# 1. Current Water Resources, Water Related Disasters as well as the Role of Agro-environment Education in China

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**Abstract**

The general situation of Chinese water resource and water related disasters are introduced in the paper. China has a sever water resource situation until 2050, only $2.7\times10^{12}m^3$ surface water available now every year, with increasing serious water pollution. Eco-environment is in deterioration under a great water deficit. Torrent, drought, soil and water loss and water pollution are dominant water related disasters in China, they have affected our productivity, daily life and the whole eco-environment. Water pollution is comparatively better than before, but it is also sever.

Current situation of agro-environment education is closely followed. China has 44 middle and high agricultural and forestry schools, with 15 corresponding disciplines. High agro-environment education mainly exists in soil and water conservation and combating desertification, agricultural resources and environment, horticulture in 53 schools. By 50 years of development, Chinese forestry environment education companied with water resource and environment related discipline has formed a omni bearing cultivation system, which benefits Chinese people to manage water resources rationally and improves their ability to combat disasters greatly.

**Key Words:** Water resources, Water related disasters, High agro-environment education, Forestry education, China

Water is a lifeline for human being, as well as for agriculture and economic construction, which is also basic for national welfare and people's livelihood. At the initial of 21 century, it is a focus for central government and the State Council, and also for the whole society. How to deal with water shortage and water related disaster (such as flood, water pollution) immediately, and how to use water rationally are key issues for agro-environment research in china for now and the near future. High school plays a main role in cultivation and agro-environment education china, and they provide powerful science and technology support for water resource research and disaster harness.

## 1 Water resource in china

### 1.1 Current situation of water resource in china

#### 1.1.1 Distribution

**1 Rivers**

There are many rivers in china, and 5000 rivers with the area lager than 100 $km^2$, 1500 rivers lager than 1000 $km^2$. For landform, they distribute regionally, most of them are located in the east of moist and rainy air, while some in the north-west of dry and rainless air, some place even of no flows.

The area of out-flow river basin is 65.2 per cent of our nation, in which 58.2% flow into the Pacific Ocean, 6.4% into the Indian Ocean and 0.6% into the Artic Ocean. The rest is inland river basin, 34.8%, divided as Xinjiang, Qinghai, Hexi, Qiangtang and Inner Mongolia. Some larger river, such as Talimu river, Yili river and Heihe river, lie in these region. Some main rivers and basins are listed in table 1.

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**Table 1 Main rivers in China**

| Name | Length km | Basin area $km^2$ | Name | length km | Basin area $km^2$ |
|---|---|---|---|---|---|
| Yangtze river | 6300 | 1808500 | Haihe river | 1090 | 263631 |
| Yellow river | 5464 | 752443 | Huaihe river | 1000 | 269683 |
| Heilongjiang river | 3420 | 1620170 | Nuanhe river | 877 | 44100 |
| Songhua river | 2308 | 557180 | Yalu River | 790 | 61889 |
| Zhujiang river | 2214 | 453690 | E'erqisi river | 633 | 57290 |
| Yaluzhangbu river | 2057 | 240480 | Yili river | 601 | 61640 |
| Talimu river | 2046 | 194210 | Yuanjiang river | 565 | 39768 |
| Lancang river | 1826 | 167486 | Min river | 541 | 60992 |
| Nujiang river | 1659 | 137818 | Qiantang river | 428 | 42156 |
| Liao river | 1390 | 228960 | Zhuoshui river | 186 | 3155 |

**Note:** Basins with rivers out-flowing into neighbor country are counted from the border, with in-flowing rivers cover the area in our nation and boundary river in neighbor countries. Yellow river basin excluded closed-flowing area.

## 2 Lake

China is a county of abundant lakes, with about 2300 lakes (excluding season lakes) lager than 1 $km^2$. The total area occupied 71790 $km^2$, storing water 708.8 billion $m^3$, including 31.9% of fresh water. The total area of our-flowing river basin is 30650$km^2$, with 214.5 billion $m^3$ of water; others occupy 41140$km^2$, with 494.3 billion $m^3$ of water. They can be classified into 5 lakes region as in table 2.

