周　斌　丁丽霞等　编著

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中国农业出版社

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Development and Application of Information System for Change Detection of Zhejiang Tidal Flat Soil Resources Utilization

Edited by Zhou Bin Ding Li-xia et al.

China Agriculture Press

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序

早在西汉时代，勤劳的浙江人民就开始不断地围垦海涂土壤。根据作者运用2001年的遥感资料调查结果，全省共围垦海涂土壤354.42万亩[①]，其中仍用作耕地的207.63万亩；新中国成立以后围垦255.41万亩，其中仍用作耕地的156.47万亩，分别占2001年全省耕地面积的6.65%和5.01%。根据浙江省土地勘测规划院的研究报告，1997年的浙江省耕地面积为3 120.55万亩，到2004年减至2 997.93万亩。七年时间净减耕地122.62万亩，年均减少17.52万亩。再据2007年第10期《浙江国土资源》报道，2004—2007年的4年期间，全省围垦海涂53.21万亩，年均围垦13.30万亩。如果以50%补充用作耕地，则年均增加耕地6.65万亩，每年大约补充全省损失耕地的1/4。又据《浙江省滩涂围垦总体规划（2005—2020年）》，15年计划围涂面积52.01万亩，年均增加涂地土壤3.47万亩。这些都充分说明：围垦海涂土壤，对浙江省近期乃至十多年以后的耕地占补平衡都将起到重要的作用；对实施浙江省的经济可持续发展具有重要意义。

新中国成立以后，根据围垦利用方式和科技含量划分浙江省的海涂围垦发展阶段，可以概分为单纯农业用地围垦、农林复合利用围垦、农林生态建设围垦三个阶段，现已进入科学利用安全围垦阶段。各个阶段的围垦利用实践都证明：全面研究开发现代信息技术，为海涂围垦和科学利用提供信息化技术支撑是十分迫切的。《浙江海涂土壤资源利用动态监测系统的研制与应用》专著，是综合运用多项当前最先进的信息技术，经过6年（1999—2004年）的持续研究，在取得丰硕的系列科技成果的基础上，再经过3年（2005—2007年）的系统总结和深化提升后撰写而成的。因此，该书不仅资料详实、数据可靠、内容丰富，而且研发的系统功能比较齐全，并具有较高的科技水平。该书的主要特色有：①研制的浙江海涂土壤资源利用动态监测系统，既为浙江省海涂土壤资源利用管理提供了信息化技术支撑（已供浙江省围垦技术开发中心使用），并为进一步开发利用海涂土壤资源提供了信息技术平台，对提高海涂土壤利用动态监测的信息化管理水平具有重要意义；②首次完成的浙江省1600年来海涂围垦演变的重现，形象地恢复了浙江省海涂围垦历史原貌，揭示出海涂围垦土壤利用的发展过程，为浙江省海涂地区的历史文化和海涂围垦等研究提供了扎实的基础资

① 1亩=667m²。

料；③在海涂土壤利用动态分析和评价结果的基础上，针对随着海涂围垦出现涂区更为严重的缺水问题，提出“三节（农业节水、工业节水、居民节水）四利（西水的有效利用、雨水的有效利用、废水的有效利用、海水的有效利用）”的用水建议，对解决涂区缺少淡水问题具有重要的指导意义；④研究提出的基于B/S结构的耕地等级评价技术、基于WebGIS的地图式海涂水稻土施肥推荐技术、基于高光谱遥感技术研制的土壤有机质含量反演与盐碱土特征评价技术、基于协同克立格的盐碱土电导率空间变异特征和剖面采样技术等的突破或新进展，为进一步提高海涂土壤利用动态监测系统的开发利用提供了新的信息技术支撑。

