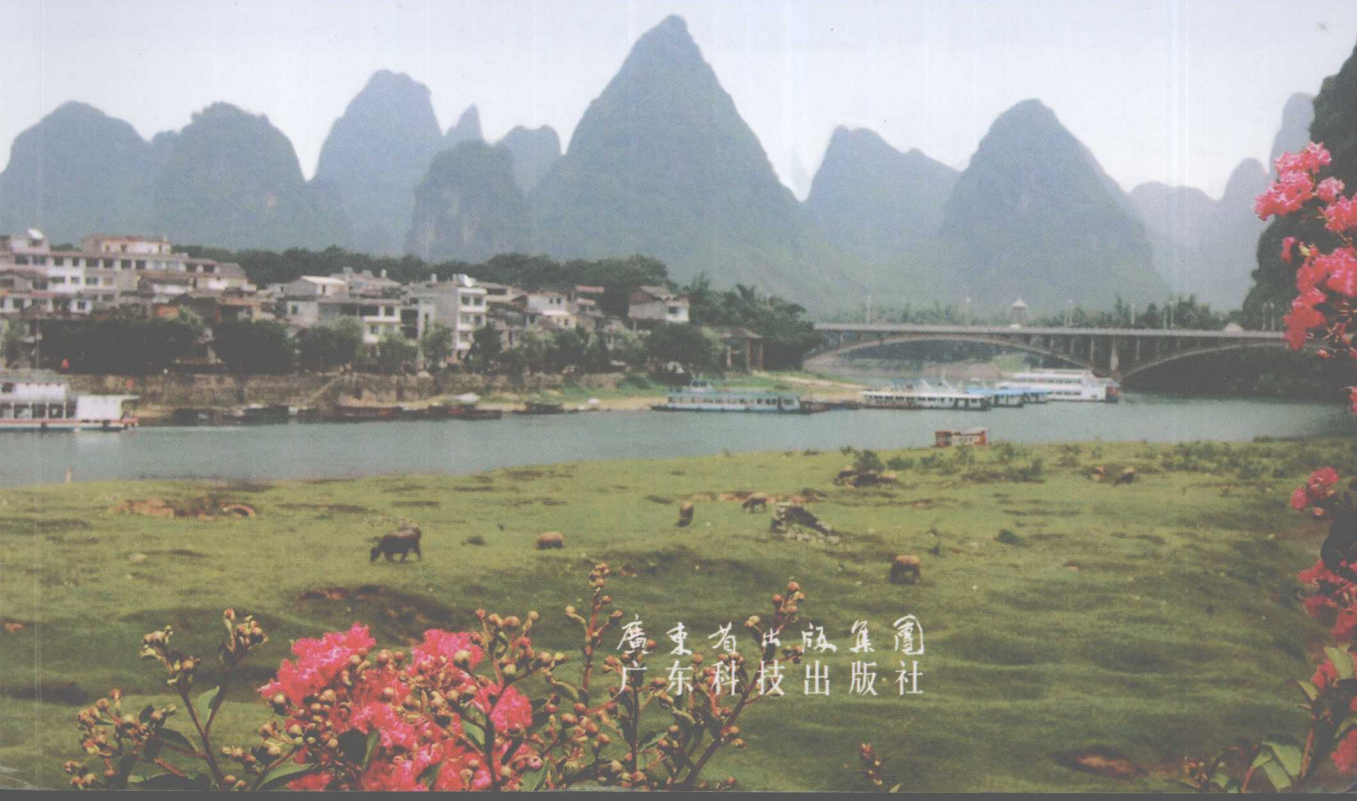


# 城乡建设与地质环境

Urban Rural Development and Geologic Environment

城乡发展 坡地工程 资源开发 灾害防治

刘瑞华 唐光良 卢薇 刘卫平 孙宁 编著



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## 内 容 简 介

城乡建设、土地利用、资源开发等都与地质环境息息相关。作者根据丰富的第一手资料,从城乡建设与土地利用、边坡及坡地灾害、泥石流的形成及其灾害、岩溶地面塌陷、城乡居屋地盘的特点及其灾害的形成、城市化过程的水环境效应、城乡建设导致河道演变与水文效应、砂石资源开发与环境效应、软土分布区的工程病害等方面,分析城乡建设与地质环境问题。从保护地质环境、建设人类美好家园的角度,提出进一步做好城乡建设与地质灾害防治工作的设想。

本书内容丰富,有文字叙述和大量的现场照片及插图,可供城乡规划与基础工程建设、地质环境与地质灾害防治勘察、地质工程、道路工程、水利建设等设计施工及教学和科研工作者参考。

