

水与发展(II)

主编：朱琰 副主编：Klaus-Dieter Balke Dieter Prinz

地质出版社

714.013

水 与 发 展 (Ⅱ)

主 编 朱 琰

副主编 Klaus-Dieter Balke
Dieter Prinz

地 质 出 版 社

· 北 京 ·

内 容 提 要

本书是一本全面反映水资源利用和水环境保护的论文集。内容包括欧洲和亚洲在地表水与地下水综合利用、水源地开发和资源保护、城市和农村供水、城市和区域水环境与水资源管理、节水、水土保持、污水处理和海水淡化等方面的研究成果和应用技术。

图书在版编目 (CIP) 数据

水与发展 (Ⅱ) / 朱琰主编. —北京: 地质出版社,
2004.9
ISBN 7-116-04217-2

I. 水… II. 朱… III. 水资源 - 资源保护 - 国际学
术会议 - 文集 IV. TV213-53

中国版本图书馆 CIP 数据核字 (2004) 第 098632 号

SHUI YU FAZHAN

责任编辑: 林景星 何 蔓

责任校对: 李 玫

出版发行: 地质出版社

社址邮编: 北京海淀区学院路 31 号, 100083

电 话: (010) 82324508 (邮购部); (010) 82324580 (编辑室)

网 址: <http://www.gph.com.cn>

电子邮箱: zbs @ gph.com.cn

传 真: (010) 82310759

印 刷: 北京中科印刷有限公司

开 本: 787mm × 1092mm $1/16$

印 张: 12

字 数: 285 千字

印 数: 1—500 册

版 次: 2004 年 9 月北京第一版 · 第一次印刷

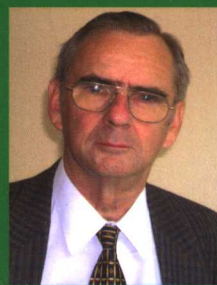
定 价: 38.00 元

ISBN 7-116-04217-2/T·114

(凡购买地质出版社的图书, 如有缺页、倒页、脱页者, 本社出版处负责调换)



朱琰，浙江杭州人，1989年成都理工学院水文地质专业工学硕士，1997年浙江大学经济学第二专业本科，1998年毕业于德国图宾根大学热带与亚热带地区水文地质与工程地质高级研修班，1999年起任教于浙江大学，现为浙江大学地球科学系副教授，德国图宾根大学博士候选人，长期从事于水资源与地质环境科学领域内的科研、咨询和教学工作。在国内外发表学术论文近30篇。



Prof. Dr. Klaus - Dieter Balke, 1964 Diploma in Geology at University of Wuerzburg, 1969 Dr.rer.nat at University of Bonn, 1981 Habilitation in Hydrogeology at University of Tübingen, 1988 Professor for Hydrogeology at University of Tübingen, now Senior Professor at University of Tübingen. Professor and Coordinator of the Master's Course "Tropical Hydrogeology". 30 years research and teaching activities in Germany and several countries of Latin America, Africa and Asia, especially related to groundwater resources, contamination, protection, environmental hazards, etc. in developing countries. More than 60 national and international publications.



Prof. Dr. sc. agr. Dieter Prinz, 1967 B. Sc. In Horticulture at Geisenheim, Germany, 1972 Dipl.-Ing. agr., then Dr. sc. agr. at Göttingen University. Now Senior Professor at the University of Karlsruhe, Head of the Department of Rural Engineering, Head of the "Resources Engineering" Postgraduate Program, Head of an Alumni-Program on "Sustainable Resources Development" (SURED) for Southeast Asia & China. Research and teaching at 3 German and 7 foreign universities. Project planning and evaluation in 13 countries of the tropics and subtropics. Related to small scale irrigation (incl. water harvesting), soil erosion, soil protection, and watershed management. More than 80 national and international publications.