**Table 2 Lake area and water storage in China**

| Lake locality | Lake Area $km^2$ | Area Percent(%) | Water (billion $m^3$) | Freshwater (billion $m^3$) | Freshwater percent % |
|---|---|---|---|---|---|
| Qingzang plateau | 36889 | 51.4 | 5182 | 1035 | 45.8 |
| Eastern plain | 21641 | 30.2 | 711 | 711 | 31.5 |
| Mongolia-xinjiang plateau | 9411 | 13.1 | 697 | 23.5 | 1.0 |
| Northeast plain & hills | 2366 | 3.3 | 190 | 188.5 | 8.3 |
| Yuan-Guizhou plateau | 1108 | 1.5 | 288 | 288 | 12.7 |
| Others | 372 | 0.5 | 20 | 15 | 0.7 |
| Total | 71787 | 100 | 7088 | 2261 | 100 |

### (3) Glacier

China has the most glaciers located in mid or lower latitude in the world. The total area is generally counted to 58650 $km^2$, storing water 5132 billion $m^3$, most of which located in Xizang and Xinjiang provinces, and mainly are continental glaciers.

### 1.1.2 Quantity assessment

The total average rainfall is $6.2\times10^{12}$ $m^3$ annual, amounting to 648mm high in China, which is 20% lower than the globe level and 44% of that form into flows. The total river flows is $27115\times10^{12}$ $m^3$, amounting to 284mm high. For current conditions, the average underground water is $8288\times10^{8}$ $m^3$. Except for reused surface water and underground water, our total water resource is$2.8\times10^{8}$ $m^3$. Considering inflowing water ($1.72\times10^{10}$ $m^3$) and that produced in our nation ($2.7\times10^{12}$ $m^3$), we have $2.7\times10^{12}$ $m^3$ available annually (Table 3 listed in detail).

**Table 3 Water amount flowing in and out**

| Districts | Local river ($\times10^8$ $m^3$) | Flowing in ($\times10^8$ $m^3$) | Total ($\times10^8$ $m^3$) | Flowing out ($\times10^8$ $m^3$) | Flowing into sea ($\times10^8$ $m^3$) | Consumed ($\times10^8$ $m^3$) | Consumed/available % |
|---|---|---|---|---|---|---|---|
| Out-flowing | 25951 | 81 | 26032 | 7185 | 17148 | 1699 | 6.5 |
| In-flowing | 1164 | 91 | 1255 | 135 | 95 | 1025 | 81.6 |
| The total | 27115 | 172 | 27287 | 7320 | 17243 | 2724 | 10.0 |
| % | 99.4 | 0.6 | 100 | 26.8 | 63.2 | 10.0 | |

## 1.2 Water resource utilization in china

### 1.2.1 Water usage

The total water usage is $1.03\times10^{11}$ $m^3$ in 1949, but it doubled in the after 10 years. In 1980, the usage is $4.4\times10^{11}$ $m^3$, which is 3.3% larger than that of 1965; and the usage in 1993 is 1.2%

larger than that of 1980. In 1997, the total water usage reach $5.6\times10^{11}$ $m^3$, which is 1.7% larger than that of 1993.

**1 Eco-environment**

In the west of arid, semi-arid and semi-humid area, for water shortage, urban industry and agro-construction place a great pressure on eco-environment. The total available water is $8.31\times10^{10}$ $m^3$ in Xinjiang province, Hexi Corridor and Caidamu basin, in which $4.5\times10^{10}$ $m^3$ is consumed by eco-environment, that is 54%.

**2 Agro-construction**

In 1993, the total effective irrigation area is $7.46\times10^{8}$ acre. But water consumed by forestry, husbandry and fishery increased fast in recent years, from $1.19\times10^{10}m^3$ in 1980 to $3.05\times10^{10}m^3$ in 1999. However, the irrigation area and agriculture water usage per person decreased from0.74 acre and $375m^3$ in 1980 to 0.64 acre and $307m^3$ in 1999.

### 1.2.2 Water supplication

According to the statistic of the Water Resource Ministry, the national water supplication capability is 5640 $m^3$ of water conservancy. In 1980 and 1993, the practical supplication are $4.4\times10^{11}$ $m^3$ and $5.2\times10^{11}m^3$, the average increasing rate is 1.27% in the past 17 years, while the correspond increasing rate of GDP is 9.53%, the water supplication elasticity coefficient is 0.13, which is obviously lower than other developing countries (0.20~0.30). After 1993, the increase of supplication speeds up. The average increment reaches $1.0\times10^{10}$ $m^3$, and the elasticity coefficient is about 0.20 during 1993~1997. And the supplications rise up to $5.6\times10^{11}m^3$, $5.4\times10^{11}m^3$, $5.6\times10^{11}m^3$ during 1997~1999.