# 序 1

广东地处华南沿海，地质环境条件复杂而脆弱，气候雨旱季分明。每逢夏秋两季，台风暴雨相对集中，坡面径流量大而且侵蚀作用强烈，山地地质灾害频发；平原地区多属沿海或三角洲地带，软土层发育，地面沉降灾害多；隐伏岩溶分布区，岩溶地面塌陷问题突出。因此，为保护地质环境和宝贵的土地资源以及人类生存环境，减少或避免地质灾害所造成的损失，深入开展地质灾害与防治的研究和普及教育工作是很重要的。

刘瑞华研究员等，长期从事水文地质工程地质工作，特别在水土保持、地质灾害防治方面做了大量工作，主持完成了相关的研究项目多项，积累了丰富的第一手资料，并收集了台湾、香港以及西南省区的大量资料，经过整理研究后撰写了《城乡建设与地质环境》专著。书中概述了广东地质环境和地质灾害基本现状，介绍了城乡建设与土地利用的基本特点，叙述了边坡的类型特征、灾害形成机理、灾害发生规律及其影响因素，并逐一介绍了泥石流、岩溶地面塌陷等类型地质灾害的形成、分布及其灾害特点；通过大量实例，分析了城乡居屋地盘的特点及其灾害的成因。本书还对城市化过程的水环境效应、受污染地表水直接和间接影响地下水质的基本原理和特点、城市建设导致的河道演变及水文效应、砂石资源开发的环境效应、软土分布区的工程病害等做了介绍。提出了在实施各类建设工程时做好土地利用规划、地质环境条件评价、地质灾害风险评估，以加强地质灾害与防治知识普及教育。

书中每一章的编写过程都以简明的文字通过案例阐述学科的基本理论和学术观点，并附现场彩色照片和相应的插图。每一章节的内容，都从不同的角度突出城乡建设及资源开发与地质环境的关系，针对人为活动对地质环境造成的影响，叙述各种人为地质灾害的形成与发生过程及其成因，提出了灾害防治的基本原则和思路。该专著编写的最大特点是，全书画面直观，图文并茂，通俗易懂，而且具有科普特点。在地质灾害防治研究和地质环境勘查以及开展地质灾害防治科普教育等方面具有重要的指导意义。

中国工程院资深院士

吴元勋 教授

2007年8月8日

## 序 2

广东省地处热带—亚热带，是华南地区人口最多、经济最发达的省份，也是一个山地多平地少的省份，被称之为“七山一水二分田”。随着经济的迅速发展和人口的不断增长，城市发展、乡镇建设、交通道路改造扩建等需要大量的土地；由于对土地需求量日益增加，可作为建设用的平地日趋减少，坡地的开发利用不断兴起，并成为未来发展不可避免的趋势。省内地形地貌类型丰富，地质环境条件复杂，而从建设用地的角度来看，相当多的地区属于地质环境脆弱地带。例如，丘陵山地的坡地是斜坡地质灾害易发地带，在夏秋两季台风暴雨的作用下，坡面径流量加剧而侵蚀作用强烈；平原地区多属沿海或三角地带，软土层发育，易于引发建筑地基的失稳；在隐伏岩溶地区，岩溶地面塌陷问题也很突出。然而，一些规划部门和建设部门由于缺乏对地质环境脆弱性和地质灾害危险性的认识，致使在各类建设工程中遭受地质灾害危害的现象时有所见。据有关部门统计，人为引发的地质灾害占所有地质灾害的70%以上，并造成了较大的经济损失甚至人员的伤亡。随着建设项目的日益增加，各类土地的开发利用也不断扩大，同时，在城乡建设过程需要开发建筑材料和矿产资源，都会涉及地质环境问题。因此，城乡建设规划用地务必稳妥慎重，一有不当，开发过程或建成之后可能会引发各种地质灾害。

土地开发利用不仅需要改进技术，更需要加强管理，才能使其有序进行。为了避免和减少在土地开发利用过程中引发各种地质灾害，国务院于2003年颁发了《地质灾害防治条例》（国务院令 第394号）和《中华人民共和国行政许可法》等相关规定；国土资源部以国土资发〔2004〕69号文件，发出关于加强地质灾害危险性评估工作的通知；广东省国土资源厅为了更好地贯彻执行国务院第394号令和国土资源部〔2004〕69号文的精神，结合广东省的实际情况，以国土资发〔2004〕237号文件，制订了《广东省地质灾害危险性评估实施细则》（试行），适用于广东省地质灾害易发区内进行各类工程建设、城市总体规划、村庄和集镇规划时的地质灾害危险性评估，使广东省地质灾害防治和地质灾害危险性评估工作更有法可依、有章可循。广东省广大地质工作者在地质灾害与防治工作中做了大量的卓有成效的工作。