写完读感，再写一点我的心愿。浙江省人多地少，人均耕地更少。根据2004年资料，人均耕地0.64亩，是全国的44.8%。随着城市化和工业化的迅速发展，耕地还会快速减少。因此，遵循科学发展观，运用高新技术合理地开发利用耕地后备土壤资源，就成为可持续发展浙江省经济的关键措施之一。浙江省的历届领导和广大农业科技工作者素有“红”与“黑”两块是浙江省耕地的主要后备土壤资源之说，其中“红”指的是山地丘陵的红壤资源，“黑”是指沿海沉积的海涂土壤资源。我是一个土壤科学工作者，后又在国内首批开展农业遥感与信息技术应用研究。因此，早就有研究开发信息技术以支撑“红”与“黑”的合理开发利用的愿望。1991—1998年期间，我们经过连续8年，在完成欧共体资助项目和浙江省“八五”重点项目的研究任务，取得丰硕的系列成果的基础上，撰写出《浙江红壤资源信息系统的研制与应用》专著，中国农业出版社于1999出版发行。这是我国第一部土壤资源信息系统的科技著作。1999—2004年期间，我们再次经过6年，在组合完成中德部级合作项目、浙江省科技厅重点项目、博士后研究项目和2个国家自然科学基金项目的研究任务，取得丰硕的系列成果的基础上，周斌等撰写出《浙江海涂土壤资源利用动态监测系统的研制与应用》专著，中国农业出版社将于2008年出版发行。至此，经过1991—2007十七年的积极努力，我们终于完成了浙江省耕地后备土壤资源的“红”与“黑”科技专著“姐妹篇”的心愿。

本书的主要作者周斌，1992年获浙江大学区域地质专业学士学位；1996年和1999年分别获中国科学院地球化学研究所环境地球化学国家重点实验室、遥感中心的环境地球化学专业硕士学位、遥感与GIS应用专业博士学位。1999年，我成为周斌博士后的合作导师。他具有扎实的环境地球化学、遥感信息技术等学科基础，以及较高的科研技能水平。2001年，他在出站前就晋升副教授。丁丽霞等其他作者也多数是我的学生。他们要我为本书写个序，就以我的读感与心愿代序。

王人潮

2007年11月23日

Preface

As early as the Western Han Dynasty era, the industrious people of Zhejiang began continuously to enclose tidal flat soil for cultivation. According to the remote sensing investigation by the authors of this book, up to the year 2001, there has been 3.54 millions mu land reclaimed from the sea in Zhejiang, while 2.55 millions mu tideland was enclosed after the foundation of the People' s Republic of China. Until today, there are still 2.08 and 1.56 millions mu enclosed tideland used as arable land, which correspond to 6.65% and 5.01% of 3.12 millions mu arable land of Zhejiang Province in 2001, respectively. The cultivated land area of Zhejiang decreased from 31.21 to 29.98 millions mu during 1997—2004 based on the research report of Zhejiang Academy of Land Investigation and Planning. It showed a net decline of more than 1.73 millions mu in these 7 years, and 0.25 million mu farmland was decreased annually. However, according to the new survey published in No. 7, 2007 of the journal Zhejiang Land Resources, there was 0.53 million mu tideland enclosed during 2004—2007, and 0.13 million mu per year. Suppose half of the newly enclosed tideland was used as arable land, 0.07 million mu farmland can be increased per year, then a quarter of the loss arable land of Zhejiang will be replenished. Moreover, it was suggested in the Master Planning of Zhejiang Tideland Reclamation in 2005—2020 that 0.52 million mu tideland was planning to be enclosed in these 15 years, and 34.7 thousands mu land could be increased each year. These above have fully proved that enclosed tideland will play an important role in dynamic balance of arable land in Zhejiang Province recently or even decades of year later, which is significant to the sustainable development of Zhejiang social-economy.

