLAYEY SALINE PHYTOMELIORATION IN THE SOUTHERN PART OF ARAL SEA

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Abstract - everybody knows about the tragedy of Aral sea. This is not a regional problem any more, it became a problem of all mankind. Ecological crisis breaks the environmental balance of Central Asia as well as all Eurasian region.
The present article includes the following data: regularities of the natural overgrowing of the southern part of Aral sea's dried bottom and stated dynamic categories; information about first plants, that have grown on the salted area after the sea regression; results of the experiments on selection, examination and agricultural technique of drought- and salt-resistant phytomeliorants in order to anchor the dried bottom of the sea.

Key words: sea, bottom, saline, technology, phytomelioration.

1. Introduction

Catastrophic sinking of Aral sea level resulted in uncovering of sea bottom on the area more than 1.4 mln hectares in the Republic of Uzbekistan. New saline desert has appeared. Bottom accumulations consisted of sand, silt, salts are scattered at 1000 and more kilometres distance. This process led to the strengthening of catastrophic change of region natural regimes in ecological and social economic aspects. Due to this an acute necessity arose to work out scientific basis and methods of prevention of negative consequences of Aral sea drying, to improve ecological and social-economic situation in this region. It is necessary to find different ways and methods of anchorage of sea dried bottom clayey salines with the help of drought- and salt-resistant plants. One of the ways to anchor clayey saline lands is their washing out with mineral waters and further phytomelioration. We have possibility to fulfil this work. We carried out preliminary experiments. Washing out of upper horizons of soil ground with further ploughing and seeding resulted in anchoring of dried sea bottom on the area of 10 hectares.

2. Condition of problem study

Researches carried out by Bakhieva (1985), Vukhrer (1990), Kabulova (1990) and others showed that uncovered bottom is being overgrown with the natural vegetation, but it is very long process. Kurochkina and Makulbekova reported that permanent overgrowing of 30-70 % of the territory (depending on the structure of the region) is possible by the year of 2000. In our opinion this process will take much time. To foster overgrowing we have to execute phytomeliorative works.
The authors mentioned above described different ecological-genetic series of dried sea bottom overgrowing. They are different and depend on the salt and moisture conditions.
Koksharova, Isakov, Matkurbanov (1986); Koksharova (1987), Khanazarov, Novitskiy, Koksharova (1989) were carrying out forest meliorate researches, basically in the area of salted sand and subsand soils which are in the southern coast of Aral sea, and got some good results. Since 1987

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Khasanov,Kamalov, Tadzhiev, employers of the Institute of Botany of the Academy of Science of the Republic of Uzbekistan, carried on fundamental experimental researches on the clayey salines of dried bottom of Aral sea and of Amudarya delta. At present these researches are being carried on by Kamalov and Tadzhiev under the guidance of professor Ashurmetov.
The published works of Kravchuk (1975), Korobkova, Rabochev, Bushlyakova (1989); Nazarmamedov (1989); Korobkova, Rabochev (1990); Sarybayev (1991) include the information about implementation of mineralised (up to 10 gr./l.), surface, subsoil and sea water in irrigation of fodder fields and crops of arid zone, especially of salted soils. Krylova (1989) gave the literature survey on implementation of sea water in irrigation of fodder fields and crops of arid zone in foreign countries.

<u>3. The results of researches</u>
<u>3.1. Relief.</u> The territory of uncovered bottom of Aral sea is a very compound litholo -gemorphological construction, because of the mosaic character of former sea coast, closed contact of Aral sea with delta plains and remainder tertiary formations.

<u>3.2 Soils.</u> The surface of uncovered bottom includes the following types of soils: march, crust, crust - plump, plump, takir and sand seaside saline. They are salted very much (1.9 - 16 %). The types of their salinization are chloride - sulphate and sulphate - chloride, the last one is predominant. Subsoil water is at a depth of 0.3 - 0.5 metres next to the waterline and at a depth of 2.5 - 3.5 metres next to the coast, its mineralization is 55 - 89.6 g/l.