目 录

Welcome Speech	Yan Zhu (1)
The Current Situation and Countermeasures for Sustainable Development of Water Resource in Zhejiang Province	Mingsheng Zhang, Shanfei Chen (2)
Discussion on Sustainable Development for Water Resources in Zhejiang Province	Jinru Zhang (9)
Water Supply by Bank Filtration and artificial Groundwater Recharge	Klaus-Dieter Balke (18)
中国南方地下水水化学特征	朱 琰 (26)
Groundwater Vulnerability Assessment Based on Numerical Simulation	Longcang Shu, Adil Elkrail (30)
Drinking Water Pollution Accidents And The Hazard Minimization Technologies	Xuemin Xiang, Yanli Xu, Jiti Zhou, Ren Wang, Zhen Li (34)
Geogenetic Arsenic in Drinking Water—A Case Study	T. Schiedek, Y. Scheid, M. Beier, G. Ebhardt (42)
Microbiological Examination of Drinking Water	Konrad Botzenhart (46)
Quantification of Fuel-related Organic Contaminants in Urban Areas of Germany	T. Schiedek, M. Beler, C. Lerch (57)
Retarded Transport of Di-butyl-Phthalate and Phenol	T. Schiedek, S. Bluhm-Janßen (61)
Behaviors of Aqueous Oil Adsorption-Leaching in Oil-Contaminated Soils	Xilai Zheng, Yuying Li, Guoqin Lin, Wenxiang Xia (65)
Effects of Groundwater Over-exploitation in Urban Regions	Yan Zhu (72)
Virtual Water-A New Commodity?	Dieter Prinz, Wanli Zhao (77)
Study on Water Supply for Two Cities in East Kalimantan-Indonesia	T. Sembiring, R. M. Djuwansyah (86)
In-Situ Rainwater Management in Rural Areas	Dieter Prinz, A. H. Malik (91)
Methods of Water Harvesting in Agriculture	Dieter Prinz (97)
The Status Qua of Water Resources in Yunnan and its Development Policy	Yanbo Xiao, Congmei Yang (102)
城市雨水问题与可持续发展对策	李俊奇 车 伍 (106)
Applying Genetic Algorithms to Optimize the Sewer Network Design	Shuping Li, Suiqing Liu (114)

Legal, Institutional and Technical Aspects of Water Management	Herminia C. Tanguilig (120)
Primary Study on Water right System of China	Hugen Zhu (127)
Best Management Practice for Urban Fringe Watershed Management	Zaheer Iqba, Cui Guang Bai (135)
Reuse of Treated Wastewater: an Approach towards Sustainable Water Resource Management	Chunman Cheng, Rusong Wang (142)
城市住区水资源综合利用及水环境改善案例分析	车 伍 李俊奇 陈和平 王俊岭 (146)
On Soil Anti-Scourability Under Different Land Uses in the Sichuan Basin, China	Jianhui Zhang, Shijun Ni (154)
表面流人工湿地对城市生活污水处理效果的研究	宋春霞 项学敏 唐 皓 (155)
钱塘江流域水环境发展趋势分析	蔡临明 (161)
The Cause and Possible Solution of Flood in Dongting Lake	Xiaojie Chen (166)
慈溪市水环境整治的对策与措施	应利根 孙建锁 (170)
Hot Mineral Springs & National Geopark in Longmen Mountains of Sichuan, China	Xichun Wu, Xiao Fan, Junyi Yang, Jie Yi, Yunfu Liang (175)
The Positive Impact of Irrigation Schemes on Agricultural Production and Living Condition of Hill-Land Area-Middle Vietnam	Dao Chau Thu (179)
反渗透工程应用及发展趋势	谭永文 张维润 沈炎章 (182)

Welcome Speech

IN INTERNATIONAL SEMINAR OF WATER AND DEVELOPMENT,
DEC. 4 – 8, 2003, HANGZHOU

Yan Zhu

Dept. of Earth Sciences, Zhejiang University, 310027, Hangzhou, China

Ladies and Gentlemen

It is our special pleasure to welcome you in Hangzhou to the International Seminar “Water and Development”, which is organized by University of Tuebingen, University of Karlsruhe, cooperated with Zhejiang University, and financially supported by German DAAD.

The organizers proposed this place because you will immediately get to know how water is important in this area as in many parts of this world.

In Hangzhou sustainable drinking water, groundwater exploration, exploitation and surface water management is a major concern since Tang Dynasty, 1300 years ago.

Now we are facing with the problems of chemical pollution in surface water and groundwater protection. Therefore, today's research on water and development need to be advanced to guarantee or enhance water availability for human life and health, as well as for regional sustainable development.

We appreciate very much our German professors and experts from Asia can come to China, within the new efforts, this seminar intends to bring together international specialists

To exchange fundamental results of recent research,

To present progress in technical innovations,

To discuss the shaping of national and international strategies to harmonize water efforts,

To consider the priorities of future challenges.

