Exploiting the Potential Water Supply for Eco-Industrial Parks in an Extreme Arid Area

Zulati Litifu

***Abstract*—This paper focuses on the industrial water use in the extreme arid area and proves the feasibility of developing multi-industry by expanding the carrying capacity of limit local water resource. The potential water resource used for industry is produced from three aspects by improving the efficiency of water utilization, such as returning farmland to forest and stop land reclamation, apply technology of sprinkler irrigation and drip irrigation and save water used in urban, including the life styles of traditional living style and conservation living style. The paper suggested the industrial that fit for extreme arid area.**

***Index Terms*—Extreme arid area, industrial water use, water use efficiency, developing industrial economy**

I. Introduction

INDUSTRIAL development level is an important index to determine local economic strength. To develop the local industry can make the poverty-stricken areas out of poverty as soon as possible. In developing countries, agriculture is much less contribution to the regional economy comparing with that of industry. Therefore, to develop industries in rural areas and improve the living standard of rural residents is a common social issue faced by most countries, especially by developing countries. However, to develop industry in rural areas of extreme drought is with the constraints of water resources. Due to the continuous growth of population and cultivated land, water resources have been seriously over-exploited in many extreme arid regions, and groundwater level drops significantly. Agricultural and domestic water has been taking up all the water resources; there is almost no water to use for developing industry. This research takes the extreme arid area Turpan Prefecture as the example to prove the feasibility of developing industries in such extreme arid area.

Located in the eastern part of Xinjiang Uygru Autonomous Region (XUAR), Turpan Prefecture administers two counties and one city with a total population of 643,000 in 2014. Per capita net income of farmers and herdsmen is annually 7236 Chinese Yuan (RMB). Turpan region is seriously lack of rain and water resources, the annual average rainfall is 16.6 mm but the evaporation capacity is up to 2845 mm; belonging to the region of resource and structure shortage. In recent years, with the development of population and production, the water

shortage has become the constraint of economic development. The water using in agriculture, industry and urban life are respectively account for 90.12, 4.13 and 2.07%. Per-m^3 water used in industry can produce 231.48 [RMB] but 2.728 [RMB] in agriculture. Hence, the water's contribution to local GDP is very low, it is necessary to develop local industry and improve the economic efficiency of water utilization. Regarding to the reality of water over-exploitation of 200 million cubic meters [MCM] in this region, to increase industrial water use may cause the more serious lack of water. Therefore, the concept of expanding the water carrying capacity is applied for this reality, namely, to generate excess water by saving technique and use it in developing industrial economy. The aspects of saving water mainly include the following items:

1. To return farmland to forests and natural grasslands, stop wasteland reclamation,
2. To apply drip irrigation and sprinkler irrigation techniques for agricultural production,
3. To save urban domestic water including lawn watering.

II. Present Characters of Natural Water Resource and Industrial Economy

Turpan Prefecture is one of the prefectures where the water shortage is very serious. The main factor of lacking natural water resource is due to much less rainfall. To reasonably plan the limited water resource for industrials, it is necessary to know the characters of water resource of this region.

The Natural Water Resource of Turpan Prefecture

Total volume of regional water resources are 860 million cubic meters [MCM] and the inflow water is 400 [MCM], hence the disposable water for the regional consumption is 12.60 billion cubic meters [BCM]. Considering the unusable water, there is 12.26 [BCM] water including surface water availability of 631.73[MCM] and groundwater availability of 594.27 [MCM]. The average per capita water availability is 2016 cubic meters [CM] that accounts for 57.35% of the Xinjiang Region's average level 3515[CM]. Table 1 shows the natural water resource of Turpan Prefecture including Turpan city, Toksun county and Shanshan county.

Currently, there are 218 karez (the traditional artificial underground water channels), 6280 pump wells and 14 rives, which provide water for 1.7917 million [MU] cultivated land and 643000 peoples life. Table 2 indicates the per capita

Financial support of this research is from National Natural Science Foundation of China with Grand Number: 41261107 and the Fund of the Key Research Center of Humanities and Social Sciences in the general Colleges and Universities of Xinjiang Uygur Autonomous Region..

