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2015 年嘉陵江上游燕子河流域地质灾害调查数据集

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摘要：本数据集是依托 2015 年嘉陵江上游燕子河流域内崩塌、滑坡、泥石流和工程地质调查资料，根据中国地质调查局统一的标准和要求编制的。数据采集通过遥感解译、地面调查结合三维激光扫描、低空无人机航拍、综合地球物理勘探等工作手段获取。数据集包括滑坡数据 223 组、崩塌数据 170 组、泥石流数据 44 组，以及专门工程地质调查数据 129 组。数据集信息包括燕子河流域内崩塌、滑坡、泥石流等地质灾害的基本属性、产出的地质环境背景条件、发育特征与分布规律、孕灾的工程地质条件。通过野外数据现场采集、数据整理及校验、数据入库及审查等流程，以及完善的质量控制体系，确保了数据集的真实性、可靠性、准确性。该数据集全面提升了燕子河流域的地质灾害和工程地质调查精度，为该流域内崩塌、滑坡、泥石流的形成机理研究及易发性、危险性、风险性区划研究，提供了有效支撑，同时也为该流域地质灾害防治提供了可靠的基础数据。

关键词：地质灾害数据集；防灾减灾；工程地质；燕子河流域；嘉陵江

数据服务系统网址：http://dcc.cgs.gov.cn

1 引言

燕子河流域位于甘肃陇南市康县东南部及陕西宁强县西北部，从康县托河叶家坪邓家坝出境入陕西省宁强县，至燕子砭镇汇入嘉陵江，是嘉陵江一级支流，交通位置图见图 1。燕子河流域是长江上游的重要水源补给区，地处国家地质灾害高易发区和重点防治区（《全国地质灾害防治“十三五”规划》❶），是国家“两屏三带”生态安全屏障的重要组成部分，也位于“十三五”脱贫攻坚规划中秦巴山区连片扶贫区内，是实现“两不愁、三保障”精准脱贫，全面建成小康社会脱贫攻坚的主战区，在全国稳定大局和生态安全战略格局中具有重要的地位（唐新凯和梁收运，2012）。燕子河流域地理坐

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标：东经 105°15′~106°00′，北纬 32°50′~33°25′，流域面积约 1 338 km^2。由于该区地质条件复杂，地震活动频次高，局部降雨量大而集中，以及大范围的人类工程活动（削坡修路、开挖建房等）等内部因素和外部诱发因素的共同作用，区内崩塌、滑坡、泥石流等突发性地质灾害发生频繁（王莉霞等，2012；张小辉等，2017；陈万利等，2017）。受“5·12”汶川地震（2008 年）、“7·17”暴雨（2009 年）、“8·18”暴雨（2010 年）的影响，地质灾害发生的频率和危害进一步加剧，严重威胁人民生命财产安全，制约地方经济发展。坚持国家公益性地质调查在全国地质灾害防治体系中的示范引领定位，查明该区域内崩塌、滑坡、泥石流等地质灾害发育机理，提高区域减灾抗灾能力，中国地质调查局水文地质环境地质调查中心于 2015 年在燕子河流域开展了以流域为单元的 1∶50 000 崩塌、滑坡、泥石流等地质灾害的调查工作[2]。本次调查工作在充分分析利用原有资料的基础上以高精度遥感解译、工程地质测绘、地质灾害测量和工程地质勘查等为主要手段，查明了区域内孕灾的工程地质条件，查明了地质灾害及其隐患的发育特征、分布规律，总结出了成灾模式，建立了地质灾害空间数据库。这些地质灾害调查数据采用了规范的数据处理方法和质量控制体系，成果真实可靠，可为流域内地质灾害成灾机理分析、灾害区划研究、土地利用、城市规划、防灾减灾提供可靠的基础地质依据。

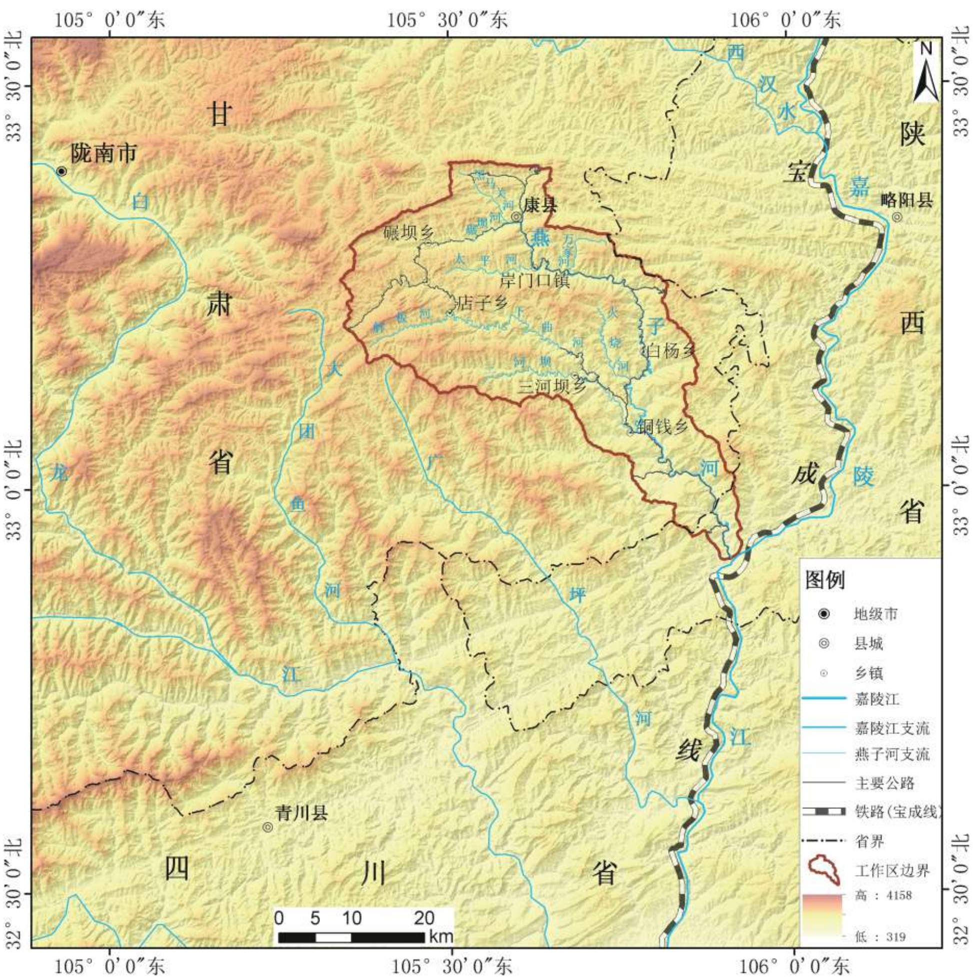

图 1　燕子河流域交通位置图

2015 年燕子河流域地质灾害调查数据集元数据简表见表 1，包括数据集的名称、作者、数据时间范围、地理区域、数据格式、数据量、数据服务系统网址、基金项目、语种、数据库（集）组成。

表 1　数据库（集）元数据简表

条目	描述
数据库（集）名称	2015年嘉陵江上游燕子河流域地质灾害调查数据集
数据库（集）作者	杨强，中国地质调查局水文地质环境地质调查中心 叶振南，中国地质调查局水文地质环境地质调查中心 高幼龙，中国地质调查局水文地质环境地质调查中心 李强，中国地质调查局水文地质环境地质调查中心 丁伟翠，中国地质科学院
数据时间范围	2015年
地理区域	地理范围为东经105°15′~106°00′，北纬32°50′~33°25′，位于甘肃省陇南市康县东南部、陕西省汉中市宁强县西北部
数据格式	*.xlsx
数据量	451 KB
数据服务系统网址	http://dcc.cgs.gov.cn
基金项目	中国地质调查局项目“嘉陵江上游燕子河流域地质灾害调查”（12120115045501）和“陇南白龙江流域地质灾害调查”（DD20160281）联合资助
语种	中文
数据库（集）组成	数据集包括4个数据文件，分别为：燕子河流域滑坡灾害及隐患点数据.xlsx（数据量181 KB），燕子河流域崩塌及危岩体数据.xlsx（数据量140 KB），燕子河流域泥石流灾害及隐患数据.xlsx（数据量59 KB），燕子河流域专门工程地质调查点数据.xlsx（数据量73 KB）