We are confident that the inspiring ambient of Hangzhou and the seminar itself will favor the exchange of valuable information, and benefit everybody who is sitting here.

I wish you have a nice stay in Hangzhou.

Warmly welcome.

The Current Situation and Countermeasures for Sustainable Development of Water Resource in Zhejiang Province

Mingsheng Zhang

Zhejiang Association for Science and Technology, 310003 Hangzhou, China

Shanfei Chen

Zhejiang University of Science and Technology, 310012 Hangzhou, China

Zhejiang Province is located in the southeast coast of China. It covers an area of 101.8 thousands square kilometers, which is one of the smallest provinces, taking up 1.06% of the whole area of the country and with 0.55 Mu (about 367 square meters) farmlands per capita. It also covers a maritime space of 260 thousands square kilometers with a coastline of 6486.24 kilometers long, ranking first in the country. The population of the province in 2000 is 46.77 million, and there are 11 municipal cities and 88 counties. From North to South there are 8 main rivers: Shaoxi River, Great Canal (the part inside the Province), Qiantangjiang River, Yongjiang River, Jiaojiang River, Oujiang River, Feiyunjiang River and Aojiang River, among them the Qiantangjiang River is the biggest and longest one.

1 General situation of water resources in Zhejiang Province

1.1 Gross water resource

Zhejiang is in monsoon district of subtropics with abundant rainfalls. It has the annual rainfall of 1600 millimeters, relatively rich in precipitation in the country. The average annual water resource as a whole for the past years has been 93.7 billion cubic meters. But due to the large number of population, water resource per capita is 2140 cubic meters in 1998, 2004 cubic meters in 2001 in Zhejiang, 600 cubic meters per capita in Zhoushan and some other islands as the least.

1.2 Basic characteristics of water resource

Firstly, water resource per capita is relatively inadequate to be seen from Fig. 1. The average yearly precipitation is about 1600 millimeters for the past years and total water resource reaches 93.7 billion cubic meters in Zhejiang. The water resource per unit area is 3 times that of the average amount of the country. However, the Province is populous, resulting in the water resource per capita only 2004 cubic meters in 2001, lower than the national average and only one fourth of the global average.

Secondly, great changes in rainfall from year to year, and usually rainfalls concentrate in certain

times in the year.

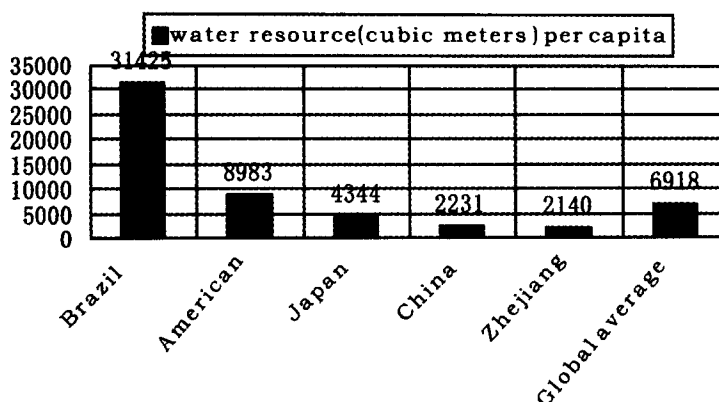


Fig.1 Water resources per capitain different area and countries in 1998

Moreover, as can be seen from Fig.2, the years with most rainfall can have nearly two times in rain volume compared with that of the years with least rainfalls. So it is likely to have floods in abundant years and drought in lean years. Rainfalls are not evenly distributed in the year. Affected by the monsoon, it usually has lots of rainfalls in “Rainy season” between spring and summer and “Typhoon season” between summer and autumn.



Fig.2 Water resources in Zhejiang from year to year

Thirdly, rivers are short and with rapid currents as can be seen from Fig.3. Most rivers originate from the Province or from the border of the Province, and flow to the sea directly. In rainy season, it is prone to have floods and difficult to prevent the water from entering the sea.

Fourthly, the distribution of water resources is not uniform. Rainfalls are concentrated in mountainous districts and Hangzhou-Jiaxing Lake, Xiaoshan-Shaoxing-Ningbo plain and Zhoushan archipelagos are lack in precipitation.