Zulati Litifu is with the Statistics and Information Institute of Xinjiang University of Finances and Economics, No. 449 Middle Beijing Road, Urumqi, 830012 China. (Phone:86-991-78433746; e-mail: zulati@foxmail.com).

ISBN: 978-988-19253-9-8
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

water of Turpan Prefecture including one city and two counties. Although Toksun County has the maximum per capita water, the amount of unusable water accounts for about 50%. The total level of per capita water only accounts for the 57.35% of Xinjiang province's level. Considering the amount of unusable water, the amount of available water is much less than list amount in Table 2.

TABLE I
THE NATURAL WATER RESOURCE IN TURPAN PREFECTURE
UNIT: [BCM]

Items	region names			
	Turpan Prefecture	Turpan city	Shanshan county	Toksun county
total water	12.6	4.28	3.03	5.29
surface water	10.6	3.6	2.45	4.55
underground water	2	0.68	0.58	0.74
total water availability	12.26	4.19	3.57	4.5
surface water availability	6.32	2.17	1.88	2.28
groundwater availability	5.94	2.02	1.7	2.22

TABLE II
THE PER CAPITA WATER RESOURCE OF TURPAN PREFECTURE

region names	PCWR [m^3]	PCWRXP [m^3]	percentage accounted for [%]
Turpan Prefecture	2016	3515	57.35
Turpan city	1553		44.18
Shanshan county	1309		37.24
Toksun county	4477		127.37

Note: PCWR denotes the per capita water resource;
PCWRXP denotes the per capita water resource of Xinjiang Province (or XUAR).

Fig.1 shows the related aspects of the carrying capacity of local water resource using in the calculation. The efforts to reduce over exploited are very important for expanding carrying capacity of water resource in the next year. The efforts to keep water quality include two aspects: The first is to keep quality of water environment, and the second is to keep water quality in the using process. The items in Fig.1 considered the ecological environment and social economic system including population and livestock and other relates aspects in social economic system, the ecological system shows the related aspects in lands and complementary.Fig.1 also indicates the relation between the water environment and the social economic including local industrials. To expand the carrying capacity means saving water of social system.

The Current Condition of Industrial Economy

In recent decade, the total GDP of Turpan Prefecture maintains the growth trend state. 2013 GDP totaled 26.089 billion [RMB], an increment of 6.7% over the previous year. In the view of local industrial structure of 2013, the proportion of the industrial structure is 15.24%, 60.78%, 23.97% in order. According to The Planning of the 12th Five-Year for National Economic and Social Development of Turpan Prefecture, the GDP should reach 32.6 billion [RMB] by the end of 2015 that is the last year of 12th five-year plan. Such value of GDP needs the average annual growth of 12%, therefore, the development of secondary and tertiary industry is very important. Table 3 shows the total GDP and output value from three industrials.

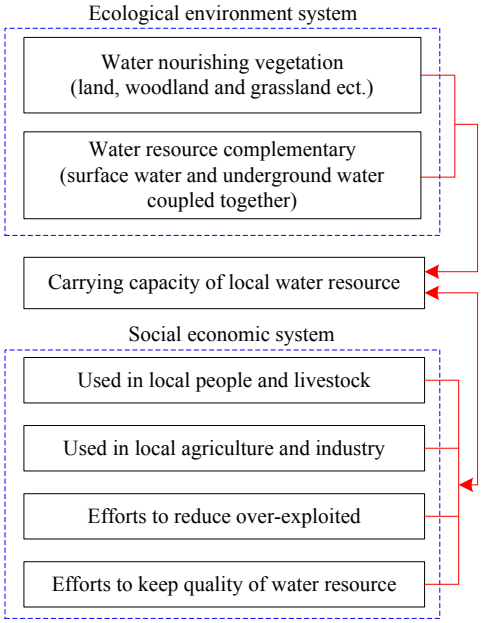

Fig. 1. Related several aspects of carrying capacity of local water resources for calculation

TABLE III
TOTAL GDP AND EACH INDUSTRIAL VALUE
UNIT: [$\times 10^4$ RMB]