刘瑞华研究员等长期从事水文地质工程地质工作，多年来在水土保持、地质灾害防治、水文地质勘察、城市地貌与环境保护等方面做了大量的调查和研究工作，主持完成了相关的科研项目30余项。根据长期调查研究工作中积累的丰富的第一手资料，通过学术交流和科学考察及其他方式长年收集的台湾、香港以及西南省区的大量资料，他们撰写了这部《城乡建设与地质环境》专著。这部书的出版，对于广东省深入开展地质灾害防治的技术管理和科学普及将起到极大的推动作用。

本书最显著的特点和最重要的贡献在于，始终结合人类活动与地质—地貌—地理环境变化和地质灾害的关系来论述问题，紧密结合广东省城乡建设与土地开发利用的基本

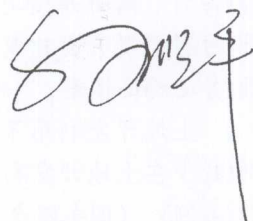


特点、现状和主要的类型，深入浅出地分析了在这些建设和开发过程中可能发生的环境地质问题和地质灾害类型，例如边坡灾害、泥石流、岩溶地面塌陷、水环境和水污染、软土工程病害等，深入浅出地分析了这些问题和灾害发生的地质条件、发生过程和机理、自然控制因素和人类活动因素以及管理与防治技术等，这些内容对于地质环境管理和地质灾害防治部门、各类城乡建设单位以及广大民众在城乡建设和土地开发利用中具有深刻的科学指导意义。

本书编写的鲜明特点是将地质环境和地质灾害与城乡建设和土地开发关系的科学道理和防治技术等内容以图文并茂的形式展示。每一部分均以文字—现场照片—各种插图的综合形式表达，全书计有彩色照片近 500 张、插图 70 多张，其中 80% 以上是作者的第一手资料。这种新颖的形式不仅适合于同行专家和专业人士阅读，也适合于有关基层管理干部、工程人员、大中专学生及有一定文化基础的居民阅读。因此，本书的写作是一种高级科普新的尝试。

本书的出版不仅对于普及地质灾害防治科学技术及宣传中国、广东省国土资源开发管理部门有关文件精神有重要意义，而且对于中国和广东省贯彻科学发展观，加快城市化进程，建设社会主义新农村以及建设和谐社会过程中正确处理人地关系具有重要应用和参考价值，并将取得良好的社会效益。因此，本人乐意为此书作序，希望本书得到读者广泛的兴趣和喜爱。

广东省地质勘查局局长  
广东省地质学会理事长  
2007 年 8 月 8 日



# 前 言

## 1. 编写本书的背景和目的

城乡建设受地质环境条件的限制,同时地质环境也会受城乡建设的影响。在不同的历史时期,由于社会发展的需求和经济发展水平的差异,这种相互影响的程度有较大的差别。20世纪50~70年代,我国以计划经济为主,科学技术水平相对较低,国外先进技术引进较慢,管理水平比较落后,经济发展缓慢,因受这些条件的限制,城乡发展速度也较缓慢。因此,各类工程建设规模总体偏小,开发建设的层次低。如交通路线一般是随弯就曲迁就地形延伸,大跨度桥梁少,尤其在山区特别明显。除了铁路之外,各种等级的公路高切边坡深填路基的现象不为多见,高层建筑物甚少。由于经济发展缓慢,工农业生产较落后,社会物质流通量小,坡地利用和资源开发的程度很低,故此,各种人类活动对地质环境或生态环境的影响不很突出。

近30年来,我国实行经济体制改革和对外开放政策,使我国进入经济高速发展时期。土地利用与自然资源开发,各种人类活动对地质环境的影响是前所未有的。广东是华南地区人口相对稠密的省份。由于在地理环境方面占有优势,先进技术和各种外资引进方便,在改革开放的初期,广东在全国扮演了“排头兵”的角色。由于具有经济和技术的优势,根据工商业发展和城乡建设的需要,从省外引进大量劳工和专业技术人才,从而使广东的人口密度进一步加大。因此,解决广大居民的居住地盘和建设各种类型的工业厂房,已成为当时城乡建设和土地利用的突出问题。在发展过程中,需要加强平原与山区的往来以及内地与沿海地区的沟通,促进山区资源的开发利用,使沿海与内地的经济和物资互相得到交流,为此,必须加强各类不同等级道路的改造和建设。可见,人口激增,城乡发展,土地利用,资源开发,交通道路建设已经成为推动社会和经济发展的巨大动力。近20年来,为满足各部门建设用地的需要,不但平地日趋减少,相当部分耕地被占用,而且各类山坡地的开发利用也在不断兴起。

