

Sustainable development countermeasure of water resources in Gansu Province

Feng Qi Cheng Guodong

Lanzhou Institute of Glaciology and Cryopedology, Chinese
Academy of Sciences, Lanzhou 730000)

Abstract There are some problems which exist in water resource in Gansu province, such as shortage of water resources, uneven distribution of water resources, deterioration of water environment, serious waste of water resources. And the contractary is more apparent in recent years in development and utilization of water resources with the economic increasing, which seriously affects the economic sustainable development of Gansu Province. Thus the article gives out the countermeasures for water resources exploitation in the future as follows: strengthening management, enhancing science and technological level in the utilization of water resources, rational allocation, optimization of water resources environment, increasing investment in water conservancy projects for sustainable use of water resources.

Key word Gansu Province water resources sustainable use of water resources

Water resources in Gansu Province is not only valuable natural resources, but also important environment factor due to little precipitation and dry climate. On one hand enormous volume of water has been developed with the development of Gansu's economic construction, on the other hand much water channelled was wasted due to unreasonable exploitation and utilization. In response to the important problems of environment and development of 21st century, we generalize the research result of water resources, analyse today's problems of water resource development and finally put forward some countermeasures to solve the water crisis.

1 Current situation water resources

1.1 Transformable water resources

Water resources exist in the forms of glaciers, precipitation, rivers, lakes (reservoirs), ground water and soil water, Annual transformable water resources can be divided into precipitation, runoff, shallow ground water recharged by other water re-

sources.

Precipitation. Precipitation is the basic origin of other water resources, which not only decides the water condition of Gansu Province, but also affects the recharge water amount of rivers, ground water and snowfall on alpine glaciers. Gansu is located more than 1000km away from the oceans, thus resulting in a higher precipitation in mountainous areas and a lower precipitation in plain areas. Hexi Corridor of Gansu have a precipitation ranging from 100~250 mm, while Ejina Banner have a precipitation less than 50 mm.

The total precipitation in Gansu Province is $36 \times 10^9 \text{m}^3$, corresponding to a thickness of 132 mm. However about half of precipitation falls on mountains and only a little falls on plains. The actual precipitation reaching to surface is only 32% of total precipitation in accordance with the data calculated by Gansu Meteorological Bureau.

Runoff. Runoff in Gansu Province comes from precipitation and thawed glaciers, but runoff can't be directly used unless they flow into channels or form spring water and transform into surface runoff.

Total amount of runoff is about $71.02 \times 10^8 \text{m}^3$, corresponding to a thickness of 25.8mm. And the total runoff of the three biggest inland river Heihe River, Shiyang River and Shule River is $66.3 \times 10^8 \text{m}^3$, accounting for 94.5% of the total runoff. So it can be said that inland rivers runoff is the main water resources.

Shallow ground water resources supplied by natural water source. Ground water recharged by natural water is a very important part of the region's water resources. According to the measurement of the seepage ratio of channel system in farmlands and analysing the amount of seepage water of channel system and farmlands in piedmont plains as well as calculating the precipitation and considering flood and storm into piedmont plains, the total ground runoff is $10.11 \times 10^8 \text{m}^3$, comprehensive ground water supplied amount is $49.80 \times 10^8 \text{m}^3$, and the natural supplied amount is $16.82 \times 10^8 \text{m}^3$.

Total water resources. Surface water resources consist of Alpine precipitation and thawed glaciers, it is calculated in accordance with the runoff flowing out of mountains. Natural ground water resources comes from precipitation infiltrated into piedmont plains from lateral direction and surface water seepages. Therefore total water resources is about $75.36 \times 10^8 \text{m}^3$, this is the transformable water sources in Gansu Province, and a part of Huanghe river water flow from Hekouzhen into middle section of the river, others water

resources have been developed.

1.2 Future water resources

Future water resources include Alpine glaciers, deep ground water, desert ground water, they are difficult to develop due to its geographical situation and long period of transformation.

Alpine glaciers. Alpine glaciers and firm is a particular form of water resources and thawed glaciers has important significance to 5~9 month's river water which affects the distribution of annual runoff and the concentration degree of the river water. Generally, alpine glaciers stores much precipitation in cold-wet years, then gives out the water in arid-warm years to distribute interyears water resources. Therefore alpine glaciers not only provide much water resources to Gansu, but also forms a stable and efficient condition for water resources development in plains. The total runoff of glaciers is $23.4 \times 10^8 \text{m}^3$, and the total area is 875.81km^2 which can supplies $6.44 \times 10^8 \text{m}^3$ of thawed water to rivers, accounting for 11.95% of total runoff.