Years	Total GDP	Primary industry	Secondary industry.	Tertiary industry
2004	972095	109903	643555	218637
2005	1197738	124661	790079	282998
2006	1482271	137803	1020501	323967
2007	1720268	164631	1174061	381576
2008	2012271	186865	1382082	443324
2009	1545755	202899	966108	376748
2010	1827866	244123	1161343	422400
2011	2214322	269967	1454538	489816
2012	2433907	339060	1542558	552289
2013	2608927	397772	1585763	625392

Define Y as the total GDP and $X_1 X_2, X_3$ respectively denote the output value of primary, secondary and tertiary industry of Turpan Prefecture, and then, the contribution of each industry to total GDP can be expressed by (1):

$$Y = \beta X_1^{\alpha_1} X_2^{\alpha_2} X_3^{\alpha_3} \quad (1)$$

where, α_1, α_2 and α_3 respectively denote the contribution of each industry. Equation (1) is nonlinear function that should be linearized to calculate each contribution by (2).

$$\ln Y = \ln \beta + \alpha_1 \ln X_1 + \alpha_2 \ln X_2 + \alpha_3 \ln X_3 \quad (2)$$

ISBN: 978-988-19253-9-8
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

Apply software Eviews 6.0 for this calculation, we obtain the following results:

$$\ln Y = 0.8068 + 0.1078\ln X_1 + 0.644\ln X_2 + 0.254\ln X_3$$
t-stat (25.358) (16.395) (55.245) (14.155)
$R^2 = 0.999$, p-value =0.00 for all t-stat values

These results mean that there are tight relations between each industry; each industry's contribution is respectively 10.78%, 64.40% and 25.40%. This means if one of the three industries increases 1% in order and other remains the same, the total GDP will increase 0.10%, 0.64% and 0.25%。The secondary industry has the maximum contribution to total GDP and the second contribution is from tertiary industry, but primary industry shows the minimum support for GDP. From the perspective of industrial structure, it is necessary to develop secondary and tertiary industries, especially develop the characteristic agricultural and resource industrial related to specialized agricultural products and local resources. Considering the reality of over exploitation of water resource, the development of secondary and tertiary industries should depend on the saving water from the agriculture and urban consumption. The practice of our works has proved that there are about 25% and 40% potential for water saving in urban and agriculture in this region.

III. The Efficiency of Water Conservation

The water supply for secondary and tertiary industries is mainly saved from the water used in agriculture irrigation and urban and rural living. The saving methods depend on the technique and theory of agriculture irrigation and urban life.

A. Water Conservation from Agricultural Irrigation

As mentioned above, there is about 40% potential for water saving in agriculture production. Table 4 shows the amount of water used in social life and production. The water used in agriculture accounted for 90.12% of total consumed water. Comparing with the available water 12.26[BCM] , the amount of total water consumption reaches 13.79[BCM] with the over exploitation of 1.53[BCM]. The water used in industrials only accounts for 4.12% of entire consumed water.

Current, the average irrigation water for one Mu of land is 651[CM/mu], which is higher than that of Xinjiang Region of 619 [CM/mu]. Turpan government carries out the irrigation quota system; however, it is difficult to limit irrigation water within the defined quota. Table V indicates the irrigation quota for main crops in this region. Table V also denotes the water consumption of drip and sprinkler irrigations. Take grape as the example, the percentage of saving efficiency accounts for 45% and 60% in sprinkler and drip irrigation, the saving efficiency of melon, wheat and corn are also very significant, this reality shows large space of water utilization and conservation.

Table VI indicates the amount of saved water. In melon irrigation, we can save 270 and 360 [CM/mu] by sprinkler and drip irrigation technique, this water accounts for 45% and 60% of traditional irrigation. When the planned cultivated land that apply sprinkler and drip for irrigation is determined, it is possible to define the amount of possible saved water.