城乡建设是在一定范围内,依赖着某种地质体作为建设的基础而进行的各类工程建设,其中包括城镇、村庄、道路和桥梁、厂矿及其他各种建筑物的施工建设。各类建设可以是在已有建筑物的基础上进行扩建、改造或者维修,也可以是在一块空白的土地上开始全新的规划和建设。传统的各种土木工程建筑以及水利设施都不可能离地而立,因此,地形地貌和地质环境条件都与各类建筑物的适宜性息息相关。建设场地或者地盘的勘查评价是整个土地开发计划的一部分,也是基础的和首要的工作。详细查明建设场地的地质环境条件可以预防或减少工程事故的发生,而且可以使工程的造价合理地降低,同时将保障工程建设的安全并延长其寿命。可见,对于城乡建设的各类工程预算来说,应该在设计和施工以及合理使用建筑材料方面降低成本,而不应该在地质环境勘查方面减少投入。



20 世纪 90 年代以来,大中城市高楼犹如雨后春笋,数十层的大厦还建有多层地下停车场;交通网络、多层立交和远程高架路、大城市地下铁道贯通东西南北;不同形式的桥梁连接江河两岸;乡镇和偏僻的山区建设了新农村,不少村民由破旧的泥砖瓦房搬进了多层的小楼房,蜿蜒曲折的山区小路变成了多车道的高等级公路;形形色式的坡地利用和各种资源开发举目可见,城乡发展和交通建设使社会产生了巨大的变化。但是在各类工程的规划设计和施工过程中,对复杂的地质环境条件认识不足,施工程序和方法欠妥;用地选址不当,边坡开挖不合理,工期短赶任务,防灾意识淡薄,防护措施跟不上,工程投资不足,这些人为的失误引发了各种不同程度的地质灾害,如崩塌、滑坡、泥石流、地面塌陷等。十几年来,各种人地过程中人为引发的地质灾害,不仅在山区,而且在大中城市也时有发生,造成了不同程度的经济损失,甚至造成国家财产的重大损失和人员伤亡事故。在华南地区,尤其广东,各类人为引发的地质灾害占本地区所有地质灾害的 70% 以上。

根据有关人为因素造成地质灾害的实例和灾害的特点分析,各类灾害都说明了在与地质环境有关的建设工程施工过程中,其中相当部分是由于对各种地质环境认识不深、施工程序和方法有误、防护措施跟不上所造成的。尤其是广东,在近 10 年来所发生的各种地质灾害中,约占 70% 是人为造成的。针对这一特点,本书遵循“科学发展观”的指导思想和以人为本的原则,努力做好地质灾害防治的科学普及工作。根据 2003 年 11 月 24 日中华人民共和国国务院令 第 394 号公布的《地质灾害防治条例》第一条,即“为了防治地质灾害,避免和减轻地质灾害造成的损失,维护人民生命和财产安全,促进经济和社会的可持续发展”的精神,旨在让社会各界、不同阶层的人群、不同层次的管理和施工人员了解和掌握地质环境和地质灾害的基本知识和科学原理,力争减少各种地质灾害,尤其是人为地质灾害的发生,降低因地质灾害所造成的各种经济损失和人员伤亡事故。这就是出版本书的目的和宗旨。

## 2. 编写本书的工作基础

近 10 多年来,笔者得到广东省科技厅、广东省水利厅、广东省环保局、广东省公路局和广东省云浮市公路局等多个地方有关行政主管部门的资助和支持,先后完成了《广东红色风化壳边坡稳定性》、《国道 324 线广东云浮段边坡稳定性》、《广东国道边坡稳定性 GIS 应用实例》、《广(州)-佛(山)高速公路软土路基工况调查研究》、《广东清远飞来寺重建工程地质勘查与山体稳定性评价》、《人地灾害信息化防治技术研究》(广东省科技创新百项工程攻关项目 2KB07002S)、《珠江三角洲经济变革对水环境影响及对策》、《珠江三角洲现代水环境管理信息技术研究》等项目。有机会在全省范围内开展工程边坡稳定性、资源开发引发的岩溶地面塌陷、城乡居屋地盘失稳、江河岸坡滑坡、人为河道缩窄及河床淤高引起洪水泛滥、人为水土流失与崩岗灾害、不合理用地遭受泥石流灾害等各种人为地质灾害的专门调查研究,为本书的编写积累了人地过程的地质环境和地质灾害的大量信息和多方面的资料。此外,还借助学术交流和科学考察的机会,收集了香港、台湾以及大陆西南省区的现场资料和文字资料。在此基础上,对各类地质灾害进行了分类和对比分析,在完成各项研究项目的基础上,根据人为地质灾害的形成和发生规律以及灾害的特点,进一步归纳整理各类资料,编写和出版了本书。

## 3. 本书的内容和编写特点

本书的内容共有 11 章。第 1 章,地质环境与地质灾害概述。根据本书编写的目的和



宗旨,采用照片叙述各类地貌和土地的自然景观,其中包括山地、丘陵和平原,还有海湾、江河及湖泊。为便于读者的阅读和理解,从地质环境的角度概述了广东省及邻区的地貌、地层、岩浆岩、构造等地质环境条件,叙述了一些与地质灾害防治有关的基本概念。