Aquifers and artesian in piedmont plains. Sediments of piedmont plains in Gansu is much thick. The ground hydrological types includes aquifers and artesian in piedmont plains and Hexi corridor formed about 1-6 artesian with a water head of 1-5 m. between 50-300 m depth, the salt content of groundwater is 1-3g/L and the discharge is 2-3L/s.

Ground water lake and lowland water. Some basin in Gansu is almost covered by desert, with a precipitation ranging from 50~100 mm which can infiltrate and form fresh water lens in thin dried sand layer. It is estimated that ground water recharged by precipitation is about $1.2 \times 10^8 \text{m}^3$ and a large amount of water are stored in 100~200 m deep aquifers under sand dunes.

2 Problems

2.1 Shortage of water resources

Water resources in Gansu Province is $75.36 \times 10^8 \text{m}^3$. Annual mean water resources, per mu of arable land and per person in Gansu is 24.6%, 34.3%, 61.5% of that of the country's average level, and is 21%, 24%, 15% of that of the world's average level. The per person occupying water resource in Shiyang River is 32.8% of that of the country's and 6.9% of the world's; the per mu share water resource is 39.4% of that of the coun-

try' and 18.8% of the world's.

The future trends of water resource changes. Precipitation in most Gansu Province is below 400mm, while evaporation is over 1000mm. Because of global climate changes and human being influences, the climate of Gansu Province is trending to become drier. From 20 century on, air temperature has risen and evaporation has increased with the warming climate, 60's—80's air-temperature of Gansu increased 0.28°C which brings about obvious changes of water resources. With the future warming climate, the air-temperature of arid northwest will increase about 1°C by 2030 and precipitation will become uncertain. In future water exploitation will greatly increase due to production development, the contraction of glaciers, and lakes as well as the disappearance of solid water in alpine regions leads to the unstability of river water.

Prediction of water demand and supply. The total water shortage in Gansu will be about $6.13 \times 10^8 \text{m}^3$ by the year of 2000 in terms of predication, which will greatly influence to agricultural production of the region.

Table 1

2.2 uneven distribution of water resources

Regional distribution. Both shortage and uneven distribution of water resources increases the conflicts of water resources, supply and demand.

Water resources in north and west of Gansu Province is more than that in south and east. Shiyanghe river basin owns least water resources in three rivers basins of Hexi corridor.

Seasonal distribution. Arid in spring, flooding in summer, water shortage in autumn and waterless in winter are the characteristics in Gansu. Because of Pacific ocean and Indian ocean monsoon influence, precipitation in Gansu is mainly concentrated in summer. Natural channeled water of Hexi corridor is 19~31% of its total from April to June which is about 35~45% of annual water demand and inflow discharge is insufficient to meet the demand of irrigation farmland, and thus result in large areas crop output of reduction. According to statistical data drought affected farmland occupies about 30% of its total farmland area due to delayed irrigation and nonirrigation. Water shortage seriously influences and limits ecological environmental improvement and the sustainable development of society and economy.

2.3 Unreasonable exploitation and utilization of water resource

Serious waste of water resources. Water resources in Gansu is both short and mis-used. Most of rivers adopt traditional multichannel irrigation method, therefore much water is wasted, and much of water resources in plain reservoirs near middle section of river and the region with high ground water level are lost by evaporation. ① Rural area. Large irrigation norm and heavy irrigation are common which leads to great loss of water resources. Present water-saving technique is of traditional method and its area is limited. Water utilization factor is very low and utilization coefficient of canal system is 0.3~0.45 or so. In Siyang River basin, the channeled water factor is 73% and utilization factor is 41%, so half of water is wasted; the channeled water factor of Heihe River is 65% and net utilization factor is 31%, about 2/3 water is wasted. If the water utilization factor can be increased, it will save much more water resources for the lower section of rivers. ② Cities. Per capita water consumption of Jingchang city and Lanzhou city is respectively 200kg/d, 185kg/d and the standard of water utilization is low. So the water utilization factor should be increased at once. ③ Industries. Water waste in industries is widespread. The water consumption of comprehensive ten-thousand yuan RMB output value is very high in Gansu, for instances, Lanzhou and Jingchang city respectively accounts for 370m³ and 470m³, which is higher than that of Qingdao of 67m³.

Deterioration of water environment. Deterioration of water environment manifested in the land desertification, soil salinization and water pollution ① Land desertification area and potential desertified lands in Gansu is about 2.7% and 1.3% of China's total desertified land area, which is invading in natural oases. The Land desertification area expanded about 51km² and the ground water table decrease to, reach 5 m in Yueyang irrigation region due to misuse of water resources and the low utilization ratio from 1969—1979. The land desertification area of Mingqi oasis expanded about 2.13×10⁴ha., the speed of sand dune movement is 8—10m a year.