TABLE IV
THE CHARACTERS OF WATER UTILIZATION IN TURPAN PREFECTURE
UNIT: [BCM]

used for	region names	subt.	type of water resource				
			surface water		underground water		
			R.W	R.W	W.W	S.W	K.W
Agriculture	TC	4.547	0.800	0.110	3.050	0.367	0.220
	SSC	4.029	0.200	0.800	2.639	0.070	0.320
	TSC	3.854	1.351	0.480	1.903	0.010	0.110
	subt.	12.43	2.351	1.390	7.592	0.447	0.650
industrials	TC	0.187	0.077		0.110		
	SSC	0.203		0.064	0.139		
	TSC	0.180		0.060	0.120		
	subt.	0.570	0.077	0.124	0.369		
Life	TC	0.140	0.100		0.020	0.020	
	SSC	0.095		0.030	0.055		0.010
	TSC	0.050			0.050		
	subt.	0.285	0.100	0.030	0.125	0.020	0.010
ecology	TC	0.177	0.070		0.011	0.060	0.036
	SSC	0.156	0.105			0.011	0.040
	TSC	0.175	0.125		0.050		
	subt.	0.508	0.300	0.000	0.061	0.071	0.076
in total	TC	5.051	1.047	0.110	3.191	0.447	0.256
	SSC	4.483	0.305	0.894	2.833	0.081	0.370
	TSC	4.259	1.476	0.540	2.123	0.010	0.110
	In total	13.79	4.372			9.421	

Note: in this table TC is Turpan City;
SSC is Shanshan County;
TC is Toksun County;
subt is subtotal;
R.W is river water and reservoir water;
W.W is well water;
S.W means spring water;
K.W denotes Karez water.

TABLE V
IRRIGATION QUOTA AND USED WATER BY SPRINKLER AND DRIP IRRIGATION
UNIT: [CM/MU]

way of irrigation	species of crops			
	wheat	corn	melon	grape
traditional irrigation	345	366	600	800
sprinkler irrigation	190	201	330	440
drip irrgation	138	146	240	320

TABLE VI
WATER SAVING EFFICENCY BY SPRINKLER AND DRIP IRRIGATION
UNIT: [CM/MU]

way of irrigation	water saving efficiency from one mu of land			
	wheat	corn	melon	grape
traditional irrigation	——	——	——	——
sprinkler irrigation	155	165	270	360
drip irrigation	207	219.6	360	480

ISBN: 978-988-19253-9-8
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

In according to the current condition of applying technique of sprinkler and drip irrigation, supposing 60 thousands mu of cultivated land are planned using new technique, the grape, melon, corn and wheat respectively accounts for the percentage of 50%, 25%, 10% and 15%, the number of cultivated land and efficiency of saving water can be defined. Here, 651[CM/mu] of the traditional average irrigation water is considered in Table VII.

Define N as number of mu land that are applied sprinkler and drip technique for irrigation, based on the relative parameters mentioned above, we have:

$$\begin{cases} n_i = N \times \eta_i \\ W_i = n_i \times w_i \end{cases} \quad (3)$$

where, n_i is number of mu planned to use drip and sprinkler technique for crop i, N denotes the total mu of land planned to save water in the year, η_i and w_i are coefficients of the land and water related to the land of crop i, W_i is amount of water saved from the land of crop i as shown in Table VII.

TABLE VII
THE EFFICIENCY OF SAVED WATER BY SPRINKLER AND DRIP IRRIGATION

relative items	number of mu and amount of saved water			
	wheat	corn	melon	grape
number of mu [mu]	9000	6000	15000	30000
saved water [10^4CM]	163	115	473	1260
in total [10^4CM]	2011 （annually）			

B. Water Conservation from Urban and Rural Life

In this part of research, we converted the entire urban water consumption to the regional population so as to obtain the equivalent water consumption of per capita. This way may provide more accurate calculation result for urban life.

