

## 《农业水土资源监控研究》专题快报

2020年第4期（总第17期）

中国工程科技知识中心农业分中心

中国农业科学院农业信息研究所

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### 【政策法规】

#### 1. 农业农村部办公厅关于印发《2020年乡村产业工作要点》的通知

发布源：农业农村部

发布时间：2020-02-17

摘要：2020年，是全面打赢脱贫攻坚战的收官之年，是全面建成小康社会的目标实现之年，促进乡村产业发展，具有重要意义。做好乡村产业工作的总体考虑是：以习近平新时代中国特色社会主义思想为指导，贯彻落实中央1号文件和《国务院关于促进乡村产业振兴的指导意见》精神，对标对表全面建成小康社会目标，牢固树立新发展理念，以实施乡村振兴战略为总抓手，以农村一二三产业融合发展为路径，聚焦重点产业、聚集资源要素，强化创新引领，突出集群成链，培育发展新动能，大力发展富民乡村产业，为全面小康和乡村振兴提供有力支撑。

链接：

<http://agri.ckcest.cn/file1/M00/00/D8/Csgk0V5OiiCADqXUAAZv8CFmFLM682.pdf>

#### 2. 农业农村部关于落实党中央、国务院2020年农业农村重点工作部署的实施意见

发布源：农业农村部

发布时间：2020-02-12

摘要：2020年是全面建成小康社会目标实现之年，是全面打赢脱贫攻坚战的收官之年。面对国内外错综复杂环境，做好2020年农业农村工作具有特殊重要意义。各级农业农村部门要以习近平新时代中国特色社会主义思想为指导，全面贯彻党的十九大和十九届二中、三中、四中全会及中央经济工作会议、中央农村工作会议精神，认真落实《中共中央、国务院关于抓好“三农”领域重点工作确保如期实现全面小康的意见》，紧扣打赢脱贫攻坚战和补上全面小康“三农”短板重点任务，坚持新发展理念，坚持稳中求进工作总

基调，以实施乡村振兴战略为总抓手，深化农业供给侧结构性改革，推进农业高质量发展，突出保供给、保增收、保小康，着力稳定粮食生产，抓好生猪稳产保供，促进农民持续稳定增收，稳步推进农村改革，保持农村社会和谐稳定，毫不松懈、持续加力，发挥好“三农”压舱石作用，为确保经济社会大局稳定提供有力支撑。

**链接:**

<http://agri.ckcest.cn/file1/M00/0F/A9/Csgk0F5Oo3GAAFJvAAaV9JsObN8944.pdf>

### **3 . 农业农村部办公厅关于印发《2020年种植业工作要点》的通知**

发布源：农业农村部

发布时间：2020-02-10

摘要：2020年种植业工作的总体思路是：坚持以习近平新时代中国特色社会主义思想为指导，全面落实党的十九大和十九届二中、三中、四中全会及中央经济工作会议、中央农村工作会议、中央一号文件精神，按照全国农业农村厅局长会议部署，对标对表全面建成小康社会目标任务，坚持稳中求进工作总基调，坚持新发展理念，深化农业供给侧结构性改革，全力抓好农业稳产保供和农民增收，坚决守住国家粮食安全底线，推进种植业绿色高质量发展，在做好新型冠状病毒感染肺炎疫情防控的同时，统筹抓好种植业稳定发展各项工作，为全面建成小康社会和脱贫攻坚战圆满收官奠定坚实基础。