The reclamation of tideland in Zhejiang after the foundation of the People's Republic of China can be generally divided into three phases according to the utilization patterns and the scientific and technological level, i. e. simple agriculture land reclamation, integrated agro-forestry utilization and ecological agro-forestry construction. At present, the tideland exploitation in Zhejiang is marching towards the new era of scientific utilization and safety reclamation. All the practices in three phases of tideland exploitation make clear that it is of crucial and imperative significance to furnish the technical support for tideland exploitation and scientific utilization through comprehensive research and development of modern information technology. The formation of this book *Development and Application of Information System for Change Detection of Zhejiang Tidal Flat Soil Resources Utilization* is grounded on the six years' (1999—2004) persistent research work adopting the currently available advanced information technologies with series of achievements gained, and on the following three years' (2005—2007) systematic generalization with analysis deepened and under-

standing promoted. As a result, the book is not only featured with vivid and detailed materials, but also with higher scientific and technological level embodied in the functional services provided by the Web Information System for Zhejiang Tidal Flat soil Resources Utilization (WISE-TAIRO) .

The highlights of this book are: ①with being operated by the Centre for Technological Development of Tidal Flat Reclamation of Zhejiang Province, the WISE-TAIRO provides the information technological support for utilization and management of Zhejiang tidal flat soil resources, builds the information technological platform for further exploitation of tidal flat soil resources, of which is great importance to the transformation of the information-oriented management for change detection of tidal flat soil utilization; ② the first attempt to reproduce the process of tidal flat reclamation over 16 hundreds year in Zhejiang gives a good picture of historical reclamation of Zhejiang tidal flat soil, reveals the development process of utilization of tidal flat soil, and provides a solid background for the research of historical culture and tidal flat soil reclamation in Zhejiang coastal region; ③concerning the increasingly shortage of water in enclosed area with continuous reclamation of tidal flat, the suggestion of "three-water-saving and four-water-utilization" was put forward on the basis of analysis and assessment of tidal flat soil utilization trend, which refers to the agricultural water saving, industrial water saving, civilian water saving, the effective utilization of western water and meteoric water, reuse of waste water, and seawater desalination; ④several technical breakthroughs or advances were made in this research including the technologies of cropland grade evaluation based on B/S structure, WebGIS-based coastal paddy field fertilization recommendation, the retrieve of soil organic matter and the properties assessment of saline soil using hyperspectral remote sensing, the investigation and sampling strategy research for spatial variation of electrical conductivity in saline soil based on co-kriging. All the results would be helpful to providing the advanced information technologies for further development of the change detection system of tidal flat soil utilization.

I would like to express some of my wishes on the heels of the above impression about this book. Zhejiang has a large population and relatively limited farmland, the per capita quantity of cultivated land in Zhejiang is only 0. 64 mu, approximately 44. 8% of national average based on the statistics data in 2004. It will be certain that the arable land decreases dramatically with the rapid growth of the urbanization and industrialization. One of the key measures to guarantee Zhejiang sustainable economy must be following strictly the viewpoint of the scientific development, and rationally exploiting and utilizing back-up farmland resources with the support of the innovative and high technologies. It is traditionally obtaining the concurrence from each term of leading groups and vast agricultural scientists of Zhejiang that "the Red and the Black" are the main reserves of farmland. The former one, Red, refers to the red soil resources distributed in mountainous and hilly region, and the latter, Black, means the tidal flat soil resources deposited along the seashore. As a soil scientist, I was engaged in the initial research work of applied agricultural remote sensing and informa-

tion technology in China. From then on, I had a desire to study and develop the information technologies for supporting the rational exploitation of the Red and the Black. During 1991—1998, we have been executing the program funded by the European Community and the key project in the 8th five-year plan of Zhejiang, then accomplished the book of *Creation and Application of Zhejiang Red Soil Resource Information System*. This book, published by the China Agriculture Press in 1999, embodied a concentration display of our fruitful research achievements during these 8 years, and had the honor of being the very first Chinese scientific monograph about soil resource information system. In 1999—2004, we successively implemented several projects, including the China-German Ministerial Cooperation Project, the Key Project from the Department of Science and Technology of Zhejiang Province, one post-doctoral research project and two projects financed by Chinese National Science Foundation. On the basis of the good teamwork and substantial results of the above projects during these six years from 1999 to 2004, Dr Zhou Bin and co-authors wrote this book of *Development and Application of Information System for Change Detection of Zhejiang Tidal Flat Soil Resources Utilization*, which would be published by the China Agriculture Press in 2008. Till then, after the seventeen years' great efforts from 1991 to 2007, we eventually achieve the aspiration of these two counterpart-writings about the Red and the Black, the back-up soil resources of farmland in Zhejiang.