1) The concept of statistics used in calculation

Weighted arithmetic average and weighted average value are used in this investigation as shown by equation (4):

$$\bar{x} = \frac{\sum xf}{\sum f} \quad \text{or} \quad \bar{x} = \frac{\sum m}{\sum \frac{m}{x}} = \frac{\sum xf}{\sum f} \quad (4)$$

here, x and f and m are indicate the target variable and frequency and number of samples related to investigation. Equation (5) indicates the standard deviation:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}} \text{ or } \sigma = \sqrt{\frac{\sum_{i=1}^{k} \sum \left(x - \bar{x}\right)^2 f}{\sum f}} \quad (5)$$

The meaning of alphabet is same as equation (4), n and k are respectively indicate the number of variation and group. The deviation coefficient is given by (6):

$$v_\sigma = \frac{\sigma}{\bar{x}} \quad (6)$$

In this research the standard score is also used for analysis on selecting the most efficient way to save water, the index of standard score based on statistics method is shown in equation (7):

$$z_i = \frac{x_i - \bar{x}}{\sigma} \quad (7)$$

Developed type of (7) is equation (8) as shown below, w and p indicate water consumed in the flow and water price of sample, and s is sample deviation.

$$z_{GEi} = \left| z_{Wi-j} + z_{Pi-j} \right| = \left| \frac{w_{i-j} - \bar{w}_i}{s_{Wi}} + \frac{p_{i-j} - \bar{p}_i}{s_{Pi}} \right| \quad (8)$$

The carrying capacity of water supply is shown as (9), here Wk is annual output water and Wpu is amount of water demand of traditional and saving lifestyle.

$$K_{CL} = \frac{W_K}{W_{PU}} \quad (9)$$

In this research, the times of population that can be supplied by local water is considered to define carrying ability for local residents as shown in equation (10), here K_{CL} is water supply ability from region resource and P_L is local population, hence, equation (10) can indicate the number of peoples that are nourished by local water.

$$K_{K-P} = \frac{K_{CL}}{P_L} \quad (10)$$

2) Saving lifestyle

Based on statistic method mentioned above, the sample analysis is managed. To estimate the potential amount of conservation water, this research created per capita method namely saving lifestyle. Saving lifestyle indicates the minimum water consumption but suitable for living demand. Consumed water in saving lifestyle represents all aspects related to people's life and converts the water to per capita. The advantage of this method is that it can be easily applied for different arid areas with clear indexes, which may be used for comparing with traditional lifestyle formed in different areas and environment, and this method also shows entire consumed water in society system.

3) Traditional lifestyle

Principle of traditional lifestyle indicates the normal water demand in a person's life, which usually formed in defined area and environment; this way lets people keep comfortable life with natural water demand. The traditional lifestyle is managed by detail statistic investigation that reflects existing reality in water utilization. In this way, all aspects related to people's life are converted to the per capita value of water consumption. The advantage of this method is that it shows water utilization condition without wasteful behavior.

4) Efficiency of water conservation

In this study, resident's age is divided into four degree, less than 18 is the first degree (Deg.1) and 18 to 35 is the second (Deg.2), 35 to 60 is the third (Deg.3) and over 60 years old is the fourth degree (Deg.4) as well. The converting calculation includes the following aspects:

① water consumed in synthetic personal family life;
② water consumed for people and animals drinking;
③ water consumed in meat production and demand;
④ water consumed in personal and animal food demand;
⑤ water consumed in demand of fruits and vegetables.

The mentioned five aspects are the main items related to urban and rural living. The consumed water is converted into water consumption of per capita, hence, there are five tables

ISBN: 978-988-19253-9-8
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

to indicate the consumed water converted to per capita water demand. By this way, the general water demand in urban and rural can be expressed by per capita value. To make water demand more accurate, the traditional lifestyle and saving lifestyle are considered. Regarding the publication page limit, we only provide the important table related to meat demand as shown by Table VIII. The meat of lamb and beef is considered in this calculation, and the water amount of 48.75 and 120.27 liter for per kilogram lamb and beef meat is managed from investigation and statistics. As the result, we obtained the final water demand caused from meat demand is 3121 and 1918 liter annually.

C. General Efficiency of Water Conversation

Combine the amount of water saved from the agriculture irrigation and urban and rural living, the total amount of water conservation is shown in Table X. Considering the reality of water resource and the experience of water conservation, at least, annually 60000mu of cultivated land should be applied sprinkler and drip technique for irrigation. We apply the traditional irrigation water of 651 [CM/mu] and average water saving efficiency of 414 and 334 by drip and sprinkler for Table X, water of saving lifestyle increases annually 20% from 2016, the water indexes of GDP [566CM/10000RMB] and industrial [43.4CM/10000RMB] is also considered.