As for the source of supplication, it more and more relies on underground water. There are $6.2\times10^{10}$ $m^3$ of available underground water in 1980, and it rise to $1.03\times10^{11}$ $m^3$ in 1997, $1.08\times10^{11}$ $m^3$ in 1999.

The water resources exploration rate is16.1% in 1980, and it rise to 18.9% in 1993, 19.9% in 1997 and 1999. But it is 50% in 1997 in the north of china, which has led to some eco-disasters as river cutoff, lake dry and water table sink. Though it is relative lower in south of china, water pollution should also be cared.

### 1.3 Trend of water supply and development

### 1.3.1 Prediction of water requirement

Water requirement includes GDP and eco-environment water requirement. From the view of the whole nation, it will meet its summit of $7.0\sim8.0\times10^{11}$ $m^3$ in 2050 (See Table 4), and 457 $m^3$ per person.

**Table 4 Total water requirement for GDP Unit $\times10^8$ $m^3$**

| Situation | Year | Songliao river | Haihe river | Huaihe river | Yellow river | Yangtze river | Zhujiang river | Rivers in southeast | Rivers in southwest | Rivers in-land | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Current | 1997 | 626 | 466 | 680 | 429 | 1752 | 835 | 297 | 91 | 538 | 5714 |
| High | 2010 | 745 | 498 | 747 | 495 | 2116 | 935 | 325 | 109 | 621 | 6591 |
| | 2030 | 807 | 561 | 853 | 571 | 2551 | 1058 | 362 | 133 | 677 | 7573 |
| | 2050 | 839 | 587 | 897 | 605 | 2760 | 1109 | 373 | 159 | 708 | 8036 |
| Normal | 2010 | 732 | 492 | 733 | 480 | 2045 | 916 | 319 | 107 | 601 | 6424 |
| | 2030 | 759 | 539 | 815 | 535 | 2341 | 1006 | 345 | 127 | 652 | 7119 |
| | 2050 | 767 | 556 | 839 | 545 | 2429 | 1021 | 353 | 145 | 664 | 7319 |
| Low | 2010 | 698 | 488 | 729 | 478 | 2012 | 899 | 315 | 105 | 581 | 6305 |
| | 2030 | 711 | 527 | 799 | 523 | 2252 | 976 | 336 | 125 | 631 | 6880 |
| | 2050 | 706 | 537 | 816 | 530 | 2327 | 987 | 340 | 142 | 642 | 7027 |

Comparing with the current water situation, the general trend of water requirement is that agriculture need less water, but industry and domestic need more water. The rate for agriculture, industry and domestic is 57 27 16 in 2050.

### 1.3.2 Water supplication ability

We have developed $5.6\times10^{11}$ $m^3$ of water resources now, resting $3000\times10^{11}$ $m^3$ mainly in the south of our country. There are not more than $5.0\times10^{10}$ $m^3$ in the north, three quarter of which is from Nenjiang river, Songhuajian river and some international river in Xinjiang province.

By the middle of 21 century, there are $9.0\times10^{11}$ $m^3$ of water available. And it is potential to get more than $5.7\times10^{10}$ $m^3$ of available water in south china, amount to 65% of the total.

### 1.3.3 Water balance analysis

We have $1.3\times10^{10}$ $m^3$ of water shortage by 2030, and that will be balanced by 2050. The rate of water exploitation will get to 24.5% in 2030, and 25.4% in 2050. The water balances of each watershed are listed in table 5.