2　数据采集和处理方法

2.1　数据来源

2015 年燕子河流域地质灾害调查数据均来源于“嘉陵江上游燕子河流域地质灾害调查”项目的野外实测，主要为地质灾害点及专门工程地质点调查数据。由于调查跨距范围及野外采集数据量巨大，野外调查工作分为 3 组，历经 136 天完成。野外调查工作以服务生态文明建设和防灾减灾为目的，重视基础性和公益性为原则，在充分分析利用调查区以往工作资料的基础上，围绕地质灾害高发区（灾害体）、地质灾害重点威胁区（承灾体）、地质条件复杂区（致灾因素），以高精度遥感解译、工程地质测绘、地质灾害测量、工程地质勘查为主要手段，对典型地质灾害体辅以必要的钻探、物探、槽探、低空航拍等手段进行勘查，按照中国地质调查局《崩塌滑坡泥石流地质灾害调查与风险评价技术要求（试用版）》的要求，以 1∶50 000 标准图幅为单元分一般调查区、重点调查区和典型地质灾害体 3 个层次开展调查评价工作，查明了流域内孕灾的地质环境背景，查清了流域内地质灾害类型、规模、特征，综合分析地质灾害时–空分布规律，建立了成灾模式。工作流程见图 2。

野外工程地质调查和地质灾害调查采用点、线、面相结合的专业调查方法，工程地质调查充分考虑地质构造、地层岩性和斜坡地质结构，重要地质构造和岩性分界线等采用追踪法和穿越法，地质灾害调查采用调查和核查相结合的方式，根据不同精度要求进行相应的调查。高精度遥感解译采用 Pléiades 高清遥感数据。根据前期调查资料，结合调查区地质灾害的几何特征，建立遥感解译标志体系，对调查区进行精细化解译。充分

考虑地质构造、地层岩性、河流干（支）流分布、交通线路及重点城镇、重要建筑设施及威胁对象，设置合理的调查路线，燕子河流域设置18条调查路线。根据调查路线，对调查点进行精细调查，获取专门工程地质点及地质灾害点数据信息，沿调查线路进行追踪或者穿越调查；同时，根据成图需要，充分考虑面上地质灾害和工程地质的总体情况，查明了燕子河流域的地质灾害发育情况，对部分地质界线、构造线进行了修测，查明了调查区地质灾害发育的背景条件，查清了典型灾害体的斜坡结构及物质组成，划分了工程地质岩组等。

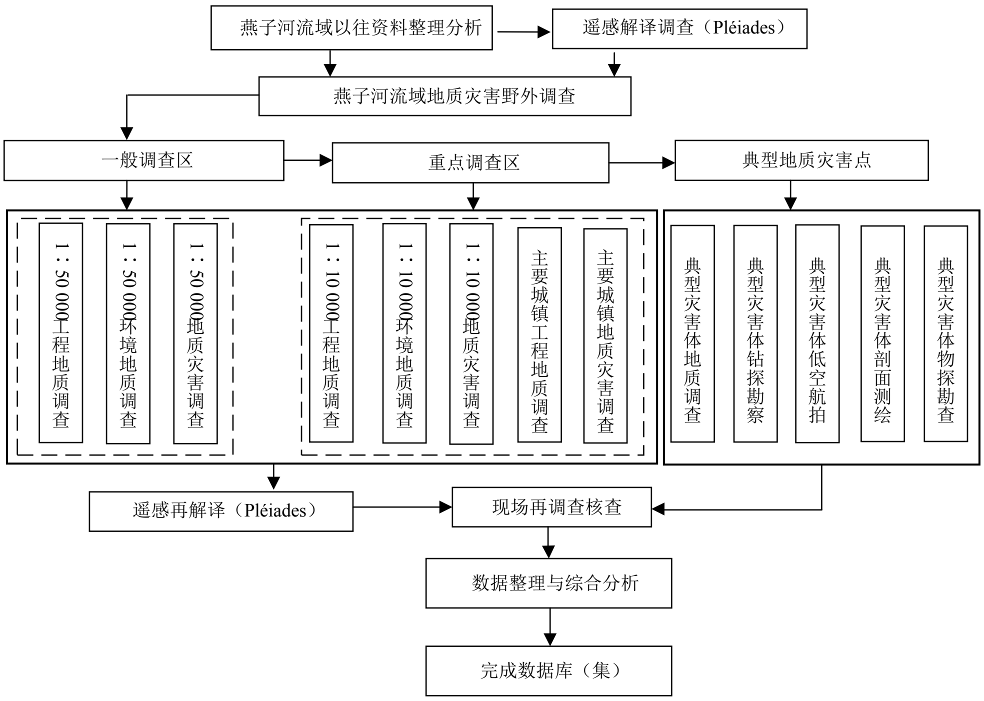

图2　工作流程图

2.2　数据处理

2015年燕子河流域地质灾害调查数据获取经过了以往数据点收集整理分析、数据点高精度遥感解译、数据点信息现场采集、数据点信息整理、数据点信息校验、数据点信息入库等系列流程（谭永杰，2016）（图3）。首先对前期地质灾害调查资料、工程地质资料、区域地质及构造地质资料进行整理分析，依托以往地质灾害点信息及地质信息，制作适用于调查使用的地质灾害图件及相关地质图件（坐标系统统一采用了CGCS2000坐标系、高斯-克吕格投影、1985国家高程基准），并利用高精度遥感（2014年Pléiades高清数据）图件进行地质灾害和地质方面的解译；根据解译结果结合地质图件开展数据点现场调查，通过手持GPS、数据采集PAD、红外线测距仪、高精度望远镜、激光扫描仪、低空无人机、地质罗盘、RTK等设备，确定地质灾害及工程地质数据点的位置（经纬度、隶属行政村等）、形态（坡度、坡向等）、规模（长、宽、高等）、结构（岩性、组成等）、产出背景（基岩的岩性、产状等）等数据信息；室内对野外采集的数据进行整理分析，使其与数据库要求一致；经过进一步自检、互检、抽检等多道检查校验工序后，按照统一格式存入数据库中。

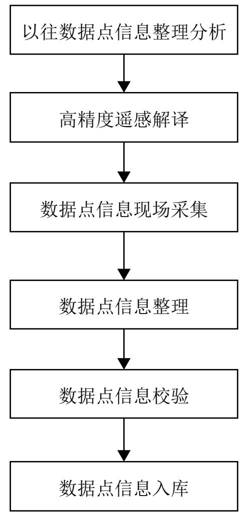

图 3　数据获取流程图

3　数据样本描述

2015 年嘉陵江上游燕子河流域地质灾害调查数据集为*.xlsx 表格型数据，共包含 4 个 Excel 数据文件，分别为：“燕子河流域崩塌及危岩体数据.xlsx”、“燕子河流域滑坡灾害及隐患点数据.xlsx”、“燕子河流域泥石流灾害及隐患数据.xlsx”、“燕子河流域专门工程地质点数据.xlsx”。

“燕子河流域崩塌及危岩体数据.xlsx”数据文件为燕子河流域截至 2015 年 12 月发育的 170 处崩塌及危岩体的特征调查数据，每处崩塌点及危岩体点的数据项包含：崩塌点及危岩体的基本属性和发育特征（名称、野外编号、坐标位置、运动形式、崩塌类型、控制结构面类型、宏观稳定性评价、活动状态、崩塌源扩展方式、主崩方向、崩源高程、最大落差、最大水平位移、崩塌源宽度、崩塌源厚度、崩塌源面积、崩塌源体积、诱发因素、堆积体平均厚度、堆积体面积、规模等级、确定性程度）；崩塌或危岩体产出地质环境背景（地形地貌、地层岩性、岩性组合、斜坡结构与地质构造、水文地质条件、植被及土地利用、人类工程活动）；危险性分析；危险及危害分析等数据项。崩塌时间、直接损失等数据项，由于是以前发生的，无法准确推定，这些数据暂缺。文件中包含了崩塌或危岩体基本力学特征（危岩体岩性及岩体结构、控制面结构、产状、卸荷裂隙发育特征及其组合形式、交切特点、贯通情况，崩塌堆积体几何形态、厚度、规模、新鲜程度、岩性及分选状态及空间分布特征，崩塌路径区斜坡几何形态、地层岩性、植被发育情况、是否有建筑设置）相关数据，为后续研究奠定了基础。