The lead author of this book, Dr Zhou Bin, graduated from Zhejiang University with a Bachelor' s degree in geology in 1992. In 1996 and 1999, he respectively received his Master' s degree in environmental geochemistry and Doctor's degree in applied remote sensing and GIS from Center of Remote Sensing and Lab of State Key Environmental Geochemistry, Institute of geochemistry, Chinese Academy of Sciences. After that, Dr. Zhou inaugurated his career as a postdoctoral fellow in our institute, and I became his cooperative professor during his postdoctoral research. Dr Zhou is a high calibre research scientist with expertise in environmental geochemistry and remote sensing, and I was deeply impressed by his keen interest, his well-designed plans for researches and his dedicated performance of those projects he involved. In 2001, Dr Zhou was promoted to be an Associate Professor with a special approval in Zhejiang University. Dr Ding Li-xia and other co-authors are mostly my students. They kindly asked me to write preface for this book, so I am very happy to do it with my impression and wishes.

Wang Renchao

2007. 12. 23

前　言

浙江省海涂土壤资源丰富，整个海岸线都有分布。自西汉以来，人们就开始开发利用海涂土壤资源，至今已有2000多年的历史。人们在获取巨大社会经济效益的同时，也遇到了过度开发、环境破坏等许多开发与保护矛盾的资源管理问题。运用遥感与信息技术全面调查与掌握海涂土壤资源的数量、质量及其发展变化规律，并在此基础上采取信息化的管理措施，对缓解人地矛盾、合理利用海涂土壤资源、实现海岸带的可持续发展具有特别重要的意义。

海涂土壤资源处于海陆交接带的特殊地理位置，决定了它有别于陆域土地资源的特殊属性：①海涂土壤资源是浙江省重要的土地后备资源。几千年来，新的海涂不断形成，原有海涂经过围垦改造变成良田，为沿海地区的粮食生产提供了大量的农用土地；同时，也为工业、交通、港口、城镇、开发区和旅游业提供了建设用地，并带动了相关产业的发展，对沿海地区的经济和社会发展做出了重要贡献。②海涂土壤资源利用具有显著的时空动态性和多样性。海涂土壤资源从淤涨到围垦开发利用，从潮间带逐渐过渡到陆地区域，从海岸湿地发育为陆地，从渔业养殖到农业耕地、林地、园地等。③海涂土壤资源对海岸带的生态平衡起到重要作用。海涂处于海洋与大陆相互作用较强的地带，生态环境脆弱。海涂土壤作为这一区域的重要生态环境因子，它的状态及变化对维持海岸带生态平衡、保持环境稳定有重要作用。④海涂是重要的湿地资源。海涂土壤资源在未开发利用或利用初期，属沿海湿地，具有调节沿海地区地下水、净化环境、调节气候、生物多样性保护、消浪护岸等重要作用。但是在围垦利用之后，它的湿地属性就消失了。因而开发利用海涂土壤资源时不能过度，需保留一定量的湿地资源，维护湿地功能，在获取社会、经济效益的同时，不能忽视了生态效益。

为科学合理的开发利用海涂土壤资源，实现海岸带地区的经济可持续发展，浙江省历届省委、省政府都把海涂开发与利用列为重要的经济发展战略。“六五”以来，浙江省的每个五年科技规划都把海涂列为重点研究项目。海涂资源科学管理与可持续开发利用依赖于对海涂土壤资源与环境保护动态信息的掌握和对海涂土壤资源不同开发利用方式的未来结果做出正确预测。遥感、地理信息系统、GPS等现代信息技术的综合运用，为解决海涂土壤利用动态监测，实时提供海涂围垦、土壤性质、时空变异、利用变化等现势资料，发挥了巨大的作用。