Integrate five aspects of water saving, we have Table IX:

TABLE VIII
CONVERTED PER CAPITA WATER CONSUMPTION FROM MEAT DEMAND

lifestyle and index	Amount of meat consumed by per capita [kg/a]			
	Deg.1	Deg.2	Deg.3	Deg.4
traditinal lifestyle	50.40	46.80	46.80	54.00
saving lifestyle	30.96	28.80	28.80	33.12
Water equivalent of meat	Lamb: 48.75 [L/kg]		Beef: 120.27[L/kg]	
structure coefficient in consumption	Lamb: 0.800		Beef: 0.200	
Water equivalent of meat under structure coefficient	63.054 [L/kg]			
amount of water cacoused by meat consumptiom [L/a]	3178 Tra.lifestyle	2951 Tra.lifestyle	2951 Tra.lifestyle	3405 Tra.lifestyle
	1925 Sav.lifestyle	1816 Sav.lifestyle	1816 Sav.lifestyle	2088 Sav.lifestyle
average amount of water from meat consumptiom [L/a]	under traditinal lifestyle: 3121 [L/a] under saving lifestyle: 1918 [L/a]			

TABLE IX
SYNTHETIC WATER DEMAND OF PER CAPITA CAUSED BY SIX ASPECTS IN URBAN AND RURAL

lifestyle	related aspects to water consumption					
	people and livestock	courtyard and health	meat	cereals	vegetable	fruit
Tra.lifestyle [L/a • PC]	5823	37467	3121	26285	2700	6985
Sav. lifestyle [L/a • PC]	----	27045	1918	24970	1800	3742
in total	Tra.lifestyle: 82381[L/a • PC]			Sav.lifestyle: 59476[L/a • PC]		

Note: PC indicates per capita in above table.

TABLE X
GENERAL EFFICIENCY OF WATER CONSERVATION AND EXPANDED VALUE OF GDP AND INDUSTRIALS

annually efficiency of water conservation		
from irrigation	from living	in total
2011 [10^4CM]	1473 [10^4CM]	3484 [10^4CM]

accumulative saved water and expanded value of economy					
year	2016	2017	2018	2019	2020
accumulation of saved water [104CM]	2306	4611	6917	9222	11528
increase the value of GDP [BRMB]	4.07	8.14	12.21	16.28	20.35
increase the value of industry [BRMB]	53.1	106.2	159.4	212.5	265.6

ISBN: 978-988-19253-9-8
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

Based on above calculation, annually saved water is 0.3484 [BCM], which almost accounts for the 60.49% of water used in current industry. In according to the plan of local government, the action of water conservation will be the most important task in thirteen five-year plans. Based on the irrigation experience of water conservation, to annually make 60000 mu of cultivated land irrigated by sprinkler and drip technique is possible in the investment and devices. Hence, the method mentioned in this research may be directly applied for practice in Turpan Prefecture.

IV. The Scale of Industrial Economy Based on the Water Conservation

The amount of saved water makes it possible to estimate the scale of increased industrial economy, which is determined by the consumed water of per 10000 [RMB]. Table XI provides the information of quota water in the local industrials.

A. Stipulated Water Consumption of Per Unit Product

Turpan Prefecture stipulated the quota of water consumption of per unit product. This quota is made based on the local natural and environment conditions as well as the current degree of industrial technique. And some quotas are introduced from other province that natural condition is close to this region. Table XI indicates the water quotas of per unit industrial product.