“燕子河流域滑坡灾害及隐患点数据.xlsx”数据文件为燕子河流域截至 2015 年 12 月发育的 223 处滑坡灾害及隐患点的特征调查数据，每处滑坡点的数据项包含：滑坡点的基本属性和发育特征（名称、野外编号、坐标位置、运动形式、滑坡类型、滑面类型、宏观稳定性、扩展方式、滑坡时代、诱发因素、滑坡形态、前缘高程、后缘高程、滑坡体平均厚度、滑坡面积、滑坡体积、威胁对象）；产出斜坡环境（地形地貌、地层岩性及岩性组合、斜坡结构特征、地质构造、地表水及地下水、植被与土地利用、人类工程活动）；滑坡基本特征（边界条件、形态特征及物质结构、水文地质特征、变形特征及活动历史）；危险性及危害性分析等数据项。滑坡发生时间、滑动速度、直接损失等因多数滑坡发生在多年以前，当时并无监控数据，现在调查存在难度，所以这些数据项暂缺。

“燕子河流域泥石流灾害及隐患数据.xlsx”数据文件为燕子河流域截至 2015 年 12 月发育的 44 处泥石流灾害及隐患调查数据，每处泥石流及隐患点的数据项包含：泥石流的基本属性和发育特征（沟谷名称、野外编号坐标、物质组成、物源补给、汇水面积、水动力类型）；沟口扇形地特征（扇形完整性、扇长、扇宽、扩散角、扇面发展趋势、扇顶至扇源轴坡降、沟口至主河道距离）；土地利用情况（缓坡耕地、陡坡耕地、乔木林地、乔灌木、草地、荒地等）；泥石流冲出方量；规模等级；威胁对象；防治措施；防治类型；泥石流沟宏观特征（物源区特征、水动力来源及特征、流通区特征、堆积区特征）；泥石流活动历史；泥石流危险性分析；危害性特征；其他补充性说明；泥石流综合评判（不良地质现象、补给段长度、沟口扇形地、主沟纵坡、新构造影响、植被覆盖率、冲淤变幅、岩性因素、松散物储量、山坡坡度、沟槽横断面、松散物平均厚度、相对高差、流域面积、堵塞程度、评分情况、易发程度、发展阶段）；其中，泥石流冲出方量、新构造运动影响等数据由于调查中存在不同估算方法和不同认识，可能存在一定程度的偏差。

“燕子河流域专门工程地质调查点数据.xlsx”数据文件为燕子河流域内截至 2015 年 12 月调查的 129 个专门工程地质调查点调查数据，每个专门工程地质点的数据项包含：工程地质点的基本属性（名称、野外编号、高程、坐标、点类型）；工程地质特征描述（地形地貌、滑动构造点、岩土体工程地质性质、地表水与地下水、植被与土地利用类型、人类工程活动、其他动力地质作用与现象）等。

为解决文本格式的数据不能直观展现数据集内各种数据的相关性的问题，本次研究通过绘制承灾体与地质灾害类型表（表 2），滑坡数量与坡度关系、坡高关系图（图 4），以及滑坡坡向坡度密度图（图 5）这类相互关联的图表等途径，对数据样本进行了展示。崩塌、滑坡、泥石流的主要的威胁对象为道路、居民（学校及村落），以及农田，三者占 98.1%。滑坡多发育在原始斜坡坡度为 20°~50°的区间，占全部滑坡的 86%，该坡度范围有利于风化物堆积及降雨入渗。由于滑坡多分布在坡度较缓、坡积物较厚的河（沟）谷地带斜坡体前缘，坡高相对较小，坡高因素对滑坡影响较小。从滑坡的坡向和坡度密度上来看，由于阳光照射和昼夜温差的影响滑向朝南的滑坡数量明显多于朝北的滑坡。

表 2　调查区地质灾害承灾体与地质灾害类型统计结果汇总表

承灾对象类别	滑坡（处）	崩塌（处）	泥石流（处）	合计（处）	比例（%）
居民（学校、村委会）	145	8	43	196	28.70
道路	176	180	44	400	58.57
砖厂或采石场	0	0	0	0	0
农田	24	4	46	74	10.83
电站	0	1	1	2	0.29
风景区	0	5	0	5	0.73
排洪渠道	0	0	1	1	0.15
无威胁对象	3	2	0	5	0.73
合计	348	200	135	683	100

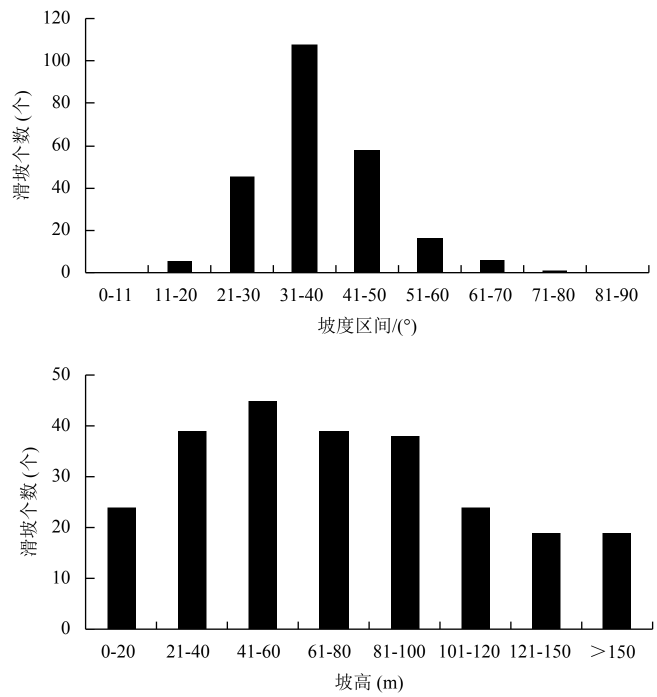

图 4 滑坡数量与坡度、坡高关系图

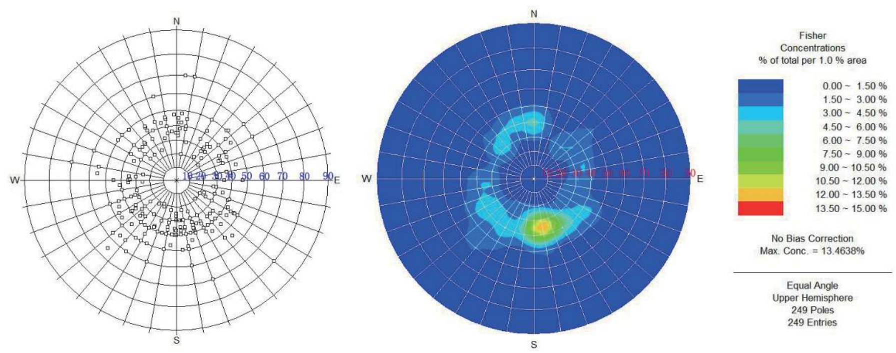

图 5 滑坡坡向、坡度密度图

燕子河流域崩塌、滑坡、泥石流灾害及其高危地段分布图见图 6。由图可知，地质灾害高危地段以条带状集中分布于燕子河主干流、重要支流沿线人类工程活动频繁的河谷，以及主干道路切坡沿线地段；这些区域或地段受河流侵蚀、地形地貌、地层岩性、地质构造及人类工程活动影响较为显著，因而区内各种地质灾害的发育密度也较大，危险性较高。本次研究标示出了崩塌高危段有 5 处，滑坡高危地段有 5 处，泥石流高危地段有 2 处。

4 数据质量控制和评估

在采集原始数据及数据处理过程中，数据质量控制手段主要包括野外采集数据的校验、数据整理、数据入库、数据再次校验几个方面。项目在实施过程中根据实际需求，建立了完善的数据质量控制体系。野外数据采集的重点是数据的真实性和准确性及完整性，项目落实各项责任具体到每个人，对每个环节都进行了严格把控，对各种数据点对应于表格里的数据进行了多次校验，自检率为 100%；在自检基础上进行互检，互检率也达到 100%，抽检率达到 60%。数据整理入库过程中，通过专人专入、自查互检、最