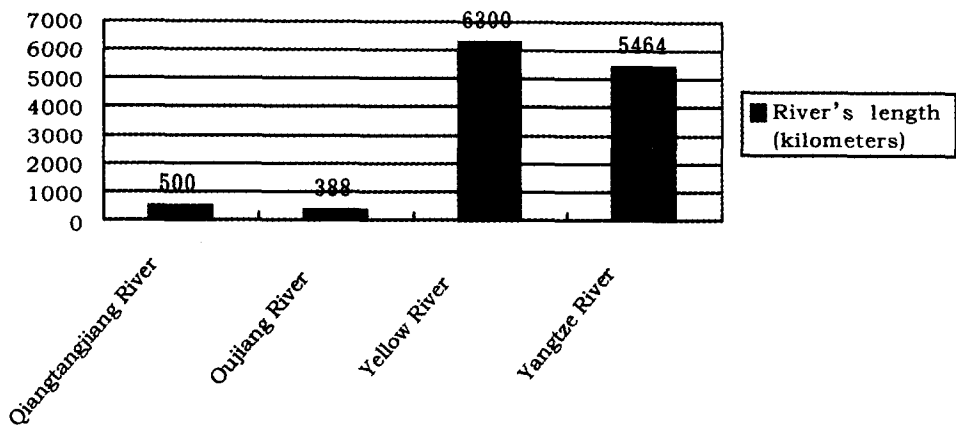


Fig.3 Four rivers' length(kilometers)

2 Main problems existed

2.1 Some districts are short of water because of the uneven distribution of water resources

Because of the uneven distribution of water resources, some districts are short of water as can be seen from Fig. 4, especially high-quality drinkable water. The dimensional distribution of water resources is not in accordance with the situation of population, farmland and economy. Those relatively

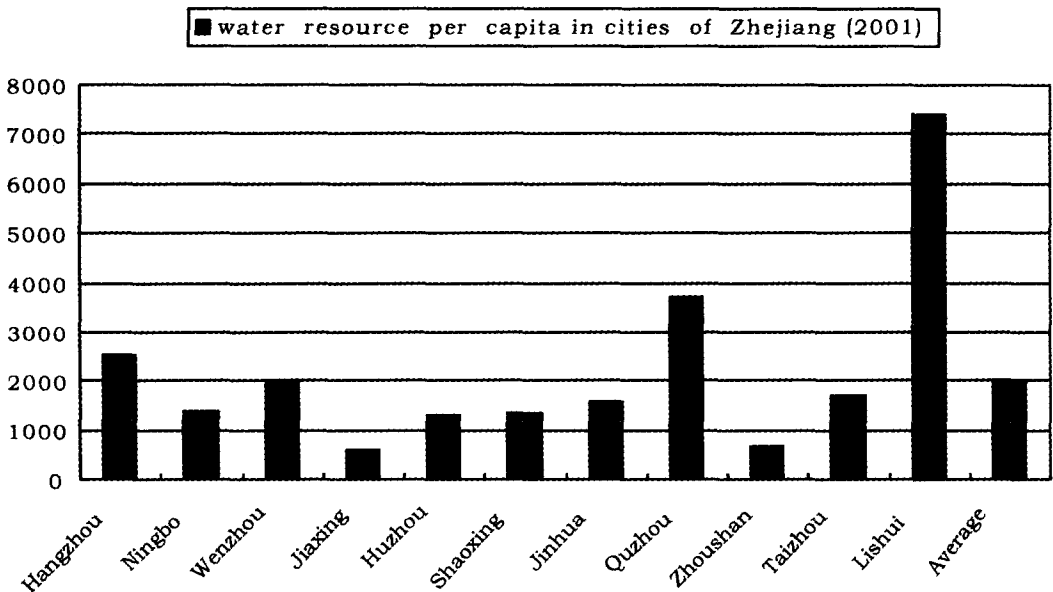


Fig.4 Water resource (cubic meters) per capita in different cities of Zhejiang (2001)

undeveloped mountainous districts usually have plenty of water while economically developed, socialized and populous coastal plains have few rainfalls. Thus appears the shortage of water in the coastal areas and plain districts.

2.2 Water resource per capita on the decline

With the ever increasing population, water resource per capita is on the decline, see Fig. 5. However, with the grow in population and number of cities, and the development of industry, the demand for water is on the rise, which exert great pressure on the existing water resources.