我们组合中德部级合作项目："中国浙江沿海盐碱地的复合农林业"的"研制浙江省海涂区土壤利用动态监测系统"专题、浙江省科技厅重点项目："浙江省海涂土壤利用动态监测系统的研制与应用"、博士后研究项目"基于数据挖掘的土壤自动制图研究"以及"土壤空间变异与景观模型支持下的土壤遥感解译技术研究"与"农田土壤养分变异的遥感与地统计定量评价研究"两个国家自然科学基金项目等，成立了统一领导的课题组。课题组经过6年（1999—2004年）的相互协作系统研究，完成了浙江省围垦区土地利用的动态监测、浙江省大陆淤涨型海岸线变迁调查、网络化海涂土壤动态监测系统的建设与应用、海岸带盐碱土的养分空间变异、土壤高光谱测试及其特征与评价等主要研究内容。同时，对利用传统遥感数据如何提高土地利用分类精度；土壤的机械组成、有机质含量和总氮含量与高光谱反射波段之间的相关性；水稻土有机质含量光谱预测模型；海涂围垦区盐碱土时空变异特性及其在田间分区精确管理中应用；土壤资源智能制图等一系列问题进行了深入的研究与探索。研究成果对今后进一步研究海涂土壤资源的开发与持续利用具有重要的理论价值和实践意义。

我们在上述研究成果的基础上，综合运用空间数据库技术、WebGIS技术、Web3D技术、网络数据统计报表技术、FLASH动态网站设计技术等多项最先进的信息技术，研制开发出基于Web的浙江海涂土壤利用动态监测系统，进而以该系统为平台，研发出基于WebGIS的浙江海岸带耕地等级评价和施肥推荐两个专业应用系统。这些系统不仅为浙江省海涂围垦潜力研究和海涂资源合理开发利用提供了数据资料和科学依据，还能为沿海地区建立县级大比例尺海涂土壤利用动态监测系统提供先进技术，为县级耕地质量评价、农业区划（利用分区），以及农田分区精确管理等服务。

本书分三篇内容，详细介绍了以浙江海涂土壤资源利用动态监测及其网络信息系统的研制方法、过程与应用。第一篇是浙江省海岸带土壤资源概述，简要介绍浙江省海岸带基本情况和海涂区土壤资源类型。第二篇是浙江海涂土壤资源利用动态监测及其系统研制，是本书的重点，较详细地介绍了浙江省的海涂土壤利用遥感动态监测、大陆淤涨型海岸线变迁的遥感调查、典型试验区的海涂土壤资源监测研究、网络化海涂土壤资源动态监测系统的总体设计及其开发与实现。第三篇是浙江海涂土壤资源利用动态监测系统的专业系统开发与应用，介绍了以浙江海涂土壤资源利用动态监测系统为平台，开发出海岸地区耕地等级评价和海涂水稻土施肥推荐两个专业应用系统的初步实践。参与本书写作的主要人员有周斌、丁丽霞、史舟、王新、张新刚、王繁、黄明祥、周炼清、周清、李艳。王人潮教授在系统的研制过程中做了大量的组织与协调工作，并在本书审稿时提出了许多建议和帮助，还为本书写序，在此表示衷心感谢！

最后，在本书得以出版之际，要特别感谢国家科技支撑计划项目（2006BAD10A07）“基层农村综合信息服务技术集成与应用”、国家重点学科土壤学科、浙江大学农业遥感与信息技术应用研究所、浙江省农业遥感与信息技术重点研究实验室的大力支持与经费资助。

编　者

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Forward

Zhejiang has abundant tidal flat soil resources along its whole coastal region. People in Zhejiang started to exploit and utilize tidal flat soil resources from the Western Han Dynasty era with the history of over 2000 years. While the great social-economical benefits being obtained from the utilization of tidal flat soil resources, many problems appeared about exploitation and protection in resources management including overexploitation and environment degradation. Therefore, investigation and acquisition of the magnitude, quality and its change of tidal flat soil resources by remote sensing and information technologies, and further carrying out the information-based management, are extremely significant to alleviation of the problem of large population and relatively limited farmland, reasonable utilization of tidal flat soil resources, and sustainable development of coastal region.