终审核等手段，确保了入库数据质量的可靠性和合理性，最终的成果数据通过了中国地质环境监测院的检查验收。通过以上的步骤和措施，从总体上保障了数据集的真实性、可靠性。

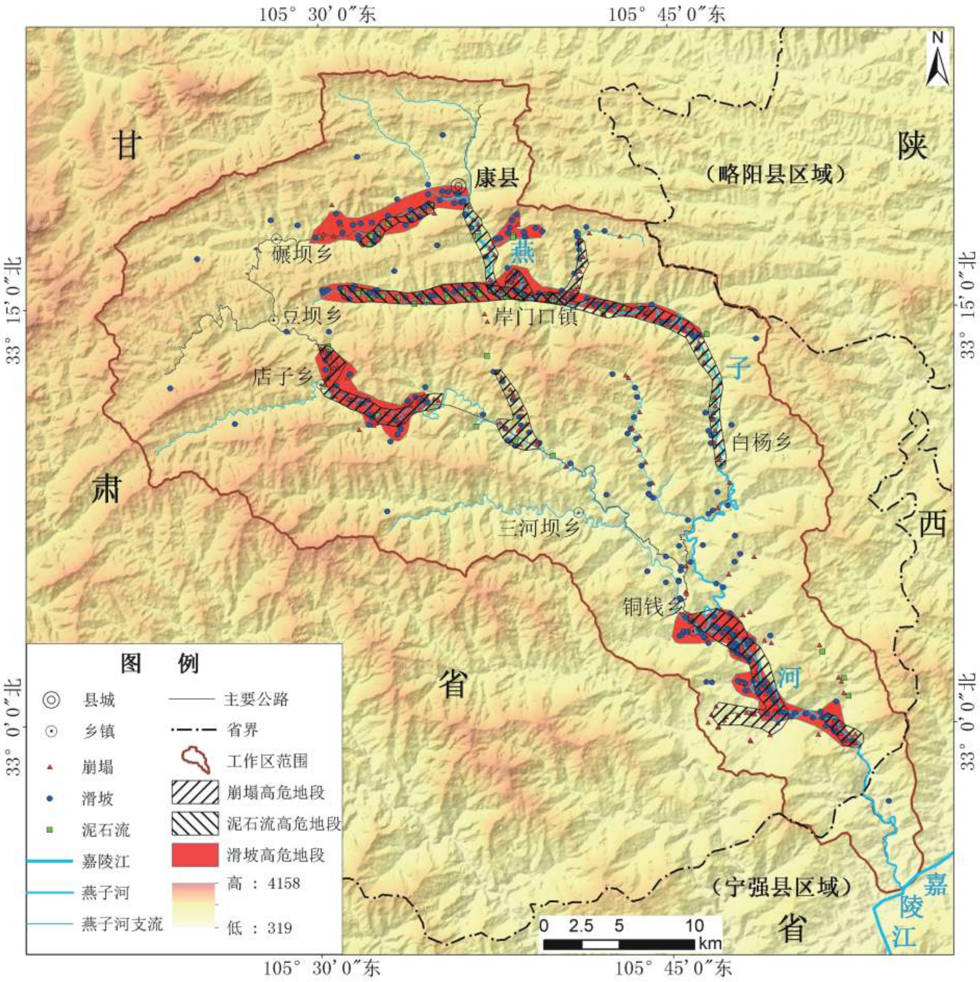

图 6　崩塌、滑坡、泥石流及其高危地段分布图

5　数据价值

本数据集采用 2014 年的 Pléiades 高清遥感数据作为解译数据源，融合了 2015 年以前该流域的地质灾害、工程地质等调查成果，按照一般调查区、重点调查区和重点典型灾害体三个层次，通过点、线、面相结合的方法进行了拉网式的调查，采用了无人机低空航拍、三维激光扫描仪、综合地球物理勘探等相对先进的手段，得到了一批真实可靠的数据，为数据集的准确性和可靠性提供了保证。调查的精度、调查方法可靠性、调查内容的全面性、调查结果的真实性等方面均取得了较大提高，全面提升了该流域的地质灾害和工程地质的调查精度，查明了崩塌、滑坡、泥石流地质分布及主要威胁对象，摸清了流域内具有重大威胁的崩塌、滑坡、泥石流地质灾害的发育特征，为流域地质灾害易发性、危险性、风险性区划研究提供了可靠的基础保障，为流域内崩塌、滑坡、泥石流的形成机理研究和防治奠定了基础，为崩滑流地质灾害的群测群防提供了选点依据和监测依据，能有效的提升该流域地质灾害减灾防灾的总体水平。同时为土地利用、城市规划等有效避灾提供详实的数据支撑。

6 结论

（1）“2015年嘉陵江上游燕子河流域地质灾害调查数据集”以2015年开展的“嘉陵江上游燕子河流域地质灾害调查”项目为数据来源，包含了2015年12月前燕子河流域发育的滑坡数据223组、崩塌数据170组、泥石流数据44组和129组专门工程地质调查数据。数据集为满足国家对区域地质信息集成的需求，实现基础性、公益性地质调查工作数据资源共享创造了条件。

（2）数据集成果在野外数据采集、数据整理及校验、数据入库及审查阶段均建立了完善的质量控制体系，确保了数据真实、可靠、准确。该崩塌、滑坡、泥石流地质灾害调查数据集涵盖2015年12月之前燕子河流域内崩塌、滑坡、泥石流地质灾害的基本属性、产出的地质环境背景条件、发育特征与分布规律、孕灾工程地质条件，有效提升了燕子河流域地质灾害调查的精度。

（3）该数据集在融合以往数据的基础上，传统遥感解译、地面调查结合无人机低空航拍、三维激光扫描仪、综合地球物理勘探等新技术、新方法，获得了一批详实可靠的调查数据。数据集为流域内崩塌、滑坡、泥石流的形成机理研究，地质灾害易发性、危险性、风险性区划研究提供了可靠的数据；为崩塌、滑坡、泥石流地质灾害的群测群防提供了选点依据和监测依据，为土地利用、城市规划提供基础依据，能有效的提升该流域地质灾害的防治总体水平。

致谢：本数据集的获取得到康县国土资源局等相关单位的大力支持和帮助，在此表示衷心感谢。

注释：

❶ 全国地质灾害防治“十三五”规划[S]. 国土资源部, 2016.

❷ 杨强, 叶振南, 王洪磊. 2016. 嘉陵江上游燕子河流域地质灾害调查[R]. 河北保定: 中国地质调查局水文地质环境地质调查中心.

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Dataset of the 2015 Geo-Hazard Survey of the Yanzi River Basin, Upstream of the Jialing River

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Abstract: This dataset is prepared based on the data and information obtained from the survey of collapse, landslide, debris flow and engineering geology within the Yanzi River Basin, upstream of the Jialing River, in accordance with the unified standards and requirements of China Geological Survey (CGS). The data were acquired by remote sensing interpretation and surface survey as well as 3D laser scanning, low altitude aerial photography using UAV, and comprehensive geophysical exploration. The dataset contains 223 sets of landslide data, 170 sets of collapse data, 44 sets of debris flow data and 129 sets of data from specific geological engineering survey. The dataset covers the following information within the Yanzi River Basin: the basic attributes of geological hazards such as collapse, landslide and debris flow; geological environment background, development characteristics and distribution of the hazards; and engineering geological conditions inducing hazards. To guarantee the truth, accuracy and credibility of the dataset, processes such as field data acquisition, data collection and verification, data storage and review and a well-developed quality control system were adopted. Thus the dataset has comprehensively increased the accuracy of geological hazard knowledge and engineering geology survey in the Yanzi River Basin, providing an effective support for the study of the formation mechanism of collapse, landslide and debris flow and the study on zoning by susceptibility, hazard, and risk of these geological hazards. Furthermore, the dataset will provide reliable basic data necessary for the prevention and control of geological hazards within the basin.