**Table 5 Watershed water supplication and requirement in 2030 and 2050 (unit: $\times10^8$ $m^3$)**

| Year | District | Local supplication | Input | Output | Available | Usage | Rate % | Requirement | Shortage | Rate % |
|---|---|---|---|---|---|---|---|---|---|---|
| 2030 | Whole | 6640 | 350 | 350 | 6990 | 6800 | 24.7 | 7119 | 129 | 1.8 |
| | Songliao river | 746 | | | 746 | 721 | 37.4 | 759 | 13 | 1.8 |
| | Hainuan river | 352 | 135 | | 487 | 311 | 73.8 | 539 | 52 | 9.7 |
| | Huaihe river | 644 | 130 | | 774 | 600 | 62.4 | 815 | 41 | 5.1 |
| | Yellow river | 443 | 85 | 30 | 528 | 443 | 59.6 | 535 | 7 | 1.3 |
| | Yangtzge river | 2340 | | 320 | 2340 | 2647 | 27.5 | 2341 | 1 | 0 |
| | Zhujiang river | 1005 | | | 1005 | 989 | 21.0 | 1006 | 1 | 0.1 |
| | River in southeast | 344 | | | 344 | 328 | 16.7 | 345 | 1 | 0.2 |
| | River in southwest | 126 | | | 126 | 126 | 2.2 | 127 | 1 | 0.6 |
| | River inland | 640 | | | 640 | 635 | 48.7 | 652 | 12 | 1.8 |
| | Northern 5 parts | 2825 | 350 | 30 | 3175 | 2710 | 50.6 | 3301 | 126 | 3.8 |
| | Southern 5 parts | 3815 | | 320 | 3815 | 4090 | 18.5 | 3818 | 3 | 0.1 |
| 2050 | Whole | 6850 | 450 | 450 | 7300 | 7050 | 25.6 | 7319 | 19 | 0.3 |
| | Songliao | 766 | | | 766 | 733 | 38.0 | 767 | 1 | 0.1 |
| | Hainuan | 364 | 190 | | 554 | 311 | 73.8 | 556 | 1 | 0.3 |
| | Huaihe | 673 | 165 | | 838 | 606 | 63.1 | 839 | 1 | 0.1 |
| | Yellow river | 448 | 95 | 30 | 543 | 439 | 59.0 | 545 | 2 | 0.3 |
| | Yangtzge river | 2428 | | 420 | 2428 | 2833 | 29.5 | 2429 | 0 | 0.1 |
| | Zhujiang | 1020 | | | 1020 | 1003 | 21.3 | 1021 | 0 | 0.0 |
| | River in SE | 353 | | | 353 | 335 | 17.0 | 353 | 0 | 0.0 |
| | River in SW | 144 | | | 144 | 144 | 2.5 | 145 | 1 | 0.0 |
| | River inland | 654 | | | 654 | 646 | 4935 | 664 | 10 | 1.6 |
| | Northern 5 parts | 2905 | 450 | 30 | 3355 | 2735 | 51.0 | 3371 | 16 | 0.5 |
| | Southern 5 parts | 3945 | | 420 | 3945 | 4315 | 19.5 | 3948 | 3 | 0.1 |

**Note:** The amount of input and output include current exchanges. Usage is only for local one, excluding resourceful supplication.

# 2 Water related disasters in China

## 2.1 Flood

### 2.1.1 Types and classification

Because of rainstorm or abrupt ice melt as well as water conversancy accident, the water flood in rivers or lakes rapidly, breaking up dams or cannels, which is flood disaster.

It can be classified by reason: rain flood , melt flood and project accident flood (as in table 6). However, the rain flood is most seen with the largest scale.

**Table 6 Flood types**

| Types | Kinds |
|---|---|
| Rain flood | Rainstorm, continued rains, typhoon, prolonged waterlogged |
| Melt flood | High mountain ice melt, season melt, ice block in cannel, ice burst |
| Project accident flood | Dam burst river bank burst |

According to torrent coverage and duration, flood is classified into 5 grades as in table 7.

### 2.1.2 Main features of flood in China

Alluvial plains in the east and south of china is the most serious areas hit by flood , the total area is about $7.38\times10^5$ $km^2$, occupying 8% of our land, but almost half of our population

**Table 7 Flood classification according to coverage and duration**

| Grades | Coverage $\times 10^4$ km$^2$ | Duration day |
|---|---|---|
| I | <0.01 | <2 |
| II | 0.01-0.1 | 2-4 |
| III | 0.1-1 | 4-7 |
| IV | 1-10 | 7-12 |
| V | >10 | >12 |

condense here, contributing to 2/3 of our gross value of industry and agriculture. Large scale and long time of heavy rainstorm is the generally reason for flood . Influenced by hesitate subtropical high pressure in summer, tropical windstorm and provoking typhoon, rainstorm in transmit of hills and plain is the major source of flood . The largest rainstorm reaches 1000 mm during 24h in east china. In Yellow river watershed and its northern parts, a heavy rainstorm can last 2~7d, covering 3~7$\times 10^4$ km$^2$, total rainfalls is 1.0~5.5$\times 10^{10}$ m$^3$.

The flood disasters in recent 11 years are listed in table 9.

## 2.2 Drought

### 2.2.1 Grades of drought

Drought grades are often classified by rainfall horizon rate ($H_R$) presently, which counted by many years of rainfall records (see table 8).