Tidal flat soil resources develop on the fringe area of land and sea with the following particular attributes distinct from land resources: ① tidal flat soil resources is one of most important back-up land resources in Zhejiang Province. For thousands of years, with ongoing development of new tidal flat, the reclamation of tidal flat furnished not only huge areas of farmland for grain production, but also much construction land for industry, transportation, habour, town, development zone and tourism which played very important roles in economic and social development in coastal region by stimulating the booming of relevant industries. ② tidal flat soil resources has significant spatio-temporal characteristics of dynamics and diversity with varying from accumulating sedimentary area to reclamation area, from intertidal zone to land zone, from coastal wetland to upland, and from aquaculture to cropland, forest, and orchard garden etc. ③ tidal flat soil resources play an important part in ecological balance of coastal region. As an important ecological environmental factor, tidal flat locates at the fringe area strongly interacted by ocean and land, the status and its change of tidal flat soil is crucial to balancing the coastal ecology and protecting the environmental stability. ④ tidal flat is one kind of precious wetland resources. At its prior and initial period of exploitation, tidal flat soil resources become part of coastal wetland having important functions of underwater level adjustment, degradation of pollutant, climate regulation, biodiversity protection, waves absorbing and bank erosion reducing. However, tidal flat soil resources lost its above attributes of wetland once they are enclosed for land reclamation. Therefore, the exploitation of tidal flat soil resources should be cautious and adequate areas of coastal wetland must be reserved in order to maintain its functions. The ecological benefits can not be ignored while economic and social profits being pursued.

Aimed at implement of economic sustainable development in coastal region, each term

of leading groups in Zhejiang Province took exploitation and utilization of tidal flat into account as strategic target of ecomonic development. Tidal flat have been always covering by the key research projects in each Five-Year Science & Technology Planning since the Sixth Five-Year Plan. The scientific management and sustainable utilization of tidal flat resources rely on our abilities of rapid acquisition of information about tidal flat soil resources and environment, and validity of prediction about results from different utilization of tidal flat soil resources. Integrated application of advanced information technologies such as remote sensing, GIS and GPS etc. can be certain to play a large role in change detection of tidal flat soil utilization, and provide the current information about tidal flat reclamation, soil attributes, spatio-temporal variation and landuse change.

In 1999—2004, we successively undertook several projects, including the Task VI-*Development of Monitoring System for Zhejiang Tidal Flat Soil Utilization* of the China-German Ministerial Cooperation Project-*The Integrated Agro-forestry in Salinate Fields of Zhejiang Coastal Region*, the Key Project from the Department of Science and Technology of Zhejiang Province-*Development and Application of Information System for Change Detection of Tidal Flat Soil Resources Utilization in Zhejiang Province*, two projects financed by Chinese National Science Foundation-*Study on Soil Interpretation Using Remote Sensing Based on Spatial Variation and Landscape Model* and *Quantitative Assessment of Soil Nutrients Spatial Variation in Farmland Using Remote Sensing and Geostatistics*, one post-doctoral research project-*Intelligent Soil Mapping based on Data Mining*. We linked all above projects together by setting up a unique research group. On the basis of the good teamwork and substantial results of the above projects during these six years, the following research tasks were implemented: change detection of soil resources utilization in Zhejiang tideland reclamation area, investigation of shoreline change in the accumulating sedimentary coasts of Zhejiang, development and application of web information system of soil resources utilization in Zhejiang tidal flat area, spatial variation of saline soil attributes in representative tidal flat area, retrieving and assessment of soil attributes based on hyperspectral measurement. A series of intensive studies and exploratory researches were carried out including how to increase accuracy on landuse classification by remote sensing, correlation between soil mechanical composition, organic matter content, total nitrogen content and reflective spectrum band, hyperspectral modeling of organic matter content of rice paddy soil, spatio-temporal variation of saline soil in tideland reclamation area and its application on precision management, intelligent mapping of soil resources. All the results of those researches are believed to be very helpful to any further studies on exploitation and sustainable utilization of tidal flat soil resources.