<u>3.3 Climate</u> The climate of the southern part of Aral sea dried bottom and Amudarya delta is sharply continental. The average air temperature in January is - 6.4 - 7.1 C, in July -+ 36 + 38 C;the absolute minimum is -23 - 33 C, the absolute maximum - + 44 + 46 C. The average quantity of precipitations is 115 - 131 mm. They usually fall not even during the year. But the quantity of solid precipitations has increased (dust, salt formations).

<u>3.4 Fundamental researches.</u> We have been carrying them out since 1987. They are directed on determination of regularities of the natural overgrowing of southern part of Aral sea's dried bottom on the territory of Muinak region in order to foster this process. Salicornia Europaea L. had been found at a whole range of 20 km from the waterline to seaside (1990) on very much salted, but moisted crusted saline with subsoil waters, bedding very close to the surface. Salicornia europaea L. was replacing by Suaeda crassifolia Pall. comunity, when the salinization and humidity of the soil were decreasing and it was turning into the salted crusty - plumpy saline. We have found Bassia hyssopifolia (Pall.) Kuntze in the areas where there are decrease of salinization of crysty - plumpy saline up to the average indices and appearance of thin salt crust. On the average salted crusty - plumpy saline above mentioned plant is replaced by Atriplex fominii Iljin, where there is 15-20 centimetre cover of sand. This one is replaced by Tamarix hispida Willd. and T. ramosissima Ldb. because of rise of subsoil water level and level of soil salinization, the reverse process causes the growing of Haloxylon aphyllum (Minkw.) Iljin. The increasing of deflation processes causes the growing of Halostachys belangeriana (Moq.) Botch. The pioneer step of syngenese, when march, subclayey and clayey crusty saline lands, that is moist ones, are overgrowned with Salicornia europaea L. is described in the local and foreign literature.

Botany research of key lots (No 11-12) in Rybatskiy bay, carried out in 1989, showed the presence of 2 year self-sowns of Tamarix hispida Willd. It ment that the pioneer step of syngenese is included the growing of 1 year Salicornia europaea L. as well as Tamarix hispida Willd. bush. This fact had been stated by us for the first time and it is a theoretical contribution in geobotany development.

3.5 Experimental researches. We have carrying out experimental researches on anchoring dried bottom of Aral sea with the help of drought - and salt-resistant plants. We have sampled and tested more than 40 species of aboriginal and contiguous drought and salt -resistant plants from growing wild flora, that belong to 26 general and 8 families. Because of oversalinization of the soils (crusty-plumpy saline) of experimental lots, they were washed well with river or lake water (mineralization was 2.5-5 g/l and the norm was 7000 cubic metres/ hectare (4000 at once and 3000 after a week)) before the sowing.
Gradually, in the process of getting normal soil humidity, the loosening had been made there at a depth of 15-20 cm, after that the plants were sown there. The depth of doing up is 0.5-1 cm. The following plants were promising among the all tested ones: Ceratoides evesmanniana (Stschegl et Losinsk.) Botch. et Ikonn., Kochia prostrata (L.) Schrad., Haloxylon aphyllum (Minkw.) Iljin, Halothamnus subaphyllus (C.A. Mey) Botch., Tamarix hispida Willd, T.ramosissima Ldb., Halostachys belangeriana (Moq.) Botch., Glycyrrhiza glabra L., Halocnemum strobilaceum (Pall.) M.B., Crambe amabilis Butk. et Majlun, Salicornia europaea L., Suaeda crassifolia Pall., Bassia hyssopifolia (Pall.) Kuntze, Climacoptera aralensis (Iljin) Botch., Atriplex fominii Iljin, Sameraria boisseriana (Rchb.f.) Nab., Kochia scoparia (L.) Schrad.
3 and 5 year plants covered the dried bottom of Aral sea on 60-70 % and gave 20-35 metric centners/ hectar as an additional animals feed. We have noted the self-recommencement of phytomaterials in the crop on the dried bottom of the sea, that is a positive fact confirming the stability of the agro-phytocenoses being created.