第2章,城乡建设与土地利用。先用文字简述城乡建设和土地利用的类型,其中包括城市、乡镇及山区农村,交通道路、工业厂房和旅游业等多方面建设和土地利用状况。反映了近20年来建设用地与日俱增,可建设的平地日趋减少,大城市的地下工程及坡地利用大幅度增加,山区城镇乡村的坡地开发不断兴起等现状。然后采用照片叙述各种不同类型的工程建设及其土地利用的特点。

第3章,边坡及其灾害。从不同角度描述工程建设所涉及的边坡问题。首先根据边坡的物质组成和边坡与周边环境的关系及其所处的空间位置划分边坡的类型。接着叙述顺向坡与反向坡的形成特点以及顺向坡滑坡问题。然后通过实例照片逐一介绍风化红土边坡滑坡、破碎岩土边坡滑坡(崩塌)、岩石边坡滑坡崩塌、陡坡路堤的稳定性、坡地侵蚀与崩岗灾害、江河岸坡滑坡与崩塌,逐一介绍各类边坡的形态特征以及地质环境与岩土体结构和物质条件,叙述了各类边坡变形破坏与灾害的形成与发生规律,分析各类边坡变形失稳的基本原理和过程,接着又以插图和实例照片介绍边坡稳定性的影响因素和边坡防护。

第4章,泥石流的形成及其灾害。文字简述了形成泥石流的地形地貌特征及地质环境条件,介绍华南和西南地区泥石流的类型及物质特征,泥石流的发生条件及过程,不同地区的泥石流灾害的特点,再介绍泥石流的防治。

第5章,岩溶地面塌陷。首先介绍岩溶和岩溶发育的条件,简述了广东岩溶地面塌陷分布的基本情况和地面塌陷的基本类型,叙述岩溶地面塌陷的地质环境条件;采用插图分析岩溶地面塌陷的形成及其发生过程的基本原理,再以实例照片介绍岩溶地面塌陷的类型及其灾害状况,并叙述灾害的预防基本方法。

第6章,城乡坡地居屋地盘的特点及其灾害的形成。概述了大中城市和山区城镇乡村居屋地盘的地质地貌特征,并叙述居住环境发生地质灾害的基本原理和主要原因,指出居屋建设地盘选址应注意的事项和灾害防治措施。

第7章,城市化过程的水环境效应。反映近20年来经济变革,城乡工业发展和农业生产转型以及人口激增的社会发展现状,以牺牲环境利益去掠夺经济效益的经济发展模式导致水环境恶化;不良的水环境条件给工农业生产和居民生活用水造成不同程度的影响;为满足生活生产的需要,一些地区出现滥开滥采地下水资源现象。指出应加快对不良水环境的治理和完善地下水资源的管理;加强水环境的监测,确保水环境良性持续发展和水资源可持续利用。

第8章,城乡建设导致河道演变与水文效应。叙述城市发展、资源开发、土地利用、道路建设等各种工程行为导致河床淤高与河道缩窄,影响排洪排涝,使大中城市和山区城镇乡村遭受洪水袭击,并带来不同程度的灾害。指出在进行资源开发、土地利用和城镇建设的同时,应注意保护生态环境和河道的自然景观,确保江河堤岸安全和水道畅通,预防水患。

第9章,砂石资源开发与环境效应。叙述近20年来,区域发展,城乡建设,处处大兴土木,砂石已成为不可缺少的建材物质。在这个时期,为满足建筑市场的需求,无原则地开采石材导致城市近郊和交通干线两旁满目创痍、千疮百孔的景象,对人们的视觉



景观造成一种不良影响；有的还引发水土流失甚至泥石流灾害问题。本章还介绍了一些值得借鉴的有计划开采和及时复绿的规范开采模式。

第 10 章，软土分布区的工程病害。主要针对珠江三角洲的软土分布地区，以一些道路工程为例，指出由于软土所具有的特性，在工程设计和施工过程，如果对软土的处理不当，将会对工程造成影响，甚至工程建成后达不到预期效果。同时还指出在软土层上进行工程建设时，应根据工程的类型和性质，查明软土的类型、厚度及分布，为工程的施工设计提供软土处理的依据。

第 11 章，保护地球环境 建设人类美好家园。作为全书的一个总结，提出各类建设工程，应进行土地利用规划和地质环境条件评价，并作出地质灾害风险评估，加强地质灾害与防治普及教育，保护地球环境，建设人类美好家园。