**链接:**

<http://agri.ckcest.cn/file1/M00/0F/A9/Csgk0F5OovmACODWAAYqGb3bE9c609.pdf>

### **4 . 农业农村部办公厅关于印发《农业绿色发展先行先试支撑体系建设管理办法（试行）》的通知**

发布源：农业农村部

发布时间：2019-11-25

摘要：《农业绿色发展先行先试支撑体系建设管理办法（试行）》要求，第七条 建立和完善绿色农业标准体系。加快制定一批资源节约型、环境友好型农业标准，健全提质导向的农业绿色标准体系。在生产领域，制定完善农产品产地环境、投入品质量安全、农兽药残留、农产品质量安全评价与检测等标准。建设绿色生产标准化集成示范基地，整县推动规模主体按标生产。在加工领域，制定完善农产品加工质量控制、绿色包装等标准。在流通领域，制定完善农产品安全贮存、鲜活农产品冷链运输以及物流信息管理等标准。第十一条 建立和完善绿色农业数字体系。将遥感、物联网、大数据等现代信息技术与农业绿色发展结合，对农作物生长发育、畜禽养殖和渔业生产对土壤、水等环境质量状况的影响进行长期跟踪监测和分析。加快数字农业建设，对推进农业生产过程

全程精细化管理，提升农业发展信息化水平、智能化水平，为农业绿色发展的理论研究和实践创新积累数据支撑。第十五条 建立长期固定观测试验站。每个试点县依托县农技推广、畜牧兽医等单位现有资源，建立农业绿色发展长期固定观测试验站。观测试验站实行站长负责制，由试点县人民政府负责同志担任站长，并组织实施。保障观测试验用地用房，购置植物、土壤、水等理化分析和气象观测等设施设备。明确监测点位、指标、方法和频次等，对资源利用、投入品使用、废弃物回收利用、农产品产出和价格、环境指标变化等情况进行监测、分析。省级农业农村科研单位要加强对观测试验站的工作指导。符合条件的观测试验站及时纳入国家农业科学观测体系。

链接:

<http://agri.ckcest.cn/file1/M00/0F/A9/Csgk0F5OUDuAXvDxAAbbhDudAxM293.pdf>

### 【动态资讯】

#### 1. 融合人工智能和多传感器技术打造农业机器人，助力农业智能化转型

【OFweek机器人网】随着农作物的种植以及收割采摘全程机械化趋势不断发展，中高端农机智能产品将迎来市场机会，尤其是智能农机的推广和应用，将会帮助农机企业扩大新的市场与高峰期。当农业机械足够智能，农民将不再需要面朝黄土背朝天，而是面对着电脑或手机终端，控制机械完成农业生产。那时，农民这一职业也许会像现在的“程序农”一样，成为新一代的潮流工种。

链接:

<http://agri.ckcest.cn/file1/M00/0F/A9/Csgk0F5OpnmAU0yOAAAT4f5ijKKc297.pdf>

#### 2. 荷兰八成农民借助传感器技术实现精准农业

【传感器专家网】在荷兰，精准农业已显现出巨大的竞争优势。目前，荷兰八成的农民已在政府支持下，通过传感器、无人机等方式收集田间信息。在荷兰，几乎所有的田间防治都基于大数据分析。

链接:

<http://agri.ckcest.cn/file1/M00/0F/A9/Csgk0F5Opf6AIXKoAAOA6z9VX80549.pdf>

#### 3. 宁夏利用信息服务农业生产 促进农业高质量发展

【中国农网】宁夏回族自治区科技部门为确保春季农业科技工作不误农时，各级科研机构等要做好防疫工作，利用信息平台，建立“互联网+农业科技服务”机制，促进春耕生产节本增效，精心指导贫困户开展春季生产工作。

链接:

<http://agri.ckcest.cn/file1/M00/0F/A9/Csgk0F5OpLKA07mAAMgvtP50LE767.pdf>

#### 4 . 蝗灾肆虐非洲之角 联合国提醒关注粮食安全

【中国新闻网】中新社北京2月19日电 综合消息：去年12月以来，一场肆虐东非地区的蝗灾拉响了全球警报，肯尼亚、埃塞俄比亚和索马里三国已因此宣布进入国家紧急状态。目前非洲之角的蝗虫还在不断繁殖，预计在3月和4月会形成新的蝗虫群。联合国机构提醒，国际社会亟须关注东非国家可能面临的粮食安全挑战，采取措施共同应对。

链接:

<http://agri.ckcest.cn/file1/M00/0F/A9/Csgk0F5OqOyACS7TAALRNnlUcd4593.pdf>

#### 5 . 强化数字农业科技创新

【农民日报】近日，农业农村部与中央网信办联合印发《数字农业农村发展规划（2019-2025年）》，对推进数字农业农村发展作出顶层设计和系统谋划。全面贯彻落实该规划的部署要求，需要强化数字农业农村科技创新，打造农业农村现代化新引擎和新动能。

链接:

<http://agri.ckcest.cn/file1/M00/0F/A9/Csgk0F5OpQ2AMSfEAAQd4GzlsMs246.pdf>

#### 6 . 全天候监测作物长势 农业遥感再添新技术

【新京报】日，中国农业科学院农业资源与农业区划研究所农业遥感创新团队提出了基于雷达遥感的冬小麦叶面积指数反演新模型，实现了区域作物叶面积指数的高精度获取。作物叶面积指数是与作物产量形成密切相关的农学指标，即单位土地面积中作物叶面积所占的比重，据该项技术主要完成人吴尚蓉博士介绍，卫星遥感技术目前已经能够监测绝大部分作物，如小麦、水稻和玉米等。通过叶面积指数，不仅可以监测作物长势，同时在作物生长特定阶段，监测者也可以利用叶面积指数进行作物估产。

链接:

<http://agri.ckcest.cn/file1/M00/0F/A9/Csgk0F5OpCuAETviAAPe31e5gfQ162.pdf>

#### 7 . 黑龙江开放卫星遥感火情监测预警系统 东北亚区域全覆盖

【中国新闻网】中新网哈尔滨2月17日电(袁长焕 姜辉)17日，黑龙江省气象局发布消息，黑龙江省生态遥感中心近日对该省市、县级气象部门开放卫星遥感火情监测预警技术网络系统。该系统采用中国领先的火点识别技术，依托多颗气象卫星组网观测，可对黑龙江省乃至东北亚区域全天候、无缝隙、全覆盖遥感监测，实现火点实况气象要素和天气

预报的实时查询功能，同时实现在电脑端和手机APP远程同步操作。

链接:

[http://agri.ckcest.cn/file1/M00/0F/A9/Csgk0F5Op\\_mAZm3ZAAJ7Fp51GAc254.pdf](http://agri.ckcest.cn/file1/M00/0F/A9/Csgk0F5Op_mAZm3ZAAJ7Fp51GAc254.pdf)

## 8 . 2020年我国将持续推进农业绿色发展

【中国产业经济信息网】为加快推进农业绿色发展，2020年我国将抓好畜禽粪污资源化利用，深入开展农药化肥减量行动，推进秸秆综合利用和农膜污染治理，加快推动耕地质量提升，强化生物资源保护。记者从农业农村部了解到，2019年全国大力推进绿色兴农。扎实推进农业投入品减量增效，三大主粮化肥利用率达到39.2%，农药利用率达到39.8%，分别比2015年提高4个和3.2个百分点。整建制推进585个畜牧大县畜禽粪污资源化利用，实施东北地区秸秆处理和西北地区农膜回收行动。耕地轮作休耕试点面积扩大到3000万亩，启动实施长江重点流域禁捕。

链接:

<http://agri.ckcest.cn/file1/M00/0F/A9/Csgk0F5OqiOAGMF1AAJ483X8WeA215.pdf>

## 9 . 加快数字乡村建设 推动传统农业转型

【中国日报网】《中共中央 国务院关于抓好“三农”领域重点工作确保如期实现全面小康的意见》明确提出，要加强现代农业设施建设。依托现有资源建设农业农村大数据中心，加快物联网、大数据、区块链、人工智能、第五代移动通信网络、智慧气象等现代信息技术在农业领域的应用。开展国家数字乡村试点。文件明确了2020年中国农业现代化建设要以大数据为背景，通过现代信息技术在农业领域应用，为未来我国农业发展指明方向，推动传统农业向现代农业、智慧农业的转型，让农业生产变得更加智能化，减少人力和生产成本，提高农业生产率。

链接:

<http://agri.ckcest.cn/file1/M00/0F/A9/Csgk0F5Op3aAH0zFAAMUvR27BqY800.pdf>

### 【文献速递】

#### 1 . Climate change and land: Insights from Myanmar

文献源: World Development,2020

摘要: Climate change and land are linked politically. Climate change politics intersects with the global land rush in extensive and complex ways, the impacts of which affect villagers profoundly. These interconnections occur in direct and indirect ways and are often subtle, but that does not make them less important; it only makes the challenge of

governing such dynamics in the interests of marginalized working poor people even more difficult. In this paper, we focus our analysis on indirect and subtle interconnections. Examining empirical cases in Northern Shan State in Myanmar, we conclude that these interconnections occur in at least three broad ways, in which climate change politics can be: (i) a trigger for land grabbing, (ii) a legitimating process for land grabs, or (iii) a de-legitimizing process for people's climate change mitigation and adaptation practices. These interconnections in turn stoke old and provoke new political axes of conflict within and between state and social forces.

链接:

<http://agri.ckcest.cn/file1/M00/0F/A9/Csgk0F5OtieARojjAARR2IX6s9o397.pdf>

## **2 . The Land Resource Circle: Supporting land-use decision making with an ecosystem-service-based framework of soil functions**

文献源: Geoderma,2020

摘要: Land information has in the past focused on the key land and soil properties that physically or chemically support or limit the use of land. With the increasing focus on the environmental, social, and cultural impacts of land-use decisions beyond the boundaries of individual land parcels, there is a growing need for more extensive land resource information to support assessments of the benefits, impacts, and trade-offs of land-use decisions. We present a new framework for providing land resource information to support an ecosystem-service-based approach to land-use related policy development. The new framework, called "the Land Resource Circle", is first conceptually defined, then its use is explored in a hypothetical example. It draws upon the literature on soil functions and their contribution to ecosystem services. In addition, it recognizes that soils differ in their capacity for resisting the various pressures due to land use and/or climate. It also recognizes that the surrounding landscape provides functionality that can affect the delivery of ecosystem services from a land parcel and its suitability for different land uses. The Land Resource Circle is designed as a flexible and comprehensive information resource that can be used to build classifications underpinning spatial planning policy and regulation and land assessment, and to increase awareness of all the ecosystem services provided by land.

链接:

<http://agri.ckcest.cn/file1/M00/0F/A9/Csgk0F5OtumAlpvgACOGAcF13E8270.pdf>



### **3 . Decision support systems for agriculture 4.0: Survey and challenges**

文献源: Computers and Electronics in Agriculture,2020

摘要: Undoubtedly, high demands for food from the world-wide growing population are impacting the environment and putting many pressures on agricultural productivity. Agriculture 4.0, as the fourth evolution in the farming technology, puts forward four essential requirements: increasing productivity, allocating resources reasonably, adapting to climate change, and avoiding food waste. As advanced information systems and Internet technologies are adopted in Agriculture 4.0, enormous farming data, such as meteorological information, soil conditions, marketing demands, and land uses, can be collected, analyzed, and processed for assisting farmers in making appropriate decisions and obtaining higher profits. Therefore, agricultural decision support systems for Agriculture 4.0 has become a very attractive topic for the research community. The objective of this paper aims at exploring the upcoming challenges of employing agricultural decision support systems in Agriculture 4.0. Future researchers may improve the decision support systems by overcoming these detected challenges. In this paper, the systematic literature review technique is used to survey thirteen representative decision support systems, including their applications for agricultural mission planning, water resources management, climate change adaptation, and food waste control. Each decision support system is analyzed under a systematic manner. A comprehensive evaluation is conducted from the aspects of interoperability, scalability, accessibility, usability, etc. Based on the evaluation result, upcoming challenges are detected and summarized, suggesting the development trends and demonstrating potential improvements for future research.

链接:

<http://agri.ckcest.cn/file1/M00/0F/A9/Csgk0F5Ou2GA1c74ADQjgn0qvaY912.pdf>

### **4 . Effects of dynamic land use/land cover change on water resources and sediment yield in the Anzali wetland catchment, Gilan, Iran**

文献源: Science of The Total Environment,2020

摘要: Land use/land cover (LULC) changes strongly affect catchment hydrology and sediment yields. The current study aims at analyzing the hydrological consequences of dynamic LULC changes in the Anzali wetland catchment, Iran. The Soil and Water Assessment Tool (SWAT 2012) model was used to assess impacts on evapotranspiration, water yield, and sediment yield. Two model runs were performed using static and dynamic

LULC inputs to evaluate the effects of LULC change between 1990 and 2013. For the static model, the LULC map of 1990 was used, whereas for the dynamic model, a gradual change of the LULC distribution was interpolated from 1990, 2000, and 2013 LULC data. The major LULC changes were identified as an increase of agricultural area by 7% of the catchment area and a decrease of forest coverage by 6.8% between 1990 and 2013. At the catchment scale, the differences in the long-term mean annual values for the main water balance components and sediment yield were smaller than 10 mm (<2.8%) and 3 t/km<sup>2</sup> (<2.6%), respectively. However, at the sub-basin scale the increase of agricultural land use resulted in an increase of evapotranspiration, water yield, and sediment yield by up to 8.3%, 7%, and 169%, respectively, whereas urban expansion led to a decrease of evapotranspiration, water yield, and sediment yield by up to -3.5%, -2.3%, and -9.4%. According to the results of the monthly time scale analysis, the most significant impact of LULC changes occurs during the dry season months, when the increase of irrigation agriculture results in an increase in water discharge and sediment loads to the Anzali wetland. Overall, the results showed that the implementation of dynamic LULC change into the SWAT model could be adopted as a planning tool to manage LULC change of the Anzali wetland catchment in the future.

链接:

<http://agri.ckcest.cn/file1/M00/0F/A9/Csgk0F5OtYmAPewLABjtU28CRnl679.pdf>

## **5 . Pattern identification and analysis for the traditional village using low altitude**

### **UAV-borne remote sensing: multifeatured geospatial data to support rural landscape investigation, documentation and management**

文献源: Journal of Cultural Heritage,2020

摘要: Spatial pattern of landscapes is viewed as the fabric and structure of traditional village. Accurate detection and analysis for the landscapes pattern plays key role in understanding the sociocultural milieu and human-natural relations. Current methods perceive their problems. Pedestrian survey is labor and time consuming. Meanwhile, the derived data tend to be subjective, qualitative and monotonous, which can hardly be used for further analysis. Remote sensing technique has been successfully applied in the field of heritage protection for its ability in object detection. But these methods are limited by visiting circle, spatial resolution and data richness. Therefore, the scientific methods of landscape pattern detection, documentation and analysis for the traditional village has long been under discussion. By taking Baojiatun castle village as a case study, the present paper aims to



detect and analyze spatial pattern of traditional village by the geospatial data from a low altitude UAV-borne remote sensing. A four-leveled hierarchical landscape recognition scheme and the corresponding landscape category regulation were established. Based on the derived data and the established scheme, a three-level classification model was construct by using Object-Oriented Image Analysis method (OBIA) method and machine learning classifiers (Random Forest classifier and SVM classifier). The model was proven to be accurate and stable by ten-fold cross validation, and five major heritage landscape elements of the village were finally extracted. Furthermore, spatial pattern characteristics and distribution differences of targeted landscapes were unveiled based on distance statistics and clustering analysis. Lastly, further discussion is fostered, which focuses on the usefulness of remote sensing technique in the field of heritage landscape investigation, documentation and management.

链接:

<http://agri.ckcest.cn/file1/M00/0F/A9/Csgk0F5OvEGAQpp1ACnkHpvGizU229.pdf>

## **6 . Assessing potential land suitable for surface irrigation using groundwater data and multi-criteria evaluation in Xinjiang inland river basin**

文献源: Computers and Electronics in Agriculture,2020

摘要: In the present study, suitability of land for irrigation based on groundwater in Xinjiang inland river basin with GIS-based Multi-Criteria Evaluation (MCE) techniques was evaluated with the aim to promote the development of regional agriculture. The critical elements that relatively large impact on the evaluation of irrigation suitability contain physical land characteristics (land use, soil and slope), climate (rainfall and evapotranspiration) as well as groundwater data (natural recharge modulus and aquifer productivity). These factors which adopted 1 km resolution were weighted by a pairwise comparison matrix and then reclassified and overlaid to identify the appropriate area suitable for groundwater irrigation. The current work also attempts to explore weight sensitivity initiated by both direct and indirect weight changes through applying the one-at-a-time (OAT) technique in a GIS platform. The weights in association with all criteria employed for suitability modeling were changed one-at-a-time (OAT) so as to study their relative influences on the ultimate evaluation results. The groundwater irrigation potential for farming was assessed using preliminary result of land suitable, suggesting that 519,292 km<sup>2</sup> of land which is the sum of levels S1 and S2 could be used for irrigation directly and the rest needs to be diverted from

other areas. A large portion of the irrigable land is located in the Ili river valley, south of the Altai Mountain, both sides of the Tianshan Mountains and north of Kunlun Mountains, which has access to shallow groundwater making it easier to extract. Through conducting field investigation, the groundwater alone might not be abundant to support all suitable land. Nevertheless, groundwater can be used for the supplementation of surface water resources for irrigation in the area.

链接:

<http://agri.ckcest.cn/file1/M00/0F/A9/Csgk0F5OtPyARa0YAFG6-NDcNE8520.pdf>

## **7 . Monitoring of maize lodging using multi-temporal Sentinel-1 SAR data**

文献源: Advances in Space Research,2020

摘要: Lodging is a common phenomenon in maize production, which seriously affects its yield, quality, and mechanical harvesting capacity. With good penetrating power, satellite radar can monitor crop growth even under cloudy weather conditions. In this study, a method based on the change in plant height before and after lodging in maize is proposed to calculate the lodging angle and monitor the lodging degree by using dual-polarization Sentinel-1A data. The results show that the optimal sensitive polarization combinations of maize plant height before and after lodging are VH/VV and VV, respectively. The lodging angle is calculated using the plant height inversion results before and after lodging. The overall accuracy of classifying lodging grade of maize is 67%. The proposed model based on lodging angle could effectively mapped the maize lodging range on a regional scale and classify the lodging grades.

链接:

<http://agri.ckcest.cn/file1/M00/0F/A9/Csgk0F5Ou86ANW14ACzz5TY5dLw528.pdf>

## **8 . Spatiotemporal characteristics of the bearing capacity of cropland based on manure nitrogen and phosphorus load in mainland China**

文献源: Journal of Cleaner Production,2020

摘要: The discrepancy between livestock breeding and crop planting in integrated crop-livestock system (ICLSs) usually cause nutrients surpluses to the arable land. Evaluation of regional land bearing capacity and identification of environmental critical regions associated with livestock in China are benefit to nationally- and regionally-specific livestock rearing. This study was conducted to demonstrates the changes in livestock industry from

1996 to 2016 in China and identify the environmentally critical regions of livestock farming by calculating the indexes of bearing capacity of cropland based on nitrogen (IN) and phosphorus (IP). The results revealed that the scale of livestock and poultry farming, manure production, and manure nutrients has increased over the past two decades. The livestock and poultry breeding quantity was 1290.8 million heads with a manure production of 4238.0 million tons in 2016. The manure N and P were 12.0 and 1.9 million tons with an increase of 5.8% and 5.9%, respectively. The N and P demand of crops from manure were 29.1 and 4.5 million tons with an increase of 31.5% and 27.2%, respectively. The bearing capacities based on N and P were 2668.9 and 2554.7 million heads in pig equivalent, respectively. On the national level, the IN and IP were 0.43 and 0.45, respectively, which is categorized as Grade II. Livestock rearing in China was still within the bearing capacity of cropland. Both the Northeast and Northwest regions were categorized as Grade I, while Southeast region, Southwest region, the Middle and Lower Reaches of the Yangtze River and the North China were categorized in Grade II. There is