4. Conclusion. The following ecological - genetic series of overgrowing had been stated for the southern part of dried bottom of Aral sea: Salicornia europaea - Suaeda crassifolia - Bassia hyssopifolia - Atriplex fominii - Tamarix hispida, T. ramosissima - Haloxylon aphyllum - etc. We have found on the dried bottom Tamarix hispida Willd. as well as Salicornia europaea. Soil washing with weakly mineralized water positively influences on seeds germination, growing and surviving of the phytomeliorants. Among 40 tested species of plants, belonging to 26 general and 8 families, 15 species (belonging to 15 general and 4 families) stood the tests. The lands on experimental lots were anchored, the process of blowing away of salt and dust formations had been stopped. As a result of this, we have created new pastures for stock growing, because almost all species can used as a feed for domestic animals (their crop capacity is 20-35 centners/hectar).

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Study on the Selection of Sand-stabilizing Plants and their Diversity in China

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Abstract - In this paper, the utilization and development of plant diversity to select the sand-stabilizing plants are discussed. The biodiversity in the arid land is inferior to that in the tropical and subtropical zone and the number of plant species is only about 1,000. Relatively, however, the plant species, life-forms and vegetation types show variety. According to the long-term studies and practices, the large scale of anthropogenic vegetation has been established in Turpan, Mosouwan and Cele through selected excellent sand-stabilizing plants.

Key words: Plant diversity Sand-stabilizing plants Arid land

1. Introduction

The method to fix sand with plants is important for desertification control in the world. The key problem to fix sand with plants is the rational selection of sand-stabilizing plant species. The biodiversity provides not only the ways to cultivate the excellent varieties of the sand-stabilizing plants and propagate a large number of the sand-stabilizing plants, but also the patterns to establish the anthropogenic vegetation in the desert.

The deserts in China are characterized by drought, wind-sand, saline-alkali and barrenness, especially in the arid and extremely arid areas where the sand dunes are movable. Therefore, the general principle to select the sand-stabilizing plants is that the plants should have the features of resistance against the harsh natural conditions such as drought, barrenness, sand-burying, wind-sand, wind-eroding, high temperature and so on, and, meanwhile, the plants should be easy to propagate and renew and have long growth period, large biomass and high economic benefit. In fact, such ideal plant cannot be found in the world. At present, the best way to fix sand with plants is to utilize biodiversity fully to select the suitable sand-stabilizing plants according to the local conditions.

2. Plant Diversity in the Arid Land and the Selection of Sand-stabilizing plants

China has an area of deserts of 109.5 million km2, of which sandy deserts cover an area of 63.7 million km2 and gobies 45.8 million km2, which are about 11.3% of total land area in China and are mainly distributed in the temperate and warm temperate zone such as in Xinjiang, Inner Mongolia, Qinhai, Gansu and so on. The biodiversity in these regions is inferior to that in the tropical and subtropical zone and the number of plant species is only about 1,000, of them, however, many are rare and endangered species and some of them are registered in the CHINA PLANT RED DATA BOOK, for example, *Pinus sylvestsris var. mongolica, Haloxylon ammodendron, H. persicum, Populus euphratica, P. pruinosa , Ammopiptanthus mongolicus,Tamarix taklamakanensis* and so on, which are all excellent plants to fix sand and have been protected

2.1 The Diversity in the Plant Life-forms and the Selection of Sand-stabilizing Plants

Most of plants in the deserts can adapt the adverse circumstances and have good effect of sand-stabilizing. Therefore, they provide a large number to select the sand-stabilizing plants. Up to now, there are about 200 sand-stabilizing plant species in about 50 genera, 30 families to have been selected and introduced. By the long-term research and practices, the principle to stabilize sand with plants is to combine trees, shrubs with grasses, which replaces the former method of only using arbors and shrubs. In other words, the selections of the sand-stabilizing plants broaden into that of different plant life forms. In the process to construct the oil highway in Taklamakan Desert, for example, in order to ptotect the highway from shifting sands, the annual salt-resistant herbs have been planted in the checkerboards beside the highway. After irrigated by the high mineralized water only once, these grasses such as *Salsola ruthenica, Halogeton glomeratus* and *H. arachnoideus* are able to grow well depending on sparse rainfall and they have good effect to prevent blown sands, even if they withered.