本书编写的特点是每一章的开头用文字简述了主要内容，提出作者的学术观点，然后采用现场彩色照片、剖面图、示意图、素描图、平面图等各种插图的形式来进行形象表达。全书总共有彩色照片近 500 张，插图 70 多张，其中 80% 是作者在科研工作中的第一手资料。每张照片和插图都有文字说明，内容丰富，画面直观，除了表达现状和现象之外，还体现学科的基本理论和分析研究过程，同时还具有鲜明的科普特点。从本书主题考虑，内容包括的范围较广泛，对于城乡建设过程中的地质灾害与防治具有指导意义。本书内容以广东为主，还涉及广西、福建、四川、云南、海南、香港、台湾等省区；不仅适合于同行专家和专业人士阅读，也适合于有关基层管理干部、施工人员、大中专学生及有一定文化基础的居民阅读，很适合于当前城乡建设，尤其是新农村建设过程中社会各界对地质环境和地质灾害防治基本知识的了解和掌握。

广东省科技厅、广东省水利厅、广东省环境保护局、广东省东莞市水利局、广东省公路管理局、广东省云浮市公路局等部门，给予相关科研项目的资助；中国地质科学院岩溶地质研究所研究员雷明堂博士、深圳市地质局研究员易顺民博士及蓝淇峰工程师、香港特别行政区土木工程署、台湾大学王鑫教授、中兴大学张俊斌博士等提供的宝贵资料，为本书的编写补充了良好的素材。中国科学院广州地球化学研究所研究员朱照宇博士对全书稿作了审阅，为完善本书的内容提出了多方面的宝贵意见；广东省地质勘查局教授级高级工程师梁池生博士，也对本书的编写提出了宝贵意见；中国工程院院士关君蔚教授、广东省地质勘查局何熙平局长为本书作序。在此一一致以诚挚的谢意。本书第一作者的夫人窦欣，对出版本书的一系列工作给予了大力的支持和协助，在此也表示谢意。对曾经支持过本书相关方面的部门或个人，可能挂一漏万，在此未提到的，也一一表示感谢。

本书的前言、第 1~6 章、第 8 章和第 11 章由刘瑞华完成，第 9 章及全书的插图清绘和整饰由唐光良完成，第 7 章和第 10 章由卢薇和刘卫平完成，孙宁博士负责英文翻译及相关资料整理，全书由刘瑞华统稿。曾经参加过部分工作的有黄镇国研究员、姚清尹研究员、冯炎基高级工程师、邹春洋副教授、黄光庆研究员、谭惠忠高级工程师、张晓初工程师、祝功武副研究员、谭启宇博士。限于作者的水平，本书错漏之处在所难免，敬请同行和广大读者指正。

本书的照片和插图除注明资料来源外其余均为作者第一手资料。

作 者

2007 年 8 月 8 日



# PREFACE

## 1. Background and Objectives

The geologic environment and human constructions can closely affect each other, at both urban and rural areas. However, such interactions may differ dramatically because of the impact of different social and economic conditions. From 1950s to 1970s, China had been under the planned economy. During that period, the level of science and technology, management, and openness to the foreign world were relatively low. Due to these limitations, the development of rural and urban constructions had been very slow. Most of the constructions were in small scales and the levels of development and construction were relatively low. For example, most of the highways constructed during that period were simply following the terrain. There were very few long-span bridges and deep slope cutting roadbeds, and it was more obvious in the mountainous areas where the terrain conditions were worse. Only very few high-rise buildings were built at that time. In a summary, China had a slow economic development and a low industrial and agricultural production rate during that period of time, thus the material flow was relatively slow and in small volume, and the use and exploitation of natural resources were in a very low level. As a consequence, human activities didn't have great impact on both the geologic and biological environment during that time.

However, in the last 30 years, China has been under economic reforming and has become more and more open to the outside world, which has lead to a strong and booming economy. As one impact of the economy development, the interactions between human activities and geological environments have been stronger and stronger, including the usage of land and exploitation of natural resources. Benefiting from its great geologic location, Guangdong has been the "vanguard" province of the economic reforming because of its advantages in absorbing of advanced foreign technology and foreign capitals. During this period, Guangdong has absorbed a lot of labors from other provinces, including many high-tech professionals. Because of its already dense population, urban construction and land use has become a more and more prominent problem as how to accommodate the increasing needs of housing and industrial constructions. To solve this problem, we need to enhance the economical ties between the plain areas and mountainous area, between the Coastal areas and mainland area during this process, such as communication and material exchanges. In order to do that, more roads have been built and many lands have been occupied, and even hillsides have been used for construction.

Traditional civil engineering projects or irrigation facilities are all land-based, such as constructions of cities, villages, roads and bridges, factories and mines etc. Thus they are all af-

affected by geologic conditions. Such construction could be expansion, maintenance, or transformation of the existing buildings, or to start a new project at vacant land. Because of the close relationship between construction and geologic condition, it is important to include the prospection of the geologic information as an essential and primary part of the whole plan. With such prospection, the design could be improved to reduce the risk of accidents caused by the geologic conditions and decrease the budget by rationally distributing the construction materials. It is important to understand that the budget should be saved by good designs and rationally distributing resources, not by cutting the fund for the geologic prospection.