**Table 8 Grades of drought**

| | Drought | Heavy drought | Especially heavy drought |
|---|---|---|---|
| Continuous 3 months | -25—-50 | -50—-80 | Duration more than 2 years, covering more than 1 province |
| Continuous 2 months | -50—-80 | More than-80 | |
| Continuous 1 months | -80 | | |

### 2.2.2 Features

Drought is a major disaster of our nation. Comparing to other natural disasters, it has larger coverage, longer duration, and bigger loss. According to data, the disaster area and food loss is increasing due to drought. The disaster area and food loss rise from1.74$\times 10^8$ acre and 4.35$\times 10^6$ ton to 4.1$\times 10^8$ acre and 2.45$\times 10^6$ ton. The drought coverage spread from north to south, from west to east, and the duration extend from single year, season and month to continuous year, season and month. The drought not only affects agriculture, but also forestry, husbandry, industry and even whole economic development, resulting into worsen eco-environment. One reason is of little rainfall, the other is that social economic development has an increasing need and dependence of water, but decreasing disaster resistance.

The drought disasters in recent 11 years are listed in table 9.

**Table 9 General situation of flood and drought disaster in recent 11 years**

| year | Flood area $\times 10^4$ | Drought area $\times 10^4$ | Economic loss $\times 10^8$ RMY | Dead people | Food loss $\times 10^4$ ton | Crop production $\times 10^4$ ton |
|---|---|---|---|---|---|---|
| 1991 | 2459.6 | 2491 | 779.08 | 5133 | 1180 | 43529 |
| 1992 | 942.3 | 3298 | 412.77 | 3012 | 2100 | 44266 |
| 1993 | 1638.7 | 2110 | 641.74 | 3499 | 1120 | 45648 |
| 1994 | 1885.9 | 3028 | 1796.6 | 5340 | 2620 | 44510 |
| 1995 | 1436.7 | 2346 | 1653.3 | 3852 | 2300 | 46662 |
| 1996 | 2040.0 | 2015 | 2208.36 | 5840 | 980 | 50453 |
| 1997 | 1313.5 | 3351 | 930.11 | 2799 | 4760 | 49418 |
| 1998 | 2229.2 | 1424 | 2550.9 | 4150 | 1270 | 51230 |
| 1999 | 960.5 | 3015 | 930.23 | 1896 | 3333 | 50838 |
| 2000 | 904.5 | 4054 | 711.63 | 1942 | 5996 | 46218 |
| 2001 | 717.8 | 3400 | 667 | 1450 | 5340 | 45260 |

## 2.3 Soil and water loss

The 2nd remote sensing investigation shows that the area affected by soil erosion is 3.56 million km$^2$ at the end of the 1990's, of which: 1.65 million km$^2$ is water erosion, 1.91 million km$^2$ is wind erosion, and 0.26 million km$^2$ is affected by the both. Areas affected by water and soil erosion are listed in the following table.

**Table 10 Area affected by water and wind erosion by provinces (Unit: km$^2$)**

| Province | Area affected by water erosion | Area affected by wind erosion | Total |
|---|---|---|---|
| Beijing | 4,383 | 0 | 4,383 |
| Tianjin | 463 | 0 | 463 |
| Hebei | 45,662 | 8,295 | 62,957 |
| Shanxi | 92,863 | 0 | 92,863 |
| Inner Mongolia | 150,219 | 594,607 | 744,826 |
| Liaoning | 48,221 | 2,333 | 50,554 |
| Jilin | 19,296 | 14,278 | 33,574 |
| Heilongjiang | 86,539 | 8,907 | 95,446 |
| Shanghai | 0 | 0 | 0 |
| Jiangsu | 4,105 | 0 | 4,105 |
| Zhejiang | 18,323 | 0 | 18,323 |
| Anhui | 18,775 | 0 | 18,775 |
| Fujian | 14,832 | 87 | 14,919 |
| Jiangxi | 35,106 | 0 | 35,106 |
| Shandong | 32,432 | 3,555 | 35,987 |
| Hennan | 30,073 | 0 | 30,073 |
| Hubei | 60,843 | 0 | 60,843 |
| Hunan | 40,393 | 0 | 40,393 |
| Guangdong | 11,010 | 0 | 11,010 |
| Guangxi | 10,369 | 4 | 10,373 |
| Hainan | 205 | 342 | 547 |
| Sichuan | 150,400 | 6,121 | 156, 521 |
| Guizhou | 73,179 | 0 | 73,179 |
| Yunnan | 142,562 | 0 | 142,562 |
| Tibet | 62,744 | 49,893 | 112,637 |
| Chongqing | 52,040 | 0 | 52,040 |
| Shaanxi | 118,096 | 10,708 | 128,804 |
| Gansu | 119,370 | 141,969 | 261,339 |
| Qinghai | 53,137 | 128,972 | 182,109 |
| Ningxia | 20,907 | 15,943 | 36,850 |
| Xinjiang | 115,425 | 920,726 | 1,036,151 |
| Taiwan | 7,844 | 0 | 7,844 |
| Total | 1,648,816 | 1,906,740 | 3,555,556 |