The principle to combine the trees, shrubs with grasses to stabilize sands is more advantageous to maintain the balance of ecosystem and shows the trait of biodiversity in the plant life forms. Viewing from the genera which most of the sand-stabilizing plant species selected from the different bioclimatic

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zones such as deserts, semi-deserts and steppes in China belong to (Tab. 1), the selection of the sand-stabilizing plants has still great potential and numbers of plants in many genera are pending further introduction and study. Accordingly, in order to discover and select more and more excellent sand-fixing plants, the abundant plant species resource provided by biodiversity should be completely utilized and developed.

Table 1. Species Number of Genera to which Some Sand-stabilizing Plants Belong

Genera	Species number of Global	Species number of China	Species number of sand-stabilizing plants selected
Haloxylon Bge	11	2	2
Salsola L.	130	36	2
Calligonum L.	47	25	15
Tamarix L.	90	18	13
Caragana Fabr.	>100	>60	5
Populus L.	110	50	8
Artemisia L.	>500	200	8
Salix L.	>520	257	3

2.2 The Genetic Diversity of Plants and the Selection of sand-stabilizing Plants The genetic diversity of plants plays also an important role in the selection of sand-stabilizing plants. Some plants such as *Calligonum caput-medusae, C. rubicundum and C. klemenetzii* have been selected to afforest in the sand land extensively because they are easy to be planted by cuttings. These plants are all tetraploid or allopolypliod (Tab. 2), different chromosome numbers from other *Calligonum*. These excellent sand-stabilizing plants have high survival rate, about 90%, in asexual propagation. They can keep the features of high speed growth, drought-endurance and wind erosion-resistance. They are such good plants to fix sand land that about 1.5 million of their twigs and ears (about 40 cm long) have been provided by our research states for afforestation widely for years.

Table 2. The chromosome Number of Fifteen Species of Calligonum L.

Sect.	Plant	Chromosome name	Muleiple number
Calliphysa	*C. junceum*	18	2X
Pterococcus	*C. leucocladum*	18	2X
	C. aphyllum	36	4X
	C.rubicundum	36	4X
Calligonum	*C. cordatum*	18	2X
	C. densum	18	2X
	C. klementzii	18 (24)	2X
Medusa Sosk. et Alexandr	*C. mongolicum*	18 (27)	2X 3X
	C. pumilum	18	2X
	C. ebi-nuricum	18	2X
	C. arborescens	18	2X
	C. przeualskii	18	2X
	C. gobicum	18	2X
	C. caput-mednsae	36	4X
	C. roborovskii	36	4X

2.3 The Diversity of Vegetation Types and the Selection of Sand-stabilizing Plants Generally speaking, desert is the zonal ecosystem with rare rainfall, intense evaporation, extremely dry climate and sparse vegetation and, relatively, there are scare plant species and very simple food chains there. In the desert, however, the types of vegetation are also complicated and varied. According to the life forms of the dominant plant species, they are divided into the small arbor and shrub desert (Tab. 3) semi-shrub and small semi-shrub desert (Tab, 4), deciduous board-leaf bushes (Tab. 5) and desert steppe. The dominant species of the vegetation types that distribute in the harsh environment now are the ideal sand-stabilizing plants; many of plants that are edificatoes of desert vegetation have been already selected. Meanwhile, the vegetation types stated above are also referential patterns for the establishment of artificial vegetation in desert. On the basis of water supplies such as flood, water from karez and so on, the different types of anthropogenic vegetation have been built according to the local natural conditions in large scale, for example, *Calligonum* sand-stabilizing forests in Turpan, *Haloxylon* forests in Mosuowan, and the wind-breaking and sand-stabilizing system combining trees, shrubs with grasses in the fringe of Cele Oasis, the southern margin of Taklamakan Desert. All of these forests have achieved great success in the ecological and economic benefits and, also, become examples to fix sand land with plants.