Based on the above research achievement, a web information system for change detection on tidal flat soil resources utilization in Zhejiang (WISE-TAIRO) was developed by using present-available advanced information technologies such as spatial database engine, WebGIS, Web3D, Microsoft Reporting Services and dynamic website design. In addition,

two specified web information systems for cropland grade evaluation and paddy field fertilization recommendation were developed on the platform of WISE-TAIRO. All those systems can offer not only basic data and scientific references for potential research of tidal flat reclamation and rational exploitation and utilization of tidal flat resources in Zhejiang Province, but also furnish the advanced technologies for developing large-scale change detection system of tidal flat soil utilization in coastal regions which can serve for cropland quality evaluation, agricultural regionalization (landuse zoning), and precision management of farmland.

Being divided into three sections, this book describes in considerable detail how the trend of soil resources utilization in Zhejiang tidal flat area, and WISE-TAIRO was developed and applied. Section I is the *Introduction of Coastal Soil Resources in Zhejiang Province*, which introduces briefly the background of the Zhejiang coastal region and soil resource types in tideland. The main part of this book, *Change Detection and Web Information System Development of Soil Resources Utilization in Zhejiang Tidal Flat Area*, is presented in Section II, gives a panoramic view of our research works on land use change detection in Zhejiang coastal region of being enclosed for cultivation, investigation of coastline shifting in the accumulating sedimentary coasts of Zhejiang Province; monitoring the tidal flat soil resources in the representative study area, integrated designing and development of the WISE-TAIRO. The last Section, *Development and Application of the Specified Web Information Systems*, illustrates two pilot studies on the applied subsystems of cropland grade evaluation and paddy field fertilization recommendation in coastal area on the platform of the WISE-TAIRO system. The contributors of this book are Zhou Bin, Ding Li-xia, Shi Zhou, Zhou Lian-qing, Wang Xin, Zhang Xin-gang, Wang Fan, Huang Ming-xiang, Zhou Qing and Li Yan. Professor Wang Ren-chao implemented a great deal of organization and coordination works in the process of the research, provided a lot of valuable suggestion and help during the forming of manuscripts, and wrote the preface of this book. We, the authors, would like to express our sincere gratitude to him.

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Authors

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Abstract

1. Introduction

China has a large population and relatively limited land. The per capita quantity of land in China is only 0.777hm^2, approximately 33.33% of world average based on the statistics data in 2003. As one of the most advanced provinces in eastern China, Zhejiang is facing more serious problems of human and land. The per capita quantity of land in Zhejiang is only 0.23hm^2, equals to 9.87% of world average and 29.6% of national average, respectively. Since the starting of Reform Movement and Opening-up police in late 1980s, Zhejiang has a blooming land requirement for urbanization and industrialization associated with the rapid growth of local social economy. As a consequence, the area decrease and quality reduction of arable land has been becoming one of the main impediments of sustainable socio-economic development in Zhejiang.

The Red (red soil) and the Black (tidal flat soil) are main potential resources for farmland in Zhejiang. Thus, the exploration and reasonable utilization of red soil and tidal flat soil are always included in the key economic development strategy by each term of leading groups in Zhejiang Province. Especially since the Sixth Five-Year Plan, the red soil and tidal flat soil have been covering by the key research projects, and to some extent, the achievement of those projects lightened the burden from land demanding.

In order to implement tidal flat soil exploration and rational utilization, we must make clear the history and effect about the reclamation and utilization of tidal flat, and try our best to make good prediction for the consequences of the different land use patterns. For this purpose, we should develop firstly the technology for change detection of tidal flat soil utilization, and apply it on the monitoring of tidal flat reclamation, land use change, temporal and spatial variation of soil attributes. It has been proved by practical experience that no traditional technologies but only the development of information system, which integrates the advanced information technologies including satellite remote sensing, GIS, GPS, internet, simulation and modeling can meet those above requirements.

2. General technical methods

The development of a routinely operated system for change detection of tidal flat soil utilization with high standard needs not only solid professional knowledge and reliable latest