TABLE XI
INDUSTRIAL WATER QUOTA OF TURPAN PREFECTURE

name of industries	type of products	water quota
coal	coal mining	0.31 [CM/ton]
Alcohol and drinks	wine	6 [CM/ton]
Paper industry	culture paper	105.42 [CM/ton]
Oil products	asphalt	0.08 [CM/ton]
Chemical industry	The urea	8.84[CM/ton]
	Coal tar	6 [CM/ton]
	Coal gas	6.8 [CM/10^3CM]
cement	cement(dry）	0.4 [CM/ton]
	cement clinker	0.2[CM/ton]
iron	ferrous iron	3.28 [CM/ton]
Metallurgy	aluminum alloy	7.56 [CM/ton]
steel industry	Steel	12.4 [ton]
rare metal smelting	Organic silicon	37.5 [CM/ton]
building materials	brick	2.3 [CM/10^4]
Building processing	Granite plate	0.13[CM/m^2]
Non-ferrous metal	Electrolytic zinc	11 [CM/ton]

B. The industrials fit for Regional Development

The industries with high water consumption must not be applied for this extreme arid area because such industries may discharge industrial sewage. By the current technology of the Turpan Prefecture, the reuse rate of wastewater is lower than 60%, this means the absolute water consumption rate will reach 40%, and such situation is difficult to accept in this extreme arid area. In next five-year plan, the most important is to develop industrials serving for local agriculture, such as processing industrials of grape and melon as well as other high value-added agricultural products. Table XII shows the potential scale of industrials related to grape and granite plate, etc. The other possible scale of industrials related to other local products may be determined by the same principle.

TABLE XII
POTENTIAL SALE OF INDUSTRIAL RELATED TO GRAPE AND GRANITE PLATE ETC. IN 2016 AND 2018

the potential scale of industrials in 2016			
grape wine [10^4ton]	384	coal mining [10^4 ton]	7437
granite plate [10^4m^2]	17735	cement clinker [10^4 ton]	11528
the potential scale of industrials in 2018			
grape wine [10^4ton]	1153	coal mining [10^4 ton]	22312
granite plate [10^4m^2]	53206	cement clinker [10^4 ton]	34584

IV Conclusion

This research proved that it is feasibility to increase industrial economy by expanding the carrying capacity of limited water resource in extreme arid area, such as Turpan Prefecture. Considering the reality of over exploitation of water resource, which widely exists in arid area, the action of returning the cultivated land to forest should be continually carried out. Along with development of water conservation, the water used in industrial and ecology may increase in a large range. And the saved water may support some industrials of high value, such as heavy and chemical industrials. In the view of long period, the lost output value of agriculture can be compensated by increased output value from industrial production. The result of this research may become a reference for the other extreme arid areas.

References

[1] The organization of water conservation of Turpan Prefecture, “Middle period report of water conservation of test sites of Turpan water conservation establishment,” Published by prefecture organization, Investigation Rep. Jun 2013.
[2] The organization of water conservation of Turpan Prefecture, *establishment of water conservation society of Turpan Prefecture, Transmission Systems for Communications,* Published by prefecture organization, handbook, December 2011.
[3] Statistic bureau of Turpan Prefecture, “Yearbook 2010 of Turpan prefecture", turpan press, 2011.
[4] Statistic Bureau of Turpan Prefecture, “Yearbook 2011 of Turpan prefecture", turpan press, 2012.
[5] Statistic Bureau of Turpan Prefecture, “Yearbook 2012 of Turpan prefecture", turpan press, 2013.
[6] Zulati Litifu, “The Statistical Estimation on Carrying Capacity and Existing Limitation of the Karez in Turpan Basin, Xinjiang China” The International Conference of Statistics Application, Wei Hai. China. July, 2010.
[7] Karez Research Association of Xinjiang. 2004.“The Preliminary Census Report on Karez Water Resource” *Research Report*: pp 8-59.
[8] Zulati .Litifu, Hupur. Nourdine. 2011.“The Research on Comprehensive Economic Value of the Karez in Turpan Basin” *The special research project of Education Ministry of China*. Pp25-108.
[9] Zulati .Litifu and research group members. 2008. “Investigation report on existing condition of karez” *Research Report and Investigation Result of the Karez in Turpan Basin.* pp 12-20.
[10] Wupuer Nurdin, Zhang Lu and Yang Sheng-Wen. Census Investigation and Initial Research Report. Issued by Karez Research Association, July 2003, p8~68.

ISBN: 978-988-19253-9-8
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)