Table 3. Small Arbor and Shrub Desert

Desert Vegetation Types		Distribution				
		Xinjiang	Inner Mongolia	Qinhai	Gansu	Ningxia
Small Arbor Desert	1 Form. *Haloxylon am m. odendron*	√	√	√	√	
	2 Form. *Haloxylon persicum*	√				
Shrub Desert	3 Form. *Ephedra przewalskii*	√	√	√	√	
	4 Form. *Zygophyllum xanthoxylon*	√	√	√	√	
	5 Form. *Nitraia sphaerocarpa*	√	√		√	
	6 Form. *Nitraria roborowskii*	√	√	√	√	
	7 Form. *Nitraria tangutorum*	√	√			
	8 Form. *Gymnocararpos przewalskii*	√	√			
	9 Form. *Calligonum roborowskii*	√				
	10 Form. *Ammopiptanthus mongolica*		√		√	√
	11 Form. *Ammopiptanthus nanus*	√				
	12 Form. *Potanina mongolica*		√			√
	13 Form. *Tetraena mongolica*		√			√
	14 Form. *Helianthemum soongoricm*	√	√		√	
	15 Form. *Caragana korshinskii*		√			√
	16 Form. *Caragana tibetica*		√			
	17 Form. *Calligonum mongolicum*	√	√		√	
	18 Form. *Calligonum leucodadum*	√				
	19 Form. *Calligonum rubicundum*	√				
	20 Form. *Calligonum alashanicum*		√			
	21 Form. *Ammodendron argenteum*	√				

Table 4. Semi-shrub and small Semi-shrub Desert

Desert Vegetation types		Distribution				
		Xinjiang	Inner Mongolia	Qinhai	Gansu	Ningxia
1	Form. *Reaunuria soongorica*	√	√	√	√	√
2	Form. *Ceratoides latens*	√	√	√	√	√
3	Form. *Ceratoides ewermanniana*	√				
4	Form. *Salsola passoerina*		√	√	√	√
5	Form. *Salsola laricifolia*	√	√		√	√
6	Form. *Salsola abrotanoides*	√		√	√	
7	Form. *Salsola arbuscula*	√	√		√	√
8	Form. *Sympegma regelii*	√	√	√	√	√
9	Form. *Iljinia regrlii*	√				
10	Form. *Nanophyton erinaceum*	√				
11	Form. *Anabasis aphylla*	√				
12	Form. *Anabasis salsa*	√				
13	Form. *Anabasis brevifolia*	√	√			
14	Form. *Halostaohys belangerian*	√				
15	Form. *Halocnemum serobilaceum*	√				
16	Form. *Atriplex cana*	√				
17	Form. *Suaeda sp*	√				
18	Form. *Kalidium schrenkianum*	√			√	
19	Form. *Kalidium cuspidatum*	√	√	√	√	
20	Form. *Artemisia sphaerocephala, Psammochloa mongolica*		√			√
21	Form. *Artemisia arenaria*	√	√	√		
22	Form. *Artemisia santolina*	√				
23	Form. *Artemisia terrae-albae*	√				
24	Form. *Artemisia borotalensis*	√				
25	Form. *Artemisia Kaschgarica*	√				
26	Form. *Artemisia parvula*	√				
27	Form. *Brachanthemum gobicum*		√			
28	Form. *Asterothamnus centraliaticus*	√	√			
29	Form. *Ajania fruticulosa*		√			√
30	Form. *Capparis spinosa*	√			√	