Key words: Geological hazard dataset; hazard prevention and mitigation; engineering geology; Yanzi River Basin; Jialing River

Data service system URL: http://dcc.cgs.gov.cn

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1 Introduction

The Yanzi River Basin, situated in the southeast of Kang County, Longnan City, Gansu Province and in the northwest of Ningqiang County, Shaanxi Province, flows from Dengjia Dam, Yejiaping, Tuohe, Kang County, into the Jialing River at Yanzibian Town, Ningqiang County, Shaanxi, forming the Level-1 tributary of the Jialing River. The location is shown in Fig. 1. The Yanzi River Basin is an important water recharge source area upstream of the Yangtze River, a national key control and prevention region against vulnerable geological hazards (according to the *National 13th Five-year Plan for Control and Prevention of Geological Hazards*[❶]), and an important part of the national "two-barriers and three-belts" (referring to the Qinghai-Tibet Plateau and Loess Plateau as ecological barriers, the sand-prevention belt in North China, the forest belt of Northeast China and the hilly and mountainous belt of South China). Within the continuous poverty eradication area of the Qinling−Dabashan mountainous area according to the relevant section of the 13th Five-year Plan, it is also known as a major area for the achievement of precision poverty eradication with characteristics of "free from two worries and three guarantees" (referring to not worrying about food and clothing, and guarantees of compulsory education, basic health care and safe housing) in order to make China a comprehensively well-off society. Therefore, the Yanzi River Basin is important in terms of national stability and strategic ecological security(Tang XK et al., 2013). The Basin has the geographical coordinates 105°15'~106°00' E, 32°50'~33°25' N and an area of about 1,338 km^2. As a result of the combination of internal and external factors, such as complex geological conditions, frequent seismic activity, intense local rainfall, and large-scale human engineering activities such as slope-cutting to build roads and excavation to construct houses, abrupt geological disasters such as collapse, landslide and debris flow frequently take place in the area (Wang LX et al., 2012; Zhang XH et al., 2017; Chen WL et al., 2017). Affected by the Wenchuan earthquake on May 12, 2018, serious rainstorms happened on July 17, 2009 and August 18, 2010 respectively, with geological disasters happening more frequently and causing heavy damage, threatening the safety of people and their property and restricting the development of the local economy. In order to make a socially-useful national geological survey play the leading role in controlling and preventing geological hazards, identifying the developmental mechanisms of geological hazards such as collapse, landslide and debris flow in the area and enhancing the ability to mitigate and fight against such hazards in the area, the Hydrogeological and Environmental Geological Survey of China Geological Survey (CGS) carried out geological surveys on such hazards as collapse, landslide and debris flow at a scale of 1∶50 000 in the Yanzi River Basin in 2015.[❷] By making full use of existing information and by means of high precision remote sensing interpretation, engineering geological surveying and mapping, measurement of geological hazards and engineering geological exploration, this survey determined the geological engineering conditions that induce hazards, their development characteristics and the distribution of geological hazards within the area, summarized the hazard formation model and set up the database of geological hazard space. These data from the survey of geological hazards are processed by using proper data processing methods and a quality control system. In this way, true and credible results are obtained, providing a credible geological basis for analysis of the hazard formation mechanism, investigation into hazard zoning, land utilization, urban planning and disaster mitigation and prevention.

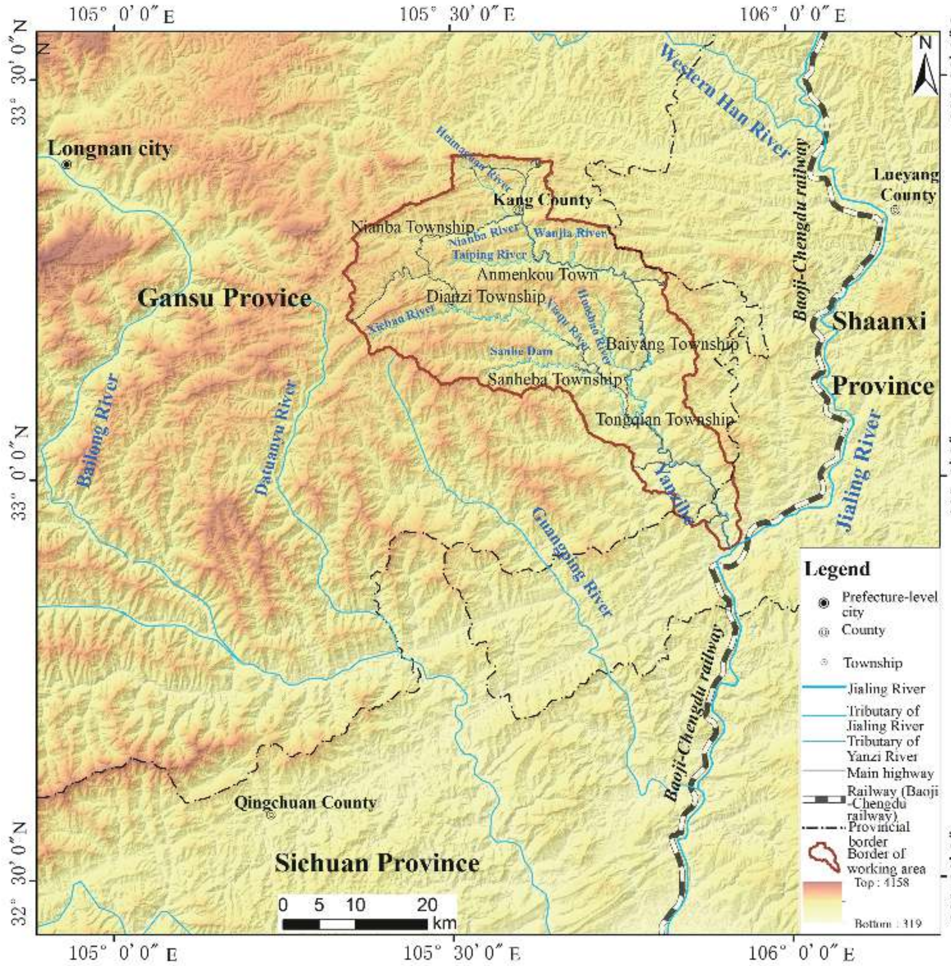

Fig. 1 Yanzi River Basin map location

The simplified metadata sheet for the dataset of the 2015 Yanzi River Basin geological hazard survey is presented in Table 1, including the dataset name, dataset authors, data acquisition time, geographic area, data format, data size, data service system URL, fund project name, language and dataset composition.

Table 1 Metadata Table of Database (Dataset)

Items	Description
Database (dataset) name	Dataset of the 2015 Geologic Hazard Survey of the Yanzi River Basin, Upstream of the Jialing River
Database (dataset) authors	Yang Qiang, Hydrogeological and Environmental Geological Survey, China Geological Survey Ye Zhennan, Hydrogeological and Environmental Geological Survey, China Geological Survey Gao Youlong, Hydrogeological and Environmental Geological Survey, China Geological Survey Li Qiang, Hydrogeological and Environmental Geological Survey, China Geological Survey Ding Weicui, Chinese Academy of Geological Sciences

Continued table 1

Items	Description
Data acquisition time	2015
Geographical area	Its geographical range is 105°15’~106°00’ E, 32°50’~33°25’ N, situated in the southeast of Kang County, Longnan City, Gansu Province and in the northwest of Ningqiang County, Shaanxi Province
Data format	*.xlsx
Data size	451 KB
Data service system URL	http://dcc.cgs.gov.cn
Fund project	China Geological Survey projects entitled “Geologic Hazard Survey of the Yanzi River Basin, Upstream of the Jialing River”(12120115045501) and “Geological Hazard Survey of the Bailong River, South Gansu” (DD20160281),
Language	Chinese
Database (dataset) composition	The dataset contains 4 data files: Yanzi River Basin landslide hazard and risk area data.xlsx (data size: 181KB), Yanzi River Basin collapse and dangerous rock-body data.xlsx (data size: 140KB), Yanzi River Basin debris flow hazard and risk data.xlsx (data size: 59KB) and Yanzi River Basin-specific geological engineering survey point data.xlsx (data size: 73KB)

2 Data Acquisition and Processing

2.1 Source of Data

Data relating to geological hazards in the Yanzi River Basin in 2015 were acquired from field measurements performed in the project “Geological Hazard Survey of the Yanzi River Basin, Upstream of the Jialing River”. Such data mainly cover information about geological hazard points and specific geological engineering points. The survey covers vast range of massive data, and was performed by three work groups in 136 days. For the purpose of serving ecological civilization, mitigating and preventing hazard, the field survey focused on fundamentality and public benefit while making full use of existing information and data in the area under investigation. Centering on areas with high incidents of geological hazards (hazard body), key areas threatened by geological hazards (hazard-affected body) and areas with complex geological conditions (hazard inducer), the survey took advantage of high precision remote sensing and interpretation, geological engineering surveying and mapping, measurements of geological hazards and geological engineering exploration, in an effort to survey typical geological hazards by adopting such methods as drilling, geophysical prospecting, trenching exploration and low altitude aerial photography as required. In the survey, *Technical Requirements for Geological Hazard Survey and Risk Evaluation on Collapse, Landslide and Debris Flow of CGS (Interim)* is followed, and the survey area is divided into three levels (i.e. general survey area, key survey area and geological hazard body) by means of the 1 : 50 000 standard map sheet. The field survey groups made clear the geological environment inducible for hazard and determined the category, scale and characteristics of the geological hazards within the basin, comprehensively analyzed the geological hazard’s time-space distribution and set up the hazard formation model. The work process is shown in Fig. 2.