**Table 11 Dynamics of water and wind erosion Unit ×10$^4$ km$^2$**

| Grades | Water erosion | | | | | Wind erosion | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | End of 1980s | | | Beginning of 1990s | | End of 1980s | | | Beginning of 1990s | |
| Slight | | | 83 | | | | | 79 | | |
| Moderate | Worse | | 55 | Worse | | Worse | | 25 | Worse | |
| Intensive | than | Worse | 18 | than | Worse | than | Worse | 25 | than | Worse |
| Extremely | moderate | than | 6 | moderate | than | moderate | than | 27 | moderate | than |
| intensive | 88 | intensive | | 82 | intensive | 94 | intensive | | 112 | intensive |
| Severe | | 38 | 3 | | 27 | | 66 | 35 | | 87 |
| total | 179 | | | 165 | | 188 | | | 191 | |

Soil and water loss is widely distributed in china, both in mountainous, hilly, sandy areas and plains, coast area. The area is up-rise from the east to the west: the water erosion area is 4.9 ×10$^5$km$^2$ in the central china, and 1.07i×10$^6$km$^2$ in the west china. The area affected by both water and wind mainly lies along the Great Wall and the crisscross of agriculture and husbandry.

By the force of erosion, it includes water, wind, freeze and gravity power. Water is the dominant erosive force in the northeast (where the gently undulating terrain is associated with black soils), the Loess Plateau in the northwest, the red hilly region of the south and in other

rock earthy regions of the north and the south. Localized mass movements including landslide and slurries also occur to a lesser extent in the afore mentioned regions. Frost-thaw erosion is dominant on the Qinghai-Tibet Plateau, while wind erosion occur in the northwest semi-arid area where agriculture and husbandry activities coexist. In this region wind erosion is the dominant force in winter and spring while water erosion occurs mainly in summer and autumn.

Statistical data shows that China loses approximately 5 billion tons of soil annually. Within the Yangtze River basin, the soil loss is as high as 2.4 billion tons a year, and 1.56 billion tons are from its upper and middle reaches. In Yellow River basin, 1.6 billion tons of sediment is transported into this river from the Loess Plateau a year, particularly in the basin area between Hekou in Inner Mongolia and Longmen in Henan, more than 70,000 $km^2$ are contributed. The rate of soil erosion is more than 10,000 tons per $km^2$, and some even as high as 30,000~50,000 tons per $km^2$. The sediment produced by this area accounts for more than half of that transport into the Yellow River.

**2.4 Pollution**

**(1) Current situation of rivers**

Chinese rivers are generally polluted. Among them, the Yangtze river receive the most waste water, almost 34.2% of the total in 1999, and the second is Zhujiang River. Water quality assessments at different stages are listed in table12.

**Table 12 Chinese rivers water quality assessment**

| Year | length | Percentage of different polluted degree (%) | | | | | |
|---|---|---|---|---|---|---|---|
| | km | I | II | III | IV | V | >V |
| 1980 | 89395 | 43.5[1] | 35.8 | 8.1 | 7.7 | 4.9 | |
| | | 56.1[2] | 21.9 | 7.1 | 13.7 | 1.9 | |
| 1991 | 98614 | 6.1 | 26.1 | 21.3 | 27.6 | 8.3 | 10.6 |
| 1998 | 109703 | 5.4 | 24.4 | 33.0 | 13.7 | 6.6 | 16.9 |
| 1999 | 113600 | 5.5 | 24.5 | 32.4 | 12.6 | 7.8 | 17.2 |

**Note:** 1. [1] is the result of an assessment of organic pollution, [2]is an assessment of five poisons.

2. III、IV、V are adopted for polluted river length in 1980, and for 1991~1999, a new standard is adopted as IV、V and >V.

According to national GB3838-88 *surface water environment assessment standard*, about 700 rivers, that is 0.1 million long, are assessed in 1991, the monitoring result shows that 47% of length is polluted to more than IV. The water resources bulletin of 1999 shows the length of polluted river descend to 37.6%, but seriously polluted river rises 6.6% in length.