Since 1990s, many high-rise buildings have been constructed in large and middle-sized cities, with some of these buildings even have underground garages. The transportation network has been much more complex, which includes many multi-level interchanges. Subways are now important transportation tools in many big cities. Long bridges across rivers have been built to shorten the transportation time. In the rural area, old mud-bricked houses have been replaced by multistoried mansions. The small pathways have now become multi-lane highways. Even many hillsides have been utilized for different projects. However, more geologic hazards have occurred since then, such as collapse, landslide, debris flow, and Karst collapse. The main reasons were lack of geologic knowledge during the designing process, wrong construction procedures and methods, lack of awareness and prevention methods, and etc. In the last 20 years, human-induced geologic hazards have happened not only in mountainous area, but also in big and middle-sized cities. These hazards have caused different levels of economic losses, and some of them even have human losses. In Southern China, especially Guangdong province, seventy percent of the geologic hazards are human-induced.

After the analysis of the causes of these hazards, it has been noticed that most of geologic hazards are caused by the lack of geologic environment knowledge, wrong construction procedures or methods, or lack of prevention. In Southern China, especially Guangdong province, human-induced geologic hazards account for more than 70% of all geologic hazards. With that in mind, this book uses the "scientific concept of development" as the guideline and "people-oriented approach" as the principle. It is strived to help monitoring and controlling geologic hazards. On Nov. 24th, 2003, the State Council of P. R. China announced the NO. 394 decree, Geologic Hazard Prevention Ordinance. In order to satisfy its first rule that is to prevent the geologic hazards, reduce and prevent the loss of life and property, and promote the sustainable economic and social development, it is very important for the related people, such as designer, management and construction staff etc., to learn and master the basic knowledge of geologic environment and hazards. Such knowledge could help reduce the possibilities of the geologic hazards, especially those human-induced, which is the object and purpose of publishing this book.

## 2. Foundation of the Study

In the last 10 years, the authors have been supported by the several bureaus of Guangdong Province, including Bureau of Science, Bureau of Water Resource, Bureau of Environmental Protection, and Bureau of Transportation, and also the Bureau of Transportation of the Yunfu



City. With their support, we have successfully carried out several projects, including Stability Analysis of the Red Weathered Crust Slope in Guangdong Province, Stability Analysis of Road Cut Slopes on the National Road 324 in Yunfu City, Guangdong Province, Study of Soft Soil Roadbed of the Guangzhou–Fushan Freeway, Stability Analysis of the Reconstruction of the Temple Feilai of Qingyuan, Prevention of Geologic Hazards using Information Technology (awarded as one of the One Hundred Technological Innovations of Guangdong 2KB07002S), Impact of Economic Development on Water Environment in the Pearl River Delta Area, Research on the Modern Information Technology for Water Environment Management. These projects provided us wonderful opportunities to study the human-induced geologic hazards around Guangdong province, which include unstable slopes, Karst Collapse triggered by the resource exploration, unstable urban or rural residences, landslides at riversides, floods due to river narrowing and siltation, human-induced soil erosion and Benggang (Gully-slope collapse) hazard, and etc. These studies provided us many precious materials for this book. The authors have also gathered many other cases of Hong Kong, Taiwan, and other south-western provinces through the academic exchanges and scientific investigations. Based on these materials, we compared and categorized geologic hazards occurred in these different areas. This book is based on such analyses.

### **3. Contents of the Book and Distinguishing Features**

This book is divided into 10 chapters.

Chapter 1: Introduction to the geologic environment and geologic hazards. Based on the objectives and purposes of this book, different kinds of geomorphology and landscapes are introduced and accompanied by pictures, including mountains, hills, rivers, lakes, and seashores. Some basic concepts of geologic hazard prevention are introduced to help readers aware and understand these problems. The geologic environment conditions of Guangdong province are summarized, including geomorphology, stratum, magmatic rock, and structure. Moreover, some basic concepts of geologic hazards are introduced.

Chapter 2: Urban and rural construction and land use. It first outlines the different types of land use and urban and rural construction, including those of cities, towns and mountain villages, roads, industrial buildings, tourism etc. This chapter also reflects that the trend for land use demand has been continuously increasing while the available plains have been diminishing in the last 20 years. In big cities, there has been a substantial increase of underground engineering and slope use. In the rural area, more and more constructions have been carried out on the slopes. Again, photographs are used to describe different types of construction and land-use characteristics.