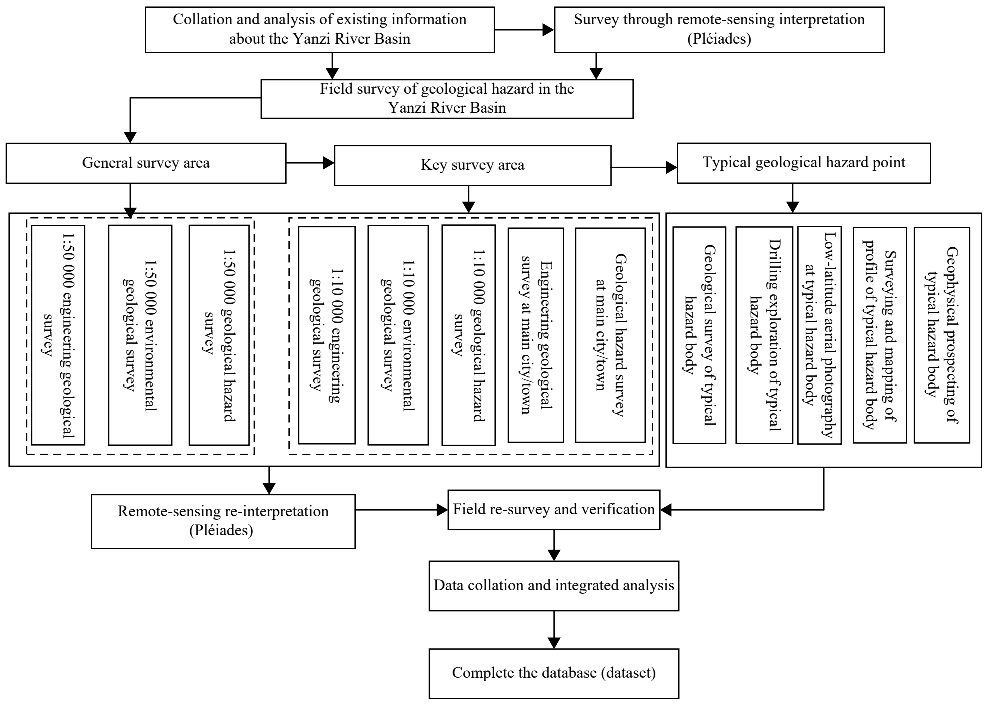

Fig. 2 Work Process

The professional survey methods of combining points, lines and planes were applied to survey the geological engineering conditions and geological hazards in the field. For the survey of geological engineering conditions, full consideration was given to geological structure, stratum lithology and a slope's geological framework, while critical geological structures and lithological border lines were investigated through tracking and crossing. Geological hazards were surveyed and then verified as per different precision requirements. High precision remote sensing and interpretation used the Pléiades high definition remote sensory data. Based on existing survey information and data combined with the geometrical characteristics of geological hazards in the investigated area, the remote sensing interpretation signage system was created to interpret the investigated area more precisely. Full consideration was given to geological structures, stratum lithology, distribution of trunk streams, tributaries, communication lines, critical towns, important building facilities and threatened objects, and 18 survey routes along the Yanzi River Basin were set accordingly. Along the survey routes, the survey points were carefully investigated through tracking or crossing to get information and data at specific geological engineering points. At the same time, based on the mapping and the general situation of geological hazards and geological engineering conditions in the plane, the development of geological hazards in the Yanzi River Basin was revealed; some geological border lines and structural lines were measured and modified; the background for development of geological hazards in the investigated area and slope structure and material composition of typical hazard bodies were evaluated; and the geological engineering formation complex was divided.

2.2 Data Processing

The acquisition of geological hazard survey data in the Yanzi River Basin in 2015 underwent a series of processes such as collection and analysis of previous data points; high precision remote-sensing interpretation, field acquisition, collation, verification and storage of data point information(Tan YJ, 2016) (Fig. 3). First, existing information relateing to previous geological hazard surveys, geological engineering conditions, regional geological conditions and structural geological conditions was collated and analyzed, and based on that, geological hazard maps and related geological maps suitable for survey were developed (CGCS 2000 coordinate system, Gauss-Kruger projection and 1985 national elevation reference were followed). The maps from high precision remote sensing (Pléiades high definition data in 2014) were used to interpret geological hazards and conditions. Based on the interpreted results and with a combination of geological maps, data points were surveyed in the field using devices such as handheld GPS, data acquisition PAD, infrared distance equipment, high precision telescope, laser scanner, low altitude UAV, geological compass and RTK, to determine information and data on positions (latitude and longitude, administrative village it belongs to, etc.), forms (slope gradient and direction), size (length, width and height), structure (lithology and composition) and output background (lithology and occurrence of bed rocks) of geological hazard and engineering geological data points. Data acquired in the field were collated and analyzed in-house to meet the requirements of the database. After undergoing a number of processes such as self-check, mutual check and random check, data were stored in the database in a unified format.

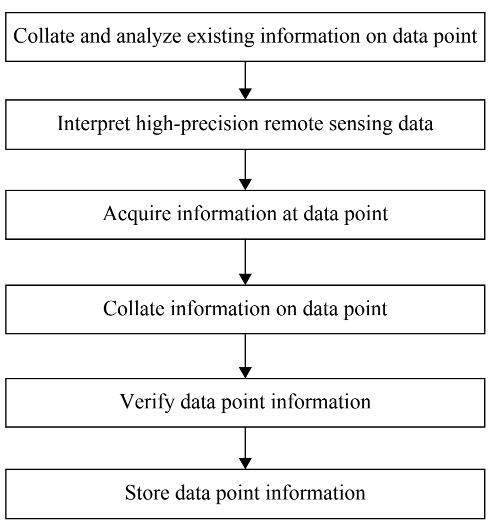

Fig. 3 Data Acquisition Process

3 Description of Data Samples

The Dataset of the 2015 Geological Hazard Survey of the Yanzi River Basin, Upstream of the Jialing River, takes the form of an .xlsx sheet containing a total of 4 Excel files: Yanzi River Basin landslide hazard and risk area data.xlsx, Yanzi River Basin collapse and dangerous rock-body data.xlsx, Yanzi River Basin debris flow hazard and risk data.xlsx and Yanzi River Basin specific geological engineering survey point data.xlsx.

“Yanzi River Basin Collapse and dangerous rock-body data .xlsx” contains the data obtained by studying the characteristics of 170 collapses of dangerous rocks developed as of

December 2015 in the Yanzi River Basin. Specific data for each location of collapse of dangerous rock includes their basic attributes and development characteristics (name, field number, coordinates, movement form, collapse type, type of control structural plane, macro stability assessment, activity state, expansion mode of collapse source, direction of main collapse, elevation of collapse source, maximum drop, maximum horizontal displacement, width, thickness, area and volume of collapse source, inducing factor, mean thickness and area of accumulation body, scale class, certainty degree), geological environment giving rise to collapse or dangerous rocks (landform and topography, stratum lithology, lithological combination, slope structure and geological structure, hydrogeological conditions, vegetation and land use, human engineering activities), and risk and hazard analysis data. Data about collapse time and direct loss are not available as the collapse happens early and cannot be deduced. The file contains data concerning the basic mechanical characteristics of the collapse of dangerous rocks (dangerous rock's lithology and rock-mass structure; structure of control plane; occurrence; development characteristics and combination form of stress-released cracks; intersection characteristics; connection; geometric form, thickness, size, fresh degree, lithology, separation state and spatial distribution characteristics of collapse accumulation body; slope's geometrical form, stratum lithology, vegetation development and whether there is any existing or proposed building at the area of collapse path), providing a basis for subsequent research.

"Yanzi River Basin landslide hazard and risk area data.xlsx" contains the data from the survey of the characteristics of 223 landslides and risk points as of December 2015 in the Yanzi River Basin. The data for each landslide point includes: its basic attributes and development characteristics (name, field number, coordinates, movement form, landslide type, landslide face type, macro stability, expansion mode, landslide era, inducing factor, landslide form, leading edge elevation, rear edge elevation, mean thickness of landslide body, landslide area and volume, threatened object); environment causing the formation of the slope (landform and topography, stratum lithology and lithological combination, slope structural feature, geological structure, surface water and groundwater, vegetation and land use, human engineering activities); basic features of landslide (boundary conditions, form feature and material structure, hydrogeological characteristics, deformation feature and activity history); risk and hazard analysis data. As previous landslides happened many years ago and no data was retained, data items such as landslide period, sliding speed and direct loss were hard to obtain and therefore omitted.

"Yanzi River Basin debris flow hazard and risk data.xlsx" contains the data from the survey of 44 debris flow hazards and risks in the Yanzi River Basin as of December 2015. The data for each debris flow and risk point include: basic attributes and development characteristics of debris flow (name of valley, field number and coordinates, material composition, material source recharge, water catchment area, water power type); features of fan at the valley opening (fan integrity, length and width, dispersion angle, fan face's developing trend, slope drop from fan top to fan source axle; distance from the valley opening to the main river channel); land use (gentle slope farmland, steep slope farmland, arbor woodland, trees, shrubs, grass land and wasteland); volume of debris flow erupted; scale level; threatened objects; prevention and control measures; prevention and control type; macro features of debris flow gully (feature of material source; source and feature of water power, feature of flow area and accumulation area); debris flow history; risk analysis on debris flow; risk feature; other additional description; comprehensive evaluation of debris flow (adverse geological phenomena, length of recharge section, fan at the valley opening, longitudinal slope of main valley, impact of new structure, vegetation coverage, erosion and deposition variation, lithology, reserves of loose materials, slope gradient, cross section of valley, mean thickness of loose materials, relative height difference, valley area, extent of blockage, scoring, susceptibility level, development stage). There may be some deviations in data such as volume of debris flow erupted and impact of new structural movement due to different estimation methods and different survey interpretations.

"Yanzi River Basin specific geological engineering survey point data.xlsx" contains data from 129 specific geological engineering survey points in the Yanzi River Basin as of December 2015. The data items for each specific geological engineering point includes: its basic attributes (name, field number, elevation, coordinates and point type); characterization of engineering geology (landform and topography, slide structure point, geological engineering properties of rock-soil bodies, surface water and groundwater, vegetation and type of land use, human engineering activities and other dynamic geological actions and phenomena).

As the text data format cannot visualize correlations between various data in the dataset, data samples in this research were represented using mutually correlated tables and graphs, including Hazard-affected Bodies and Geological Hazard Types (see Table 2), Relation Between Landslide Number and Slope Gradient/Height (see Fig. 4) and Slide Slope Direction and Slope-gradient Density (see Fig. 5). Collapse, landslide and debris flow mainly threaten roads, residences (schools, villages) and farmland, all of which accounts for 98.1% of the total number of threatened objects. 86% of total landslides develop at slopes with an original gradient ranging from 20° to 50°, which favors the accumulation of the weathered rock and soil, and rainfall infiltration. Most landslides are distributed at the front edge of slopes in a valley (gully) zone with a gentle gradient and thicker accumulation, which has a low slope height. Therefore, the slope height factor has a gentle impact on the landslide. Since the sunlight and temperature difference between daytime and nighttime affects the landslide' s slope direction and gradient density, southward landslides appear to outnumber northward landslides.

Table 2 Summary of Statistical Results Regarding Geological Hazard-affected Bodies and Geological Hazard Types in the Investigated Area

Category of hazard-affected object	Landslide (number, No.)	Collapse (number, No.)	Debris flow (number, No.)	Total (number, No.)	Percentage (%)
Residence (schools and villages)	145	8	43	196	28.70
Road	176	180	44	400	58.57
Brick factory or quarry	0	0	0	0	0

Continued table 2

Category of hazard-affected object	Landslide (number, No.)	Collapse (number, No.)	Debris flow (number, No.)	Total (number, No.)	Percentage (%)
Farmland	24	4	46	74	10.83
Power plant	0	1	1	2	0.29
Scenic area	0	5	0	5	0.73
Flood drainage channel	0	0	1	1	0.15
Object not threatened	3	2	0	5	0.73
Total	348	200	135	683	100

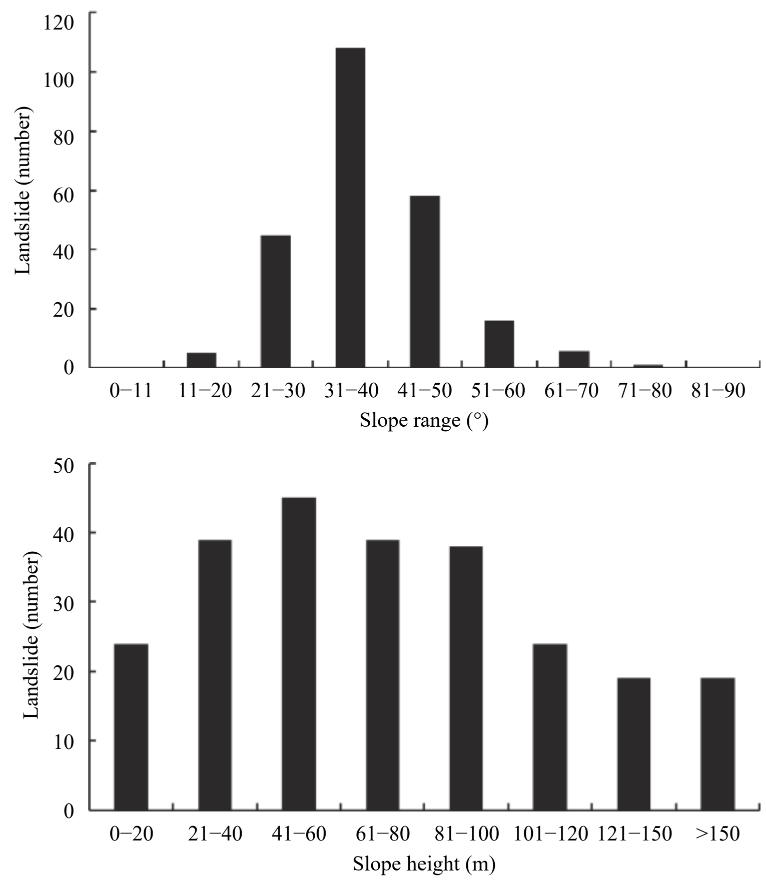

Fig. 4 Relation between landslide number and slope gradient/height

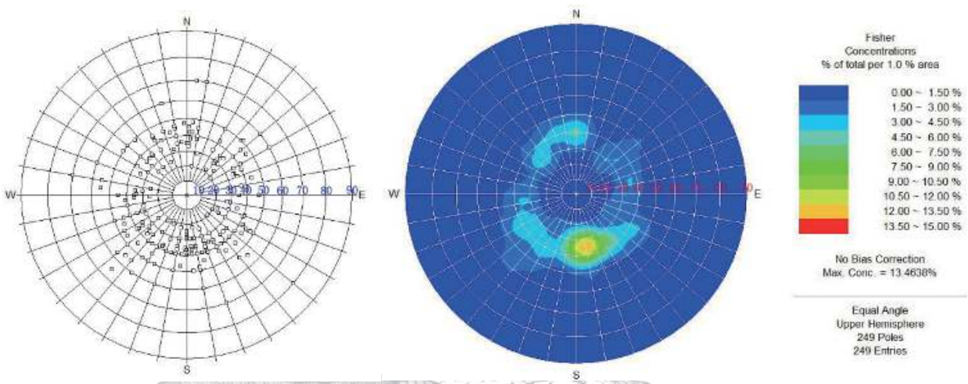

Fig. 5 Landslide Slope Direction and Slope Gradient Density

The distribution of landslides, collapses and debris flows as well as highly dangerous sections in the Yanzi River Basin is shown in Fig. 6. It is indicated in the figure that geological hazard sections with high risk are distributed in the river valleys along major streams and important tributaries of the Yanzi River where human engineering activities occur frequently, as well as sections where main trunk roads cross slopes. These areas or sections are susceptible to the effects of river erosion, landform and topography, stratum lithology, geological structure and human engineering activities. Therefore, various geological hazards are frequent around such zones and thus the impacts of geological hazards are more dangerous there. In this research, 5 highly dangerous collapse sections, 5 highly dangerous landslide sections and 2 highly dangerous debris flow sections were indicated.

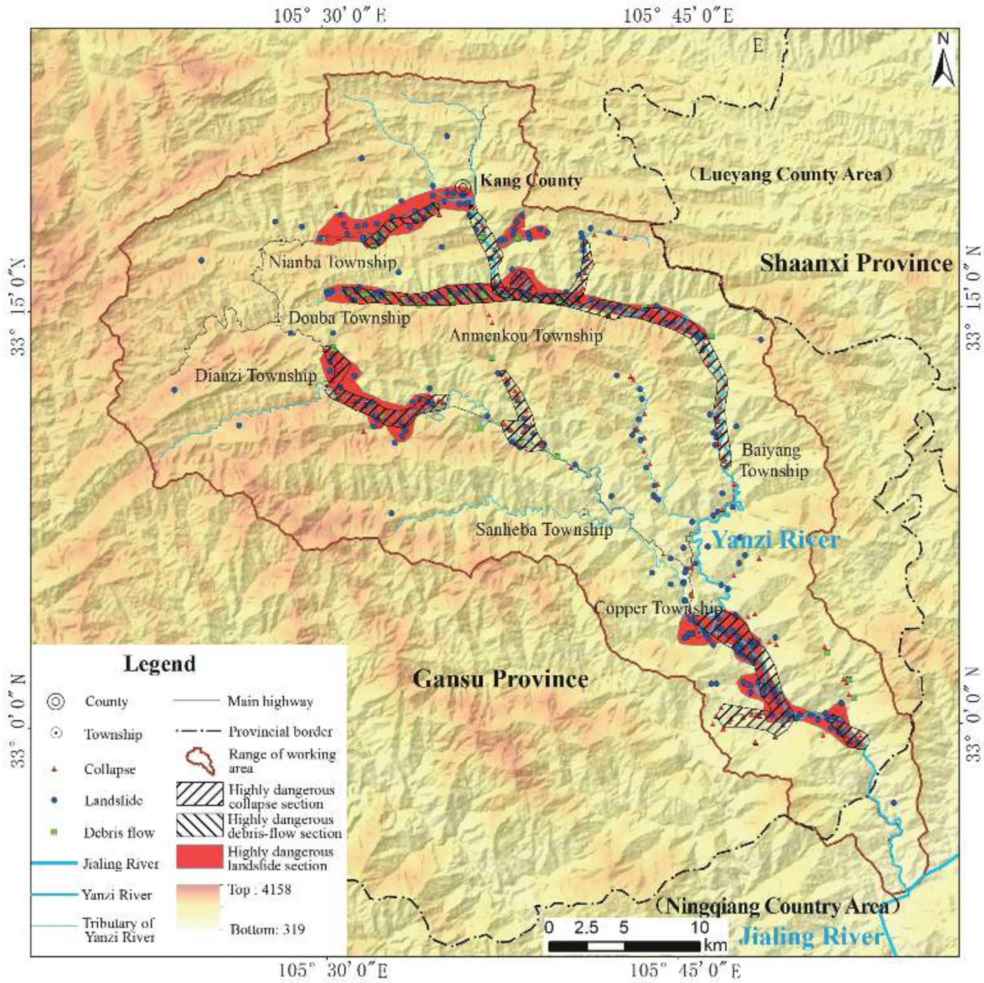

Fig. 6 Distribution of Landslide, Collapse and Debris Flow as well as Highly Dangerous Sections

4 Data Quality Control and Assessment

In the process of raw data acquisition and data processing, methods for data quality control mainly include verification of data acquired in the field, data collation, storage and re-verification. A complete data quality control system was set up during implementation in order to meet specific needs. The key for data acquisition in the field is to ensure that data are true, accurate and integral. Every responsibility in the project was assigned to individuals and every step was carried out under stringent control. Data points with corresponding data in the sheet were repeatedly verified, with a self-check rate of 100%; to boost self-check accuracies, mutual check and random check were done at the rate of 100% and 60%, respectively. During the process of data collection and storage, the reliability and rationality of the quality of the stored data were ensured by such methods as the data being stored by the personnel specifically assigned for this purpose, self-check, mutual check and final review, and the final result data met the inspection and acceptance requirements of Geo-environmental Monitoring Institute, China Geological Survey. With the aforementioned steps and methodologies, the authenticity and credibility of the dataset was generally assured.

5 Data Value

The dataset uses 2014 Pléiades high definition remote sensing data as the data source for interpretation, and integrates the results from prior surveys on geological hazards and engineering geology in the basin before 2015. A systematic survey was performed combining different points, lines and planes at three tiers, namely, general survey area, key survey area and crucial hazard body. Advanced methods such as low-altitude UAV aerial photography, 3D laser scanning and comprehensive geophysical prospecting were adopted to acquire real and credible data, thus ensuring the accuracy and credibility of the dataset. Great improvements were made in terms of survey accuracy, credibility of methods used in the survey, completeness of the survey and authenticity of the surveyed results. Accuracy in the survey of geological hazards and engineering geology in the basin was comprehensively improved; the geological distribution of collapse, landslide and debris flow and the main objects that they threatened were clearly determined. The development characteristics of geological hazards for collapse, landslide and debris flow with grave threat in the basin were identified. The dataset therefore provides a reliable basic guarantee for research on susceptibility to geological hazards, vulnerability and risk-based zoning in the basin, laying a solid foundation for research on the formation mechanisms of collapse, landslide and debris flow as well as related prevention and control measures in the basin. It provides a basis for siting and monitoring in the process of controlling and preventing land masses from collapse, landslide and debris flow geological hazards, thus effectively improving geological hazard mitigation and prevention in the basin. It also provides detailed data support to such activities as land use and urban planning for effective geological hazard mitigation and prevention.

6 Conclusions

(1) Based on the project “Geological Hazard Survey of the Yanzi River Basin, Upstream of the Jialing River” in 2015, the “Dataset of the 2015 Geologic Hazard Survey of the Yanzi River Basin, Upstream of the Jialing River” consists of 223 sets of landslide data, 170 sets of collapse data, 44 sets of debris flow data and 129 sets of data from specific geological engineering survey as of December 2015 in the Yanzi River Basin. The dataset enables sharing of data resource from fundamental and public benefit geological survey, and meets national need for regional geological information integration.

(2) To ensure that the dataset was true, credible and accurate, a well-developed quality control system was implemented in the stages of field data acquisition, collation, verification, storage and inspection. Information in the dataset about geological hazard survey of collapse, landslide and debris flow covers basic attributes, geological environment, background conditions, development characteristics, frequency of outputs and geological engineering conditions of geological hazards induced within the Yanzi River Basin as of December 2015, which effectively increases the accuracy of the geological hazard survey in the Yanzi River Basin.

(3) On the basis of integrating existing data, a collection of detailed and credible survey data were obtained in the dataset by using traditional remote sensing interpretation, surface survey and new technologies and methods, such as low-altitude aerial UAV photography, 3D laser scanning and comprehensive geophysical prospecting. The dataset provides credible data to research the formation mechanisms of collapse, landslide and debris flow in the basin, and to study the susceptibility to geological hazards, vulnerability and risk-based zoning. It provides a basis for siting and monitoring the process of controlling and preventing land masses from collapse, landslide and debris flow geological hazards. It offers a fundamental basis for land use and urban planning to effectively improve general geological hazard mitigation and prevention level.

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Notes:

❶ National 13th Five-Year Plan for Prevention and Control of Geological Disasters[S]. Ministry of Land and Resources, 2016(in Chinese).

❷ Yang Qiang, Ye Zhennan, Wang Honglei. 2016. Investigation on geological disasters in Yanzi River Basin in the upper reaches of Jialing River[R]. BaoDing HeBei: Hydrogeologyical and Environmental Geologyical Survey, China Geological Survey (in Chinese).

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