Water quality varies in different district. Lower reaches are worse than upper reaches, trunks is better than branches, and the river through cities is worst polluted. Water quality is generally better in south and central or west of china than that in the north and east.

In 55,000 km length of rivers, 23.3% of them are poison for irrigation, 45% of them have no fishes, and 85.9% of them is not better than the III class. Eco-functions are degraded heavily.

Rivers in cities are polluted even worse. For 1999, in 141 national monitoring cities, 63.8% of rivers are seriously polluted, especially in Liaohe basin, Haihe basin and Huaihe basin.

The water quality in our seven main river basin are showed in table 13.

**(2) Current situation of lakes**

During 1986~1989, the over-nutritious lakes rise to 35.76% of 34 lakes investigated. And almost all lakes live in over-nutritious condition in 1990s. Large fresh lakes and urban lakes are all polluted. Dianchi lake is seriously polluted by N and P, it is typically over-nutritious. And the blue-green algae is overabundant, where water quality is worse than V class. The Caohu lake is of the same condition. The organism is comparatively less
in Taihu lake in recent years, but N and P rose.

**(3) Current situation of underwater**

The quality of underwater of cities deteriorates in recent 20 years. In 1998, we have

**Table 13 Chinese water quality by basins**

| | Water quality class | Percentage of the total% (1997) | Pollutants | Percentage of the total% (1998) |
|---|---|---|---|---|
| Yangtze river | III or better than III | 67.7 | Phenol COD | 75 |
| Yellow river | IV | 66.7 | $NH_4$ Phenol COD | 74 |
| Zhujiang | III or better than III | 52 | $NH_4$ Hg, COD | 72 |
| Huaihe | Worse than V in 1st branch | 52 | COD | Worse than V in the trunk, 48 |
| | Worse than V in 2nd an3rd branches | 71 | | |
| Haihe | V, worse than V | 50 | $NH_4$ COD | 62 |
| Liaohe | Worse than V | 50 | $NH_4$ Hg Phenol COD | 61.4 |
| Songhuajiang | IV | 70.6 | Phenol COD | 67 |

investigated 118 cities, in which 115 cities has polluted underwater. The indicators we used include Hardness, Nitrate, $NH_4$, Organism, Chromium and Phenol. Most of them have increased hardness and Nitrate. Some of them affected by petroleum matters, and some underwater has “three cause” organic compounds.

## 3 High agro-environment education in China

In 2000, our high agro-forestry schools reduced from 65 to 50, including 44 agricultural universities and 6 forestry ones, and the disciplines are also adapted from 38 to 15. There are 248217 students in normal agro-forestry high school now, which is 4.24% of the whole high school students. Our developing aim is to keep a rising speed of 14% annually for agro-forestry high education during “Ten Fives”. The gross students in agro-forestry high school will be 477,000 in 2005, where undergraduate student are 273,000, graduate student are 27,000. This kind of cultivation will be more popularized in 2010, and student population in these schools will be 736,000.

Our cultivation contents for undergraduate students include philosophy, economics, legislation, pedagogy, literary, history, science, engineering, agronomy, medicine and administration. This category consists of 71 2nd class and 249 disciplines. The high agro-environment education mainly devote to science, engineering and agronomy see table 14 .

**1 Soil and water conservation.** By 1998, this discipline has been set up in 14 schools following Beijing Forestry College in 1958. By partial statistic, they have trained about 4000 undergraduate students. During 1980~1998, 200 students have got master degree, and 50 for doctor degree. In 1960, the first discipline of combating desertification has been set up in Inner Mongolia Forestry College, and they have trained 2800 undergraduate students and 29 graduate students in this area now.

**2 Agricultural resource and environment.** By 1995, there are 106 professional environmental disciplines in 86 schools in mainland, and 193 for undergraduate students in 135 schools, including environmental science, ecology, environmental project, environmental monitoring, plan and management, agriculture environment protection. There are 189 master positions in 150 high schools and 39 institutes, and 48 doctor positions in 39 high schools and 9 institutes. And there are also 8 postdoctoral moving stations. By now, they have trained about 30,000 students.

**3 Horticulture.** The Beijing Forestry University has train 2000 students in this discipline since 1950s, and we have 200 master and doctor of horticulture now. For recent years, we recruit 1000 of this discipline every year. This discipline has abundant student source and promising needing market.