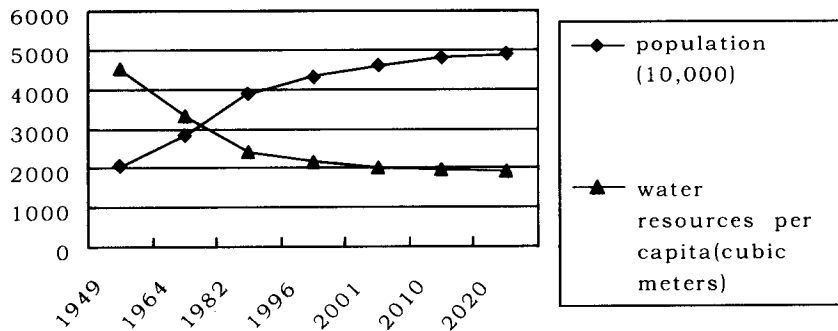


Fig.5 Changes in population and water resources per capita of Zhejiang Province

Ps: Since the absent of the actual number of water resources in the above-mentioned years, we use the average number 93.7million cubic meters in the calculation.

2.3 Water environmental problems

In the recent years, Zhejiang Province government has put great effort in fathering the water environment, and the water pollution is under control. However, with the rapid development of industry and city, a lot of polluted water is generated from industry, agriculture and living, leading to the degradation in water quality of rivers, lakes and reservoirs, especially in the cross river plains where the flow is slow and self-purification ability is weak. Combining the factors that those districts are populous and water pollution is severe, the descent in water quality in those areas can directly threat the safety of water resources.

2.4 Severe waste of water

People are unconscious and not economical in water use, and there are not effective measures in the respects. Although people pay for water usage, the fee is too low in irrigation, industry or living to fulfill the purpose of economical usage of water.

Water use in agriculture consumes more than 60 percent of total water consumption in Zhejiang, traditional surface irrigation generally achieved only around 50 percent efficiency in Zhejiang, only 43% in China. Water leakage in irrigation networks is one of the major sources of the inefficient use of water, which is a serious phenomenon in irrigation system. It is estimated that more than half of the

water is lost to leakage in canal systems (Liu and He, 1996). In some developed countries, the irrigation water efficiency is more than 70% ~ 80%.

3 Countermeasures for Sustainable development of Water Resource

The sustainable development of water resources mainly includes: to protect the limited water resources, prevent it from pollution and establish a good water environment; to scientifically allocate and reasonably explore the water resources to set up a sustainable water resources protection system; to be economical in water use and reuse recycled water; establish a rational water resource management system and water price according to the requirement of the harmonious development of man and nature and the market-oriented economy.

3.1 Protect the limited water resources from pollution

Water resource is limited everywhere. Thus, to protect it is related to the survival and development of all places.

To strengthen the monitor mechanism on water environment is the main way to ensure a sound understanding of the trends of the water resources in whole Zhejiang province. The key question in the monitor mechanism is to build up a monitor network on water quality, which regularly issue reports on water quality of main rivers, network of waterways in the plain, main large and medium sized reservoirs and other headwater, and to establish a highly effective and dependable, advanced and practical water conservancy information system and to establish informative, network transmitted and scientifically designed water conservancy system.

We should reinforce the management of water environment, study the capacity and strictly limit the polluted water outlet; we should also maintain the proper water flux of the rivers and limit or forbid overuse of surface water and groundwater. According to the Provincial goal in water conservancy construction, by 2020 the whole area will realize the integration of drink water supply in cities and counties.

We should also make trial economic compensation mechanism to protect water resource and resume the good environment and make the mechanism popular later on.

3.2 Scientifically allocate and explore the water resources, and establish water resource protection system for sustainable use

From the view point of Zhejiang Province, water resource per capita is not very low, but due to the unmatchable situation between water resource and population distributing and industry layout, territorial shortage of water is quite serious. Therefore, the major task for Zhejiang is to solve the problem of territorial water shortage. The key problem is to scientifically allocate water resource, implementing major projects for cross drainage areas and cross-region reallocation of water resources. Now that water diversion projects in eastern and northern Zhejiang are already in the process of argumentation, studying and programming, among which some mature ones, are already carried out. To unify the allocation of water resource in the Province, it is necessary that we establish the water reallocation network inside

or cross the drainage areas, design the water usage ration for industries and water distribution plan for major rivers, and workout the comprehensive program for provincial water resource.