② Soil salinization. Soil salinization of Gansu covers an area of 1.16×10⁶km², accounts for 34.35% of Hexi corridor total salinized area. About 50% farmland was salinized in different degree, and 70% farmland appears soil salinization or heavy soil alkalization. So the production output decreases about 30% of total production output when the salt content increase only two times.

③ Water pollution. Due to irrigation backwater and industrial water polluted effluent, surface and ground water are seriously contaminated. The salt content of ground water reached 17g/l, about 76 thousand people and 124 thousand cattle have no fresh water to drink and 37×10^4 km² of farmland is abandoned, for about 450×10^7 m³ of ground water was exploited in Mingqin oasis. Endemic sickness, Keshan disease and Knschi-beck disease in Qinyang of Gansu due to drinking high humic acid water and low selenium water.

3 Countermeasures

In order to rational exploitation and utilization of water resources it needs to enhance management level, increase investment in water projects for sustainable use of water resources.

3.1 Enhancing management level

Water management in Gansu Province is much backward and still practices the mean water use method which was used in Qing Dynasty. In views of regions, Gansu river source comes from Qinghai and some down river relates with Inner Mongolia; in views of departments, water conservancy, forestry, industry, environmental protection, urban institutions respectively exercise management of agricultural water, forestry water, grassland water, industrial and mining water, urban water, and there is no a scientific management system of water resources. Hence there is an urgent need to change the management system and set up new management organization to unify water management, coordinate water use, keep eyes on users to strictly abide by water law, unify exploitation and allocate water sources within a river basin as soon as possible. Only by doing so, the problems of water resources development can be solved and ensure the rational and efficient use of water resources.

3.2 Strengthening science and technology in water development.

It is a complicated system of rational and efficient development of water resources, therefore utilization and exploitation of water resources must rely on sciences and technology, in combination with water management, typical demonstration, personnel training, and popularization of advanced and practical techniques.

Strengthen science and technology in water development includes rational allocation, efficient utilization and optimizing water environment.

(1) Rational allocation

① The principle "determination the development scale of farm and, population and water resources according to the actual amount of water resources" should be abided by in utilization and exploitation of water resources, after knowing the amount of water resources .

② Viewed the surface and ground water as a whole ecological system, scientific management must be done to handle the relations of upper, middle and lower reaches of river; the relations of agriculture, forestry, husbandry animal, ecology, industry, mining and city; and the relations of surface and ground water in order to obtain a best social, ecological and economic benefits.

③ Correctly handle with the relation between water saving and allocation of water resources. According to actual situation of Gansu saving water is main task and rational allocation of water relies on saving water. In the views of development in the future, it is necessary to realize the interbasin water-transferring project based on feasibility study.

④ Study on multi-purpose planning and management of water resources within a basin

(2) Efficient utilization of water resources

Gansu province must construct efficient and economical water environments including those in agriculture, forestry, animal husbandry, industry and mining, and ecology. The efficient and economical development of water resources should be carried out through propaganda, technical renovation and personnel training.

(3) Optimizing water resources environment

Ecological environment in Gansu is fragile and the development of water resources, has a decisive influence on it, therefore the principle of optimizing environment must be carried out in development of water resources in order to coordinate ecological and economic benefits.

3.3 Increasing investment

Investment is the key to development of water resources.

The potentiality of land resources in Gansu Province is so great that it will become future main production region of Chinese agriculture, and water conservancy is blood of agriculture, so the state should preferentially invest in the water conservancy construction .

Saving water and diverting water to some extent is the basic way for water resources development in Gansu Province.

3.4 Sustainable utilization.

The aim of rational utilization and exploitation of water resources in Gansu Province is to ensure the sustainable use of water resources . So the following three principles must be abided by namely, protecting drinkable ground water and land productivity, protecting biodiversity and avoiding excessively developing of fresh water resources.

The problems of water resource in Gansu Province is an obstacle for the development of land and mineral resources. In order to do well in the development, shorten the gap between east and west China , raise people's living standard, it is very important to make an in-depth study on the sustainable development and optimum organization of water resources.

table 1 The shortage of water resources in future ($1 \times 10^8 m^3$)

	industry	agriculture	ferestry and grassland	Population and animal	city	others
total demand 81.49	2.10	72.30	6.00	0.94	0.10	0.05
Total supply 75.36	surface runoff			ground water		
	51.36			24.00		
shortage	6.13					