**Table 14 Disciplines of high agro-environment education**

| Category | Class | discipline |
|---|---|---|
| Science | Geography | Geography science |
| | | Resource, environment and urban plan |
| | | GIS |
| | Environment | Environmental science |
| | | Ecology |
| Engineering | Water conversancy | Water and electric project |
| | | Hydrology and water resources |
| | Environment and safeguard | Environmental project |
| Agronomy | Eco-environment | Soil and water conservation and combating desertification |
| | | Agricultural resource and environment |
| | | Horticulture |

These graduates above enriched our agro-environmental construction groups, they improved our nations capability for water resources management and water related disaster combating.

## 4 Features and achievements of forestry education in China

After a century of development, Chinese forestry education grows up, and a reasonable educational system has been formed, consisted of high education, professional education, adult education and primary education. Main achievements can be concluded:

### 4.1 Cultivation and research

The forestry high schools have cultivated 4309 graduated students and 124,300 undergraduate or professional students since 1950s. And our cultivation capability have obviously improved, we have 31 doctor positions, 86 master positions and 6 postdoctoral moving stations. Students on duty are 26.9 times of 1978 now.

Junior forestry professional education is in progress. In 1999, 20 of 60 schools are granted the nation key school. There are 83,000 students on duty in 1999, which is 9.3 times of 1978.

Forestry adult education emphasizes position training and further education. By 2000, there are 13,700 students on duty in senior forestry correspondence school and evening university, which is 50.8 times of 1980. The government agriculture broadcasting school has enrolled 90,000 students since 1978, half of them have graduate and they have became the backbone of the first producing line.

Forestry multi-profession training has a great achievement. During “Nine Fives”, they have trained 15 million of students. Since 2000, this training has sheared to The West Development to improve eco-environment by Natural Forests Protection, Resume Forest or Grassland from Farmland and Combating Desertification. The trainees cover basic leaders, public officials, technical backbones, forestry managers as well as forestry farmers. At the same time, basic construction and institutions are strengthened.

### 4.2 Academic communication

Our forestry high school has build up a long term and stable friendship with more than 100 schools or institutes in 20 countries. We have sent as many as 1500 people to study abroad to about 40 countries, and 60% of them returned and became the backbone of cultivation or research. Meanwhile, we have invited more than 3000 foreign experts from 50 countries to china. By this means of academic communication, cooperate research and joint cultivation, our forestry education has stepped out and the world has knew us.

### 4.3 Consulting service

In the past, our farmers have little knowledge. It is difficult for adapting agricultural structure and technology innovation, particularly for spreading new and functional techniques. Speeding professional and adult education improve farmers' ability to master scientific technology. They are more capable for economic development. In addition, agricultural and forestry high schools launch consulting and technological activities every year, providing consulting service for basic production directly. By means of scientific training, technique spreading, technological information report and kinds of negotiation, agriculture and rural life improve quickly.

## 5 Conclusion

**(1)** We have a sever water resource situation now. Though rainfalls is $6.2\times10^{12}m^3$, available surface water is only $2.7\times10^{12}m^3$, and it distribute unevenly. Water resources exploitation is rising, and increasing water usage of industry and agriculture put a great pressure on eco-environment construction. Our water supplication capability is only 5640 $m^3$ per person annually, and it is mainly from underground water, which has lead to ecological degradation. It is predicted that we can meet our water balance in 2050, and the rate of exploitation is 25.4% at that time, the ratio of water usage of agriculture, industry and domestic is 57:27:16.

**(2)** Flood, drought, soil and water loss and water pollution are dominant water related disasters in China, they have affected our productivity, daily life and the whole eco-environment. In recent 11 years in china, $1.65\times10^8$ha area is flooded, costing us $1.3\times10^{12}$ Yuan(RMB), and $3.05\times10^8$ha area is drought, costing $3.1\times10^8$ ton of food, and nearly $3.8\times10^4$ people died in them. Now, we have $3.56\times10^6$ $km^2$ area of soil and water loss, the situation appears overall good but local bad. In recent 50 years, $4.0\times10^7$ acre of land were destroyed by water erosion, and it has become our No.1 environmental problem. Water pollution is comparatively better than before, but it is also sever, the rate of polluted river length to the total assessed one is 37.6%.

**(3)** China has 44 middle and high agricultural and forestry schools, with 15 corresponding disciplines. Now there are 248,000 students in these schools, distributing in 11 disciplines of science, engineering and agronomy. High agro-environment education exists in soil and water conservation and combating desertification, agricultural resources and environment, horticulture in 53 schools.

**(4)** Chinese forestry environment education companied with water resource and environment related discipline has formed a omni bearing cultivation system, consisting of high education, professional education, adult education and primary education.

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