We should properly explore the water resources, e. g. to build reservoirs inside the drainage area to increase the amount of water usable. Reservoirs can adjust the water volume; conserve the super-abundant amount in abundant years to meet the need in lean periods. It not only improves the supply of water, but also has the capacity of flood prevention and electricity generation.

Meanwhile, it should be strengthened in the study and programming of the carrying capacity of water resources and environment, so as to provide scientific evidence for rational allocation and exploration of water resources.

3.3 Economy in water usage, reuse of recycled water

By developing water-economical industry, agriculture and city, we are to establish a water-economical society, improve the effect and efficiency of water resources usage.

Now the waste in water resources is quite common! The water usage in agriculture takes up 60% of the total amount, a major water consumption aspect in Zhejiang. However, there has been great loss in the process of water transportation. So it is important to adopt effective methods to reduce the loss and to utilize advanced irrigation technique and equipments.

In industry, water-economy techniques should be adopted to use recycled water. We should turn polluted water into a usable resource. With proper process, wastewater can reach relevant water quality standard and be reused in industry, agriculture and city.

3.4 The need for innovation

We should manage, father and use water according to laws. Only by this can we make further steps to legalize and restrict all kinds of water-related behaviors. From the study in water resource, drainage area and hydro construction, we can refine the legal system to ensure a sustainable development in water resources.

We also need water management innovation in water resources, such as to set up a rational price system for water, actively raise money for water conservancy construction through market mechanism, and by proper policy and methods, motivate public to take part in the construction. It is certainly that a water market system suitable for Zhejiang should be established. By looking for unified management model for water affairs, we can change multi-organizations to manage water affairs. Thus, the allocation and efficiency of water resource management will be improved, the economy and protection of water can be enforced, making the management more systematical and efficient. By making use of rights and market of water, a modern water network area for water supply can be established gradually.

In the market operation management, according to the principle of market operation, it is important that we encourage and support the major entities in the market to actively take part in and form water affairs enterprises including riverhead construction, water supply and drainage, and sewage dispose, operating and managing according to the plan, criterion and standards, water market entrance requirement and rules set up by government and other water affairs management entities.

3.5 Water-saving in agriculture

Different measures in agricultural areas should be taken to reduce water consumption and increase water productivity:

- (1) to reduce water use in land preparation;
- (2) to reduce the water depth, maintaining soil in alternate wet and dry conditions could save 30% ~ 75% of irrigation water without substantially lowering yield compared with continuous flooding;
- (3) to select dry-resistant and high-yielding varieties;
- (4) efforts should be made to replace or improve water-saving irrigation system. For example, the current irrigation systems used by locals were largely constructed in the 1950' and 1960'. Equipment has become obsolete and cannot utilize water efficiently.

In conclusion, there is a great need for innovation and also many measures should be taken for the sustainable development of water resources.

References

- [1] Liu C M, He X W. 1996. Water strategy for China's 21st Century. Science Press, Beijing.
- [2] Rosegrant M W. 1997. Water resources in the 21st century: challenges and implication for action. Food, Agriculture, and the Environment Discussion Paper 20. IFPRI, Washington, D C, USA, p.27.
- [3] Ruth S. Meinzen-Dich, 1998. Managing competition for water resources. Agriculture + rural development. Volume 5. No 2. 6 – 9.
- [4] Seckler, D., 1996. The New era of water resources management: from 'dry' to 'wet' water savings-Research report No. 1. International irrigation management institute (IIMI). Colombo, Sri Lanka.
- [5] Hong Yang, Xiaohe Zhang, Alexander J. B. Zehnder, 2003. Water scarcity, pricing mechanism and institutional reform in northern China irrigated agriculture. Agric. Water Manage. 61, 143 – 161.
- [6] IRRI (International Rice Research Institute), 1997. Rice Almanac, 2nd Edition. IRRI, los Banos, Philippines, p. 181.
- [7] Liu, C. M., He, X. W., 1996. Water strategy for China's 21st Century. Science Publishing House, Beijing.
- [8] Luis Santos Pereira, Theib Oweis, Abdelaziz Zairi, 2002. Irrigation management under water scarcity. Agric. Water Manage. 57, 175 – 206.
- [9] Hu Tianzhou et al. 2003, the strategy research on sustainable development in Zhejiang, Science Press, Beijing.