Chapter 3: Slopes and associated hazards. It introduces slopes from different perspectives. Firstly, different slope types, which are classified by slope materials, relationship with the surroundings and position, are introduced. Secondly, the characteristics of consequent and obsequent slope and consequent landslide are presented. Thirdly, all kinds of landslides which include landslides in Laterite, landslides in and collapse of fractured rock and rock, slope corro-



sion and Benggang (gully-slope collapse) hazard, and landslides in and collapse of river banks and lake shore, are described by field photos. The shape features, geologic environment, geotechnical structure, material conditions, slope deformation failure and hazard occurrence rule of each slope type are introduced. The basic principle and process of slope deformation failure of each slope type is analyzed. Finally, influencing factors of slope stability and slope prevention are introduced using illustrations and field photos.

Chapter 4: Debris flow development and hazards. It summarizes different types of debris flows based on material characteristics and debris flow development condition and process, especially those happened in Southern and Southwestern China. Different prevention and mitigation methods are introduced.

Chapter 5: Karst collapse. It outlines the different types of Karst collapse and its distribution in Guangdong province. Illustrations are used to help analyze the development of Karst collapse while pictures are provided to explain different types and characteristics of Karst collapse hazard and their casualties. Again, prevention methods related to hazards are provided.

Chapter 6: Features of urban and rural habitation on sloping ground and related hazards. An overview of geomorphic and geologic features of urban and rural habitation is given. It analyzes the main reasons and mechanisms of the geologic hazards happened in these areas. Then it discusses the precautions in site selection and the main methods to prevent such geologic problems.

Chapter 7: Effect of urbanization on hydrologic environment. It reflects the dramatic changes happened in the past 20 years, which includes economic reform, urban and rural industry development, rapid population growth, agricultural production restructuring, and social development. The hydrologic environment was greatly deteriorated because of the adoption of economic development model to expedite economic development with the sacrifice of the environment. The industrial and agricultural production and daily life of the residents were affected in various degrees by the adverse hydrologic environment. To meet the increasing needs of water resources for residents' daily life and industrial production, the groundwater resources in some areas were indiscriminately and over-exhaustedly exploited. Suggestions were made on how to speed up the process to improve poor hydrologic environment and management and exploitation of groundwater resources, to enhance hydrologic environment monitoring, and to ensure a healthy environment for future sustainable water resource use.

Chapter 8: River evolution and hydrologic effect due to urban and rural development. Because of resource exploration, land use, road construction, and some other human activities, riverbeds have becoming higher and higher while waterways have been shrinking. As a consequence, it will cause river siltation and narrowing. This will greatly impact the effectiveness of flood prevention and increase the possibility of flooding not only in large and medium-sized cities, but in mountain towns and villages as well. Points were made that during the process of resource development, land use, and urban construction, enough attention should be made to protect the ecological environment, so that the natural landscape of the river and the safety of

river embankment can be ensured, and flooding and correlated hazards being prevented.

Chapter 9: Development of aggregate resource and its effect on the environment. With the continuing development of construction market in the past 20 years, aggregate resource has become indispensable construction material. However, with only profit in mind, many resources were exploited without regulations and proper consideration for its impact on surrounding environment, which can be easily witnessed because there were many these sites close to urban suburbs and highways. Such kind exploration not only results in disharmony with the surrounding, but also results in different geologic hazards such as erosion or even debris flow. This chapter also introduces several mining protocols which have recovery in mind.

Chapter 10: Hazards in soft soil areas. It uses some road constructions in the Pearl River Delta region as examples. Because of its unique characteristics, special attentions should be paid both during the design and construction to gain good quality. Before a project starts, we should identify the type, thickness and distribution of soft soil. Then special treatment should be considered based on the type of projects.

Chapter 11: Protect the Earth and build a nice home. As the summary of this book, this chapter points out that before an engineering construction starts, some work, including land use zoning, assessment of the geologic environment, evaluation of geologic risk, and educating the public on geologic hazard prevention and mitigation, should be performed in order to protect the earth and build a nice home.

One of the characteristics of this book is that there is a summary of each chapter at the very beginning. Inside each chapter, different illustrations are used to enhance the contents, such as color pictures, profile charts, sketch maps, plain figures etc. Altogether there are more than 500 color pictures and 70 illustrations inside this book. More than 80% of them are first-hand materials collected by the authors during researches. Each of them has a short narrative so that the reader can easily read and understand. This book introduces and explains the current status and scenarios of civil constructions. It also describes its basic knowledge and research methods and can be used as an introductory book for general public. This book is targeted to direct the geologic hazard prevention and mitigation during urban and rural construction. The book studies mainly the cases and the situation in Guangdong Province. Those in other provinces and regions including Guangxi, Fujian, Sichuan, Yunnan, Hainan, Hong Kong and Taiwan, are covered as well. It can be not only a good reference book for experts and professionals, but also an introductory book for the management officials, construction workers, college students and others. We wish it could be a good book in helping the general public to understand and master the knowledge of geologic hazard prevention and mitigation.

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All the photographs and illustrations used in this book, unless specifically annotated, are first-hand materials gathered by the authors.

**Writer**

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