

基于GIS空间分析的区域尺度人工湿地选址



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摘要: 根据土地利用、地形、坡度、土壤质地、地质灾害等数据进行分类筛选, 通过GIS空间叠加分析得到最佳用地条件、地形地貌良好、土壤质地适宜、无地质灾害风险且靠近自然河岸的, 适合建设人工湿地的用地分布情况, 作为最适合区域尺度人工湿地的选址地点。以广州市为例进行分析, 结果表明: ①各区均包含适于建设人工湿地的可利用地, 但主要分布在番禺、花都、增城、白云和南沙等区; ②广州市地势北高南低, 地形地貌条件较好, 土壤质地粘土和壤土较多, 地质灾害只有少量分布, 整体用地条件较好; ③可用于建设区域尺度人工湿地的土地主要分布在广州市的中南部, 以白坭水道、流溪河下游、增江中下游、莲花山水道东岸、沙湾水道西南侧等周边地区为主。

关键词: GIS; 空间分析; 人工湿地; 选址; 广州市

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城市湿地具有调节环境、维护生态、供应资源、促进经济社会文化效益、安全防护等综合功能; 然而目前城市湿地存在面积不断减少、频繁受到污染、生态系统遭到破坏的现象, 这与其选址适宜程度有一定关系^[1]。人工湿地的规划选址涉及环境科学和景观规划等学科知识, 选址方法包括文献研究、跨学科综合分析、案例分析和实地调研等^[2-4]。对于更加宏观层面的基础服务设施选址, 仅靠传统方法很难体现选址条件的准确性。利用GIS进行空间分析是地理学当前最有价值的财富之一, 其在土地利用、交通规划、环境分析和规划、服务分配等方面有非常广泛的应用^[5]。目前GIS分析已应用于超市、公园、ATM、中小学、商业网点以及其他公共服务设施的选址中^[5-6], 但将其应用于人工湿地规划选址中的研究较少。本文以广州市为例, 采用GIS空间叠加分析功能对人工湿地建设所需要的地质、地貌、水文、土壤以及地质灾害条件等因素进行分析筛选, 完成了区域尺度人工湿地的选址。

广州市经济发达, 人口密集, 常住人口约为1 300万人。广州市1 a产生的城镇生活污水约为141 000万m³, 因此处理生活污水、防治河涌污染, 是广州市政府面临的严峻问题^[7-9]。近年来, 广州市政府积极推行生态城市建设, 为“花城、绿城、水城”建设做了大量的相关政策研究。人工湿地的功能和特点符合广州建设生态城市的总体目标, 若采用人工湿地处理广州市生活污水, 将面临诸多中观或宏观层面的科学问题, 如区域级的人工湿地选址分布等。针对该问题, 本文根据广州市的实际情况, 利用GIS空间叠

加分析功能分析了区域级人工湿地潜在选址点的分布情况, 以期生态城市建设过程中基础生态设施规划以及相关领域提供参考。

1 研究方法

1.1 人工湿地建设的基本要求

人工湿地的选址必须根据地质、地貌、水文、污水出口等自然环境状况以及市政规划等因素来确定^[10-11], 选址时应利用地形图、地质图、航空摄影图、土壤调查图、水文调查图以及其他相关资料进行对比确定^[12]。人工湿地应尽量靠近污染源, 同时应考虑选址的自然坡度^[13], 选择污染物流经的地带或没有利用的闲置土地^[14], 具有足够的空间使污水有合理的停留时间, 最好选择粘性土壤的底质; 一般情况下, 人工湿地选址应避免自然遗产保护区、考古或历史资源保护区、濒危物种保护区等^[13]。人工湿地面积越大, 容纳污水量越多, 污水停留时间越长, 处理效果越好^[13], 由于本文是为以市、区为单位的区域级人工湿地选址, 且广州市当前人口产生的生活污水将达387.80万m³/d, 小面积的湿地无法有效处理^[15], 所以本文以面积大于0.01 km²的可用地为选择目标。

广州市地势东北高、西南低, 地貌类型包括中低山、丘陵、台地和平原等, 受岩性、构造控制较为明显。广州市位于珠江三角洲顶部, 水系发达, 外有东江北干流、珠江前后西航道以及虎门、蕉门、洪奇门3个出海通道; 内有流溪河、增江以及三角洲河网水道、山区小溪, 建成区共有河涌231条、河道总长913 km,

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因此广州市具有较理想的建设人工湿地的自然环境。但是作为特大城市，广州市的城市、建制镇以及村庄面积占了绝大部分主城区，密集的城市建设使人工湿地的选址受限。

1.2 人工湿地选址方法

本文利用广州市土地利用、地形、坡度、土壤质地、地质灾害等数据，通过 GIS 筛选分析，获取了广州市区域尺度人工湿地选址点。首先在土地利用类型中，将坑塘水面、裸地、其他草地以及其他园地等作为湿地建设的可利用地，可排除与自然遗产保护区、考古或历史资源保护区以及濒危物种保护区的冲突；然后通过 GIS 对面积大于 0.01 km² 的可利用地进行筛选，按邻近河流水系 1 km，土壤底质为粘土和壤土，坡度小于 5°，避开地质灾害等条件进行选址分析。选址分析技术路线见图 1，具体筛选条件见表 1。

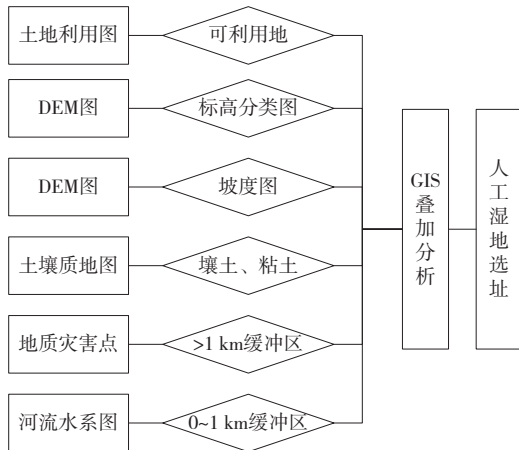


图 1 基于 GIS 的人工湿地选址技术路线

表 1 人工湿地选址条件

代码	选址筛选因素	筛选条件	筛选	赋值
A	坑塘水面、裸地、其他草地、其他园地	面积 >0.01 km ²	保留	1
		面积 <0.01 km ²	舍弃	0
B	地形	2 m < 标高 < 25 m	保留	1
		其他	舍弃	0
C	坡度	0 < 坡度 < 5°	保留	1
		其他	舍弃	0
D	土壤质地	壤土、粘土	保留	1
		其他土壤	舍弃	0
E	地质灾害	缓冲区 >1 km	保留	1
		缓冲区 <1 km	舍弃	0
F	河流缓冲区	0 < 缓冲区 < 1 km	保留	1
		缓冲区 >1 km	舍弃	0

按照筛选条件对筛选因素进行重新分类并赋值，再对筛选因素 A~F (图 2~7) 进行叠加分析，获取各因素的加权值，最后取最高值作为最佳人工湿地选址点。

1.3 数据来源

本文采用的土地利用图、河流水系图来源于第二

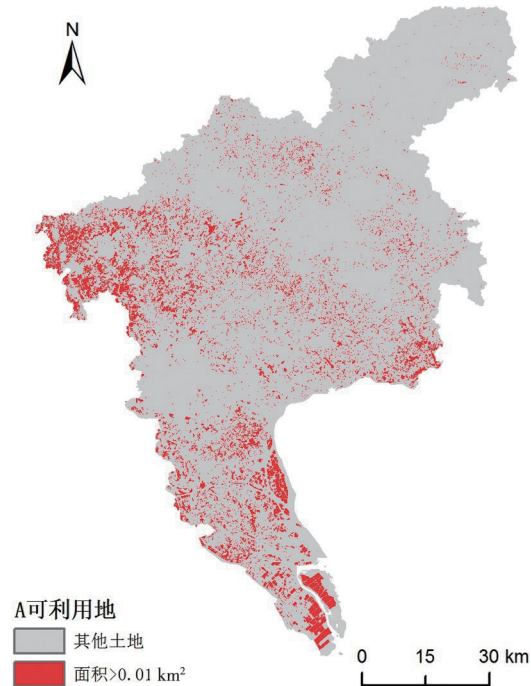


图 2 GIS 人工湿地选址筛选因素“ A 可利用地”示意图 (审图号：GS(2015)2583)

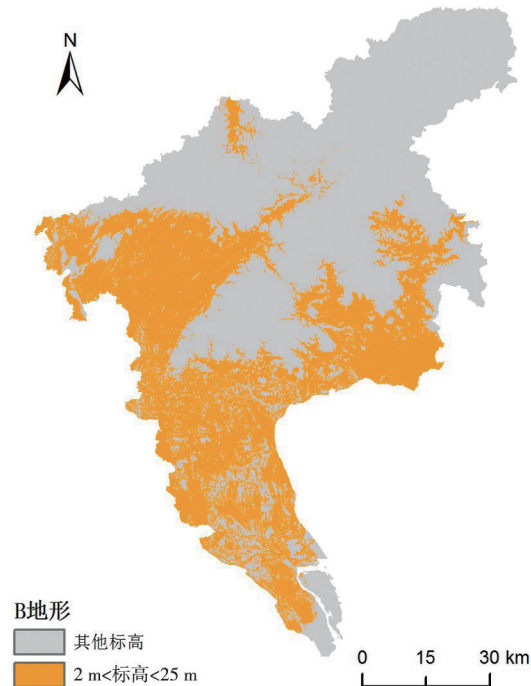


图 3 GIS 人工湿地选址筛选因素“ B 地形”示意图 (审图号：GS(2015)2583)

次全国土地调查广州地区数据，精度为 1 : 10 000；DEM 来源于中国科学院计算机网络信息中心地理空间数据云 GDEM V2 30 m 分辨率的 DEM 数据；土壤质地图来源于广东省生态环境与土壤研究所广东省数字土壤 V2.0 土壤质地数据，精度为 1 : 100 万；地质灾害图来源于广东省 2015 年度地质灾害防治方案《广东省 2015 年威胁 100 人以上地质灾害隐患点一览表》中的广州地区数据。

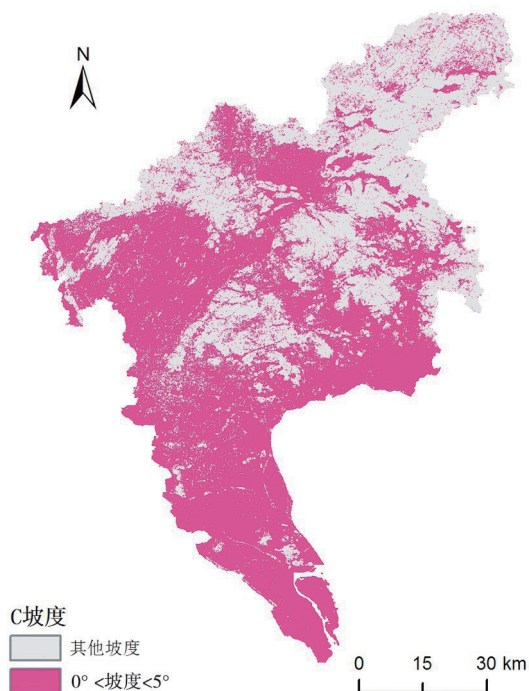


图 4 GIS 人工湿地选址筛选因素“C 坡度”示意图 (审图号: GS(2015)2583)



图 5 GIS 人工湿地选址筛选因素“D 土壤质地”示意图 (审图号: GS(2015)2583)

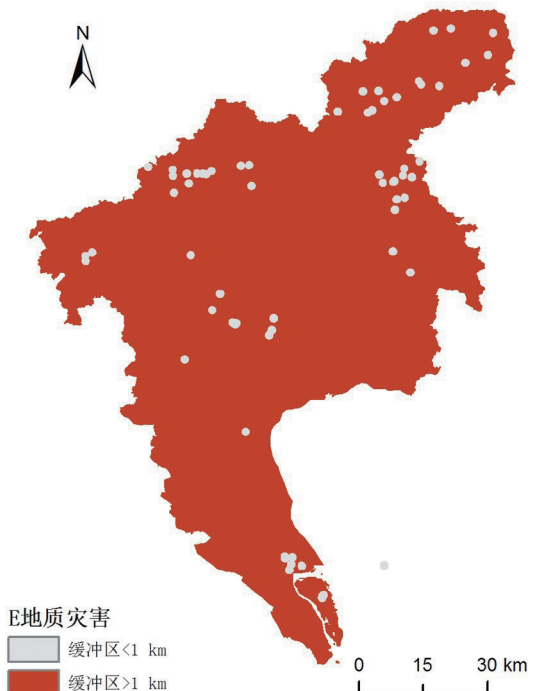


图 6 GIS 人工湿地选址筛选因素“E 地质灾害”示意图 (审图号: GS(2015)2583)

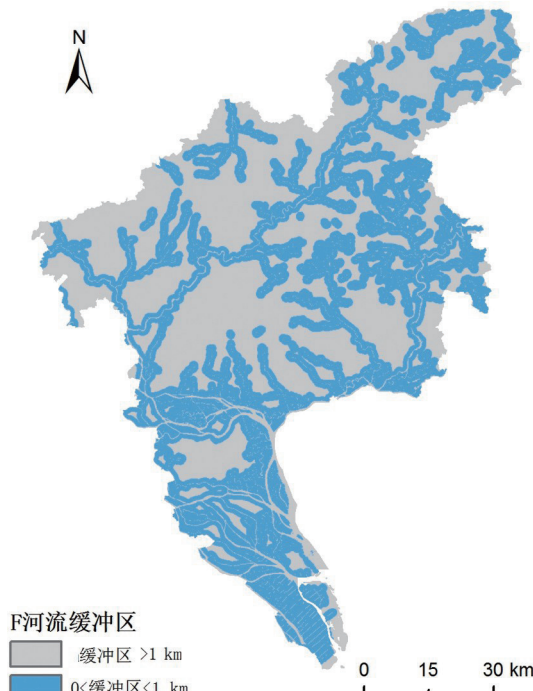


图 7 GIS 人工湿地选址筛选因素“F 河流缓冲区”示意图 (审图号: GS(2015)2583)

2 结果分析

2.1 可利用地面积

首先通过土地利用因素对面积大于 0.01 km² 的可用地进行分析, 广州市海珠、黄埔、荔湾、天河和越秀等 5 个主城区可用于人工湿地建设的土地较少, 其余各区均有大量可用于区域人工湿地建设的土地; 再

通过 GIS 对地形、坡度、土壤质地、地质灾害、河流缓冲区等因素进行叠加分析, 除越秀区没有任何适建土地外, 从化、海珠、黄埔、荔湾、萝岗以及天河 6 个区中仍有少量适于建设区域级人工湿地的土地, 白云、番禺、花都、南沙和增城均有大量适建土地; 若考虑污水(中水)的跨区湿地处理, 总体而言, 广州市有足够适于建设区域级人工湿地的土地(表 2)。

表 2 广州市各区坑塘水面、裸地、其他草地、其他园地等可利用地面积 / km²

行政区	分析前可利用地面积	分析后适建土地面积
白云区	61.20	23.13
从化市	15.24	2.12
番禺区	106.00	52.68
海珠区	0.76	0.59
花都区	131.12	47.70
黄埔区	1.55	0.90
荔湾区	2.63	1.18
萝岗区	17.07	1.14
南沙区	81.24	20.90
天河区	3.25	0.11
越秀区	0.02	0.00
增城市	67.23	34.14
总计	487.32	184.60

2.2 人工湿地选址条件分析

各区均存在适建人工湿地的可利用地，但主要分布在番禺、花都、增城、白云和南沙等区。广州全市地势北高南低，标高在 2~25 m 的土地主要分布在花都、增城以及白云山以南的区域；0~5° 的坡度与地形分布较相近，但从化区域沿 S355 线两边坡度变化较小；主要土壤质地包括中壤土、中粘土、轻壤土、轻粘土、重壤土和砂壤等，完全沙质的土壤较少，多数可利用地适建人工湿地，壤土和粘土主要分布在流溪河下游、花都区、增江河两岸、荔湾区和海珠区以南的区域；地质灾害类型主要为滑坡、崩塌，分布在北部以及白云山周边，亦有少量岩溶塌陷，分布在白坭水、琶江河以及增城北部等区域。总体而言，广州市可用于区域级人工湿地建设的土地较多，地形地貌、土壤条件较好，地质灾害不多，用地条件较好。

2.3 人工湿地选址分布分析

经过叠加分析可知，适建区域尺度人工湿地的土地主要分布在广州市中南部，多分布在花都、增城、番禺、南沙和白云等区。按流域来看，其主要分布在琶江河上游、白坭水道、流溪河下游、增江中下游、珠江南河道以南、砺江上游、莲花山水道东岸沙湾水道西南侧等周边地区。由图 8 可知，可用于人工湿地建设的土地在广州市整体分布不均匀，主要分布在花都、增城、番禺、南沙等远郊人少的区域，而荔湾、越秀、天河、海珠等人口集中的区域内只有极少分布。

3 结语

本文根据土地利用、地形、坡度、土壤质地、地质灾害等数据进行分类筛选，再通过 GIS 空间叠加分析得到最佳用地条件、地形地貌良好、土壤质地适宜、无地质灾害风险且靠近自然河岸的，适合建设人工湿地的可利用地分布情况，以本文所限的条件，该类可利用地为最适合区域尺度人工湿地选址的地点。通过

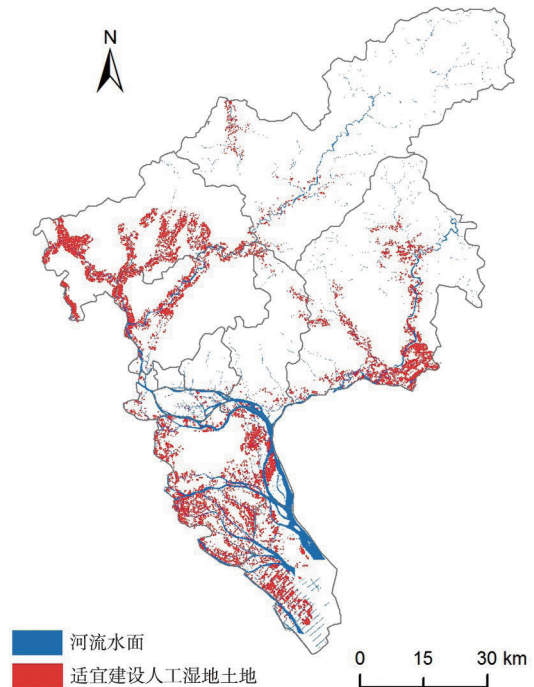


图 8 广州市区域尺度人工湿地选址分析示意图
(审图号：GS(2015)2583)

广州市的实例分析，得到以下结论：

- 1) 各区均有适建人工湿地的可利用地，但主要分布在番禺、花都、增城、白云和南沙等区。
- 2) 广州市地势北高南低，地形地貌条件较好，粘土和壤土较多，地质灾害只有少量分布，整体用地条件较好。
- 3) 适建区域尺度人工湿地的土地主要分布在广州市中南部，以白坭水道、流溪河下游、增江中下游、莲花山水道东岸、沙湾水道西南侧等周边地区为主。

相对于传统污水厂，人工湿地具有投资费用少，建设、运营成本低廉，经济效率显著，污水处理效果好，可作为城市湿地景观等特点，可为城市增加极好的生态环境效益^[16-18]，对提升城市水环境质量有重要作用。近年来，广州市的白云区、海珠区通过人工造湖，分别新增湖泊湿地面积 2.07 km² 和 1.5 km²，尽管人工湿地的建设比湖泊开挖难度更大，但从工程量和工程措施上来看，区域级人工湿地的建设具有一定可行性。

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驶态势不同。综上所述，基于车道驾驶态势的变化和分布，构建 lanezone 级别及其内部的车道拓扑关系，可实现顾及变道信息在内的车道级路径规划，为自动驾驶提供更为精确的车道级感知和认知基础。

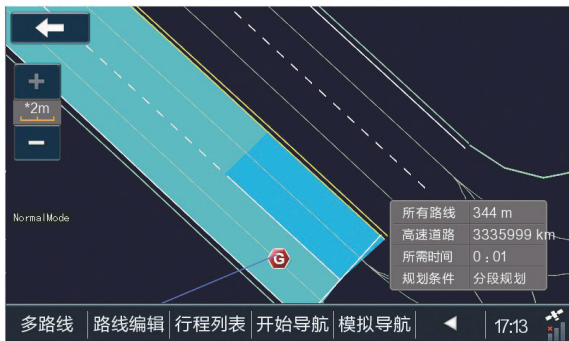


图 8 车道级路径规划展示

4 结 语

针对高精度地图在自动驾驶中的应用，本文提出了一种基于车道驾驶态势的拓扑构建和路径规划方法，并进行了实验验证；实现了车道级导航功能和自动驾驶一次规划，并为自动驾驶二次规划提供可驾驶道路区间。在 lanezone 内允许车辆直行或左右变道，且保持横向水平。lanezone 之间的拓扑关系以区间纵向长度为通行代价之一，构成含权重的有向图；运用 Dijkstra 算法进行最优路径规划，完成自动驾驶一次规划。本文通过驶入和驶出接口来表达 lanezone 内部拓扑关系，可快速完成车道级路径规划，为自动驾驶二次规划提供依据。未来还需大范围实验和测试以评估和优化该方法的应用效率，并深入融合多源传感器数据，系统

验证自动驾驶二次规划功能。

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mirror of collimation measurement can solve the problem that tank shell internal measurement is not apparent.

Key words geodesy and surveying engineering, different sizes of cubic mirror, alignment, combinative measurement (Page:41)

Location Selection of Artificial Wetland in Regional Scale Based on GIS Spatial Analysis

by YUAN Shaoxiong

Abstract In this paper, we used the land use data, topography, slope, soil texture, and geological disaster data to classify and screen the land. Through GIS overlay analysis, we got the distribution of the most suitable location for artificial wetland in regional scale which had the best land condition, well topography, suitable soil texture, no geological disaster risk and close to the natural riverbank. The results show that ① the available lands for artificial wetland are distributed in various districts, but mainly distributed in Panyu, Huadu, Zengcheng, Baiyun and Nansha. ② The overall land condition of Guangzhou City is good. ③ The lands that can be used to construct the regional scale artificial wetland are mainly distributed in the south-central area of Guangzhou. They are mainly distributed in Baini waterway, downstream of Liuxihe River, middle and lower reaches of Zengjiang River, east of Lianhua Mountain channel and southwest of Shawan waterway.

Key words GIS, spatial analysis, artificial wetland, location selection, Guangzhou City (Page:44)

Aided Tools for Thematic Map Design Based on CorelDraw

by WANG Yueping

Abstract In this paper, we introduced the research current of thematic map aided design tools, studied the data types involved in thematic map design, and discussed some tasks in thematic map design process, such as multi-source data processing, map symbol library, map color library, sample library and map configuration. Considering with the actual needs of the mapping institutions, we designed and developed thematic map design aided tools based on ArcGIS and CorelDraw. The tools had been used in practice. The result shows that the tools can improve the efficiency of thematic map design.

Key words thematic map, map design, symbol library, color library (Page:48)

Topology Construction and Route Planning Based on Lane Driving Condition

by ZU Sijie

Abstract We analyzed the global research about lane model of HAD map in this paper. Aimed at the application of lane model in autonomous driving, we proposed a topology construction and route planning method based on lane driving condition. Lane driving condition refers to space orientation and traffic situation of the vehicle when driving through the lane at the correct traffic rules. Firstly, we used lane driving condition to generate the lane-level range of passable zone, and then built the topological relationship between passable zones. In the end, we used Dijkstra algorithm to optimize route planning. Within the passable zone, the topological relationship could be achieved by entering and exiting interface points to describe that vehicle could change lane in any position of the zone. So lane-level route planning could be quickly completed, which could provide the basic reference for multi-source data fusion and second planning of autonomous driving.

Key words HAD map, lane driving condition, topology construction, route planning (Page:53)

Spatio-temporal Expression Pattern of Campus Vegetation

by SHI Guijiao

Abstract The application of traditional GIS in campus vegetation is to achieve a simple query and analysis, and provide the spatial location and attribute information. So the campus scene is presented as static pictures, dynamic expression can't be achieved. The spatio-temporal expression of campus vegetation can not only solve the traditional GIS implementation function, but also realizes the dynamic expression of campus vegetation. We constructed the spatio-temporal database, designed a special symbol library, and described the spatio-temporal expression model in this paper.

Key words TGIS, campus vegetation, special symbol, spatio-temporal expression (Page:57)

Application of Remote Sensing in the Evaluation of the Master Planning Implementation of Chongqing City

by LI Sheng

Abstract In this paper, we briefly summarized the application of remote sensing technology in Chongqing urban planning, and introduced the distinguish standards and rules of the current urban construction land scale and category. And then, through the concrete case, we expounded the content and method of remote sensing evaluation, to provide a reference for similar work.

Key words Chongqing City, urban master planning, remote sensing, implementation evaluation (Page:60)

Design and Implementation of Survey Mark Information Management System Based on WebGIS

by WANG Taotao

Abstract We proposed a design and implementation method of survey mark information management system in this paper. And then, taking the survey

mark information management system of Guangdong Province for example, we introduced the construction process, key technologies and operating results of this system in detail. This study has certain practical value.

Key words hyperspectral image, kernel method, image classification (Page:64)

Spatio-temporal Change Analysis of Seasonal Vegetation Coverage in Guanzhong Area from 2003 to 2014

by LIU Zhen

Abstract Based on MODIS-NDVI products and the rainfall time series data, we analyzed the spatial pattern and change trend of seasonal vegetation coverage in Guanzhong Area from 2003 to 2014, and discussed the correlation between vegetation coverage and standard precipitation index (SPI). The results show that ① during the study period, the vegetation coverage of I-15 in the three ecological zones of Guanzhong Area is the highest, the vegetation coverage of I-11 is the highest in spring and the vegetation coverage of I-12 is highest in summer. ② There is a slight increase in vegetation coverage in spring, summer and winter, while the whole vegetation coverage decreases in autumn. ③ There is a positive correlation between the total vegetation coverage and SPI in summer and autumn, but there is no significant correlation between vegetation coverage and SPI in spring and winter.

Key words Guanzhong Area, vegetation coverage, SPI, Sen trend (Page:67)

Semi-automatic Extraction of Road Information for Geographical Conditions Monitoring

by YANG Chunhua

Abstract There are a lot of research results on the extraction of road and road networks from remote sensing images, but there are still a lot of problems in the degree of automation, efficiency and precision. In view of the above shortcomings, combining with the situation of geographical conditions monitoring, we put forward a semi-automatic extraction method of road network, which used the combinative method of template matching and self-adaption in this paper. Firstly, we used the template matching method to preliminary extract the road. And then, we used the human-computer interaction to refinement road extraction results. Finally, we used the self-adaptive optimization method to optimize road boundary and got road network results which matched the images well.

Key words remote sensing image, road extraction, template matching, self-adaption (Page:72)

Design and Implementation of the Remote Sensing Monitoring System of Atmospheric Pollution Based on PIE

by CAO Huan

Abstract Based on the domestic remote sensing software PIE, combining with the monitoring and inversion algorithm of the atmospheric pollutant, using the plug-in development technology, we designed a remote sensing monitoring system of atmospheric pollution, which realized the visualization of atmospheric pollution in this paper. Based on the remote sensing software PIE for secondary development, using the language of C#, this system mainly focused on the real-time processing and analysis of remote sensing data (such as MODIS, OMI, MOPITT, VIIRS) to realize the real-time visual dynamic monitoring of different atmospheric pollution indexes. The system's functions mainly include the visual display, the business monitoring and analysis, and the output of thematic map.

Key words atmospheric pollution, remote sensing monitoring, PIE, aerosol retrieval (Page:75)

Analysis of Spatio-temporal Pattern in Urban-rural Income Gap in China Based on ESDA

by SUN Huanfang

Abstract Based on the urban-rural residents income ratio data of 339 prefecture-level cities or above in China from 2002 to 2014, we used the methods of the spatial autocorrelation, the semivariogram function, Kriging spatial interpolation to analyze the spatial pattern and change characteristics of the urban-rural income gap of prefecture-level cities or above in China. The results show that the urban-rural income gap is increase from 2002 to 2006. The urban-rural income gap shows clusters phenomenon obviously. H-H area are sheet distribution in the central and western regions of China, and L-L area are scattered distribution in the eastern regions of China, which indicates a significant non-equilibrium development of the urban-rural income gap in China. The urban-rural income gap has an obvious spatial heterogeneity.

Key words urban-rural income gap, spatio-temporal pattern, China (Page:80)

Suitability Analysis of Spatial Development in Xinyi City Based on GIS

by YAO Yaqing

Abstract In this paper, taking grid as the evaluation unit, we synthetic analyzed six evaluation indicators including ecological importance, the vulnerability of disaster, water environmental capacity, the proportion of construction land, traffic accessibility, population and economic agglomeration degree. And then, we used the spatial analysis model of ArcGIS to analyze the distance, density and surface (slope). Finally, we used Delphi method to standardize the original data, calculated and classified the suitability indexes. The result shows that Xinyi City is divided into five types, such as high suitability, moderate suitability, middle suitability, critical suitability and non-suitability. On basis of this, some more reasonable