Discussion on Sustainable Development for Water Resources in Zhejiang Province

Jinru Zhang

Zhejiang Provincial Department of Water Resources, Hangzhou, China

Zhejiang Province is a region of rivers and lakes in the south of the lower reaches of the Yangtze River, but it is worried about water. Along with rapid development of economic society of Zhejiang Province, the strategic study on water resources in the whole province should be further done well. Limited and precious water resources should be planned scientifically, allocated rationally, utilized effectively and protected economically. It is quite important to support the sustainable development of economic society of the whole province by means of sustainable utilization of water resources.

The basic features of water resources in Zhejiang and the present situation of its development are analyzed briefly in the paper. The main tasks and protective measures for sustainable development of water resources in Zhejiang are put forward according to the demand of the economic society for water resources.

1 Basic features of water resources in Zhejiang

1.1 It is plentiful in rainfall, but lower in water resources amount per capita

The mean yearly precipitation in the province is about 1600 millimeters. The years average water resources in Zhejiang is totaled at 93700 million cubic meters and the water resources amount per area is three times than the average of the whole country. But the water resources amount per capita in Zhejiang is only 2010 cubic meters, lower 8% than that of the national average level and a quarter of average level of the world.

1.2 It is concentrative in rainfall, with large flood runoff

Influenced by monsoon climate, the rainfall in Zhejiang is primarily concentrated on plum rain period between spring and summer and typhoon period between summer and autumn. The rainfall in plum rain period is large in scope and long in time as well as dense rainfall intensity in typhoon period. About 60 percent rainfall flow into sea in the form of flood because of short river course with rapid flow and insufficient impounding capacity. Moreover, an annual rainfall varies greatly, with a rainfall of about three times between wet and dry years, for which it expresses obviously continuous wet year or

dry year, with flooding and drought easily.

1.3 Unbalanced space distribution of water resources and great difference with population and economic development plan

Rainfall in the whole province from southwest to northeast decreases gradually. The southwest of the province is a high rainfall district and rainfall in the northeast close to plain and Zhoushan Islands is relatively lower. Population and economy are mainly concentrated in the east and it is not matched with the distribution of water resources.

1.4 Difficultly developing and utilizing water resources and hard preventing flood and drought calamities

The river courses in Zhejiang are short and the slope of upstream rivers is steep, with rapid rising and falling, so flash flood bursts easily. It is easy to cause extensive flood and waterlogging disasters due to narrow coastal plains and tidal backup. With long coastline in the province, typhoon is liable to make destructive power. There exist a lot of small watersheds in the province, in which geological disasters such as flash flood and mud-rock flow are easy to occur. As a result, rivers and watercourses are difficult to be regulated, investment cost for each engineering is high and the contradiction of short of capital is present.

2 Present situation of development, utilization, protection and management for water resources in Zhejiang

Since the establishment of P. R. China, Zhejiang provincial Communist Party committees and people's governments have paid great attention to water conservancy work and have led the people of the whole province to gain tremendous achievements of water conservancy construction. Since 1990s, following the rapid development of economy in Zhejiang and dramatic increment of economical strength, water conservancy construction has entered into a new and rapid developing period. In the recent 5 years, the total investment for water conservancy engineering reaches more than RMB 40000 million yuan. Appearance of water conservancy construction of the whole province has been greatly changed, with large scope, more items, quick speed and better benefit.

The capability of flood control has been greatly enhanced. The water control projects such as reservoirs, embankments and sluices have been built throughout the province. Since 1998, the construction of flood control system has been entered into a new stage. About 1280 kilometers of standard seawalls along the coast and 1070 kilometers of dykes on both banks of the Qiantang River have been constructed. A high standard flood control system for cities has been finished preliminary, with an investment of about RMB 10000 million yuan. A series of key water projects, such as harnessing of Taihu Lake in Hangzhou-Jiahu-Huzhou plain etc., have been completed and brought into full play. More than 1500 weak reservoirs have been strengthened, effectively lowering the reservoir's risk. The achievements of flood control system construction in Zhejiang have caused the attention of the Ministry of Water Resources. During the past 5 years, the direct disaster reduction benefit of water projects