河南省地理学国家重点学科培育经费资助

论水环境与人口健康

Water Environment and Human Health

(瑞士)许靖华 著
秦明周 译

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许靖华院士简介

许靖华，男，特聘教授，1929年生于南京市，是河南大学老校长许心武教授之子，国际著名的地质学者、海洋学者和环境学者，美国科学院外籍院士(1986)、第三世界科学院外籍院士(1986)、地中海科学院院士(1988)等。因为他对中国地质学的贡献，被授予中国科学院名誉教授(1985)、台湾中央研究院院士(1990)及南京大学荣誉博士等。

学历：1944年考入中央大学(1949年更名南京大学)地质系，1948年7月毕业并获学士学位。同年赴美留学，1950年在俄亥俄州立大学获硕士学位，1953年在洛杉矶加州大学获博士学位。

简历：1954年入美国壳牌石油公司从事研究工作，1963年到1967年在纽约州立大学和加州大学任教。1967年起移居瑞士，任教于瑞士联邦理工大学，任地球科学院院长。曾任国际沉积学会主席、国际海洋地质学委员会主席、国际海洋学委员会执行委员会理事、欧洲地球物理协会首任会长、瑞士联合国教科文组织代表、联合国核废料海底处置专家团专家、联合国的中国政府和马耳他政府技术顾问及原中国地质部、石油地质部和化工部顾问。他被《沉积学报》、《海洋地球物理学研究》等20多家世界级权威学术刊物聘为主编或编委。他担任了许多

国际科学合作项目的领导者，如JOIDES全球深海钻探项目、上地幔项目、岩石圈项目、全球变化项目以及内蒙古、新疆、西藏的国际考察项目等。

成果与奖励：已经发表SCI论文450篇，出版中英文著作20多部。

他担任过世界各洲的客座教授或客座研究员，是著名的美国古根海姆学者(1971)、伊丽莎白女王海洋地质学高级学者(1981)、Fairchild教授(1990)等。他是先后获得渥拉斯顿奖(1984)和彭罗斯奖(2001)两个奖的少数科学家之一。渥拉斯顿奖被认为是自然科学界的诺贝尔奖，曾经授予地质学的奠基人威廉·斯密斯、查尔斯·莱尔以及生物进化论的鼻祖查尔斯·达尔文和托马斯·赫胥里。他还获得了其他地学不同领域的最高奖，包括沉积学、沉积地质学、海洋地质学、石油地质学、构造学等。

他还是一位发明家，有多项专利技术。如他发明的“过滤一水转化器”是污水处理的革命性技术，“毛细管灌溉技术”将使缺水的荒地变为绿洲，“石油回采技术”将会缓解石油能源危机。他认识到亚硝酸盐污染和癌症的关系，在实验观察的基础上提出了清晰的论述。因此，他被聘为河南大学环境与健康中心主任。他希望他在学校的工作能够引领发现新方法，解救成千上万的生命。

目 录

1 Applying Integrated Hydrologic Circuits (IHC) Technology to Resolve Water Resource, Environment and Energy Problems

Abstract

The current problems of water shortage and environmental pollution could be resolved through water-recycling and through the balanced use of the groundwater reservoir. The solution of the crisis lies in the finding of a technique to amplify the water flow-rate into and out of porous medium. Hsu, assisted by his volunteer helpers, have devoted the last decade to develop the technology of integrated hydrologic circuits, and they invented hydrotransistors. This is article Part I summarizes the theory and the inventions of hydrotransistors.

R-hydrotransistors serve as groundwater-recharger without loss the use of surface land. RI-hydrotransistors serves a dual purpose of groundwater-recharge and capillary irrigation. F-hydrotransistors can reclaim waste-water for recycling as urban supply or as recharged groundwater. E-hydrotransistors extract groundwater a high enough rate to generate hydroelectricity. The innovations

are destined to replace current technology because of their economic superiority. Assisted by legislations, the new technology could pave the way for a Green Revolution.

The forthcoming Part 2 will be case-history studies at Dongguang and at Kunming China to treat polluted and waste waters for recycling to eliminate pollution. Part 3 will report a pilot program to convert desert into crop fields in the Shiyang River Drainage Basin, Northwest China. Part 4 will describe the theory and practice of a patented technology of three-dimensional water-injection for enhanced oil recovery. Part 5 will be a progressive report on groundwater-hydroelectricity.

Introduction

Industrial Revolution came after the French Revolution and the publication of the Malthusian Theory of Population; there was the necessity to resolve the potential crisis of starvation. The industrialization gave us mechanization and power, starting with the invention of steam engines, followed by fuel and electric power. Chemists played a dominant role. Engines were driven by phase and/or chemical changes. Manufacturing industries are purification or combination processes.

The Industrial Revolution created employment opportunities, but the inevitable urbanization destroys traditional values. The IT or the Second Industrial Revolution, came to remedy in part the crisis of alienation and loneliness. Information technology and telecommunication bring us closer again. Physicists played a dominant role. The inventions of transistors and integrated hydrologic circuits have made the constructions of hardware and software possible.

The two industrial revolutions have brought huge benefits to mankind, but the collateral damages of have also been considerable. Coming out of the Second World War, the greed of industrialized nation has led to a third crisis: water and energy shortages and environmental devastations. The time has come for a Third Industrial Revolution, a Green Revolution to make the Planet a better place to live in. Earth scientists will have to play the dominant role. We have to learn from Nature in our search of recipes for clean water, clean air, and renewable energy.

Statement of Problem

Current water and environment crises are a consequence of the misconception of what constitute water resources. In all books, in all practices, water resources are defined as the sum of water volumes in lakes, rivers, and other surface water-bodies. We learned from doomsayers that the World freshwater resources are rapidly vanishing. This is not true, water comes to us in the form of precipitation, and the global rainfall has not been diminishing. In fact, arid regions have received more rainfalls during the ages of global warming. 1 This ultimate water resource has been stored underground as groundwater, and indeed the groundwater reservoir constitutes 95% of the freshwater resource of the world. The natural recharging rate is very small; only 5% to 10% of the rainfall seeps underground to become groundwater, much of the precipitation flows as rivers or canals or stored in lakes or reservoirs on its way to the sea. The small recharge is enough to maintain a balanced water budget. Our groundwater resources are the savings of many million years, and there was no significant deficit spending until the 20^{th} Century. With the building of reservoirs and canals, people became then addicted to the use of surface water. Much water is lost by evaporation and by irrigation in arid region, and by pollution or wasteful human consumption in humid regions. Water shortages have become a norm rather than exception in many parts of the world. We are coming to a stage that there has to be a change in the fundamental policy, if the current crisis is to be remedied. We have to liberate ourselves from the dependence on surface water. On the other hand, the current excessive exploitations of groundwater have caused many problems, such as desertification, land-subsidence, and salinization of groundwater through. Drilling for groundwater is thus restricted or even prohibited in many communities. The solution is not to prohibit, but to regulate.

Water underground is like money in the bank. There are banking laws to regulate the overdraft of bank accounts, and there have to new legislations in order to achieve a balanced exploitation of groundwater. Bank accounts are balanced when incomes are regularly deposited, and the expenses are budgeted not to exceed the incomes. Likewise, the groundwater reservoirs have to be recharged, and use of the water resources has to be regulated by this fundamental economic principle: Those who do not make deposits in the bank are not permitted to withdraw money from the bank, and those who exploit groundwater have to share the expenses of recharging.

The importance of the groundwater recharge has been recognized by numerous scientists, and they have invented various methods of groundwater-recharge technology. As summarized in a study by the British Geological Survey, the current artificial recharge programs are grouped into the following categories:

Spreading methods:

Open wells and shaft;

Drilled wells and boreholes;

Bank infiltration;

Sand storage dams;

Roof-top water.

The category of spreading methods include infiltration or recharge basins, perennial dams, ditch and furrow, flooding, irrigations, stream channel modification, etc. Many large gravel pits are dug, for example, in the City of Beijing or in Orange County California. Flood water is stored in the pits to seep slowly down to recharge the groundwater reservoir. The disadvantages of such spreading methods are manifold. The use of surface land is lost. The clogging of the porous medium tends to hinder the recharging by infiltration. Also there is the substantial loss by evaporation of the water being temporarily stored for recharging. In view of the economics, many urban recharge-pits are filled up, and the land surface is sold as expensive real-estate. The liquidation of recharge-facilities has resulted in ever-more deficit of the groundwater budget. The BGS report has indicated that other recharge techniques are likewise ineffective and costly. Therefore, a greatest task in adopting the use of groundwater resource is to develop an economic and effective recharge technology. Recharging involves the quick entry of surface water underground, and one searches for a solution in finding a technique to amplify the water flow-rate into porous medium.

A major problem of carrying out groundwater recharge program is the lack of surface waters for recharging. The Er-Huang Village program at Beijing , for example, has to be suspended when water from Yunding River was no longer made available. Ultimately, we can trace the urban water shortages to the fact that treated waste-water, in most instances, cannot be recycled for groundwater recharge.

A waste-water has four components

(1) Organic debris, mainly algal remains

(2) Inorganic sediments, mainly sands and mud

(3) Living micro-organisms, mainly bacteria

(4) Dissolved matter, including heavy metals, phosphates, nitrates and nitrites.

One can build plants for aerobic biodegradation to produce intermediate water, zhengshui in Chinese. 3 The organic debris, mainly hydrogen and carbon compounds, are oxidized to carbon dioxide and water. The coarser suspended particles are settled in sedimentation ponds. The living micro-organisms could be disinfected. Only the very fine particles and the dissolved matter cannot be removed. Nevertheless, the treated water has no unpleasant odor and appears scenic, so that the biodegradation method is widely adopted as a standard practice of waste-water treatment.

The method underestimates the deleterious effect of the minor constituents of organic matter. Nitrogen and phosphorous are present at a ratio of about 15:1 in all living organisms. They are released as dissolved constituents, when organic debris are oxidized and decomposed. Added to those are ammonium and phosphates from chemical fertilizers and phosphates from detergents. Since nitrogen salts, especially the carcinogenic nitrites, are harmful, zhengshui is not permitted to be recycled as urban water supply. An unethical practice to use it for irrigation has caused very serious problems of groundwater pollution

An alternative to aerobic biodegradation is to remove organic and inorganic particles by coagulation and settling. Chemicals are introduced for those particles to adhere to the chemical mud before they settle. ? The residence-time of waste-water in sedimentation ponds is, however, much too brief, for reasons of economy. Fine articles tend thus to remain in treated water. The attempt to use the coagulation method for waste-water treatment at Dongguang, China , for example, has failed: the in-flow and outflow waters both have strong odor, because much of the partially oxidized organic debris fails to settle out. A critical slogan of drinking water in and stinking water out has caused the City officials to seek a better solution for waste-water treatment.

Still another alternative is to filter out the particulate matter and to absorb the hazardous dissolved matter by io-membranes. Sand filters are used, and water flow under gravity through the coarse filtering material. The disadvantages are two fold, the flow rate is too slow, and the pore size is too large. To increase the flow rate of sand filters, perforated pipes are installed near the base of sand filter, so that filtered water can be pumped out. Still the quality of filtered water leaves much to be desired because of the large pore size the filtering coarse sand.

Micro-membranes and super-membranes have been invented to remove micrometer-size particulate matter, or even some dissolved ions from polluted or treated waters. There are proposals in China , for example, to convert zhengshui into reclaimed water through such micro- or super-filters. The membranes are costly and experiments have encountered numerous problems. Consequently micro-membranes are seldom used for sewage treatment because of the economics.

Still a physical method of filtering is preferred to avoid the production of carcinogenic nitrites, Still. An effective filtering involves the rapid entry and rapid exit of water through very fine granular material. To recycle treated water, one also searches for a solution in a technique to amplify the water flow-rate into and out of porous medium.

Surface waters have been the traditional sources for irrigation. In a study of the water-budget of the Shiyang River drainage system of Northwest China, we found that the constructions of reservoirs and of irrigation canals have been the cause of desertification. Melt water from the mountains and groundwater from karst terrains were stored in reservoirs, transported by canals, and poured into the soil for plant growth. Much of the water is lost through evaporation4. Where surface waters are no longer sufficient, groundwater has to be pumped out for irrigation, causing alarming lowering of the groundwater table and its eventual salinization. The end result is desertification. Fresh or brackish water lakes are converted into salt flats and playas, large tracts of farmland lost, and people deserted their homes. This global catastrophe has alarmed the politicians. The Chinese Government, for example, is planning a 20-billion RMB program to prevent the desertification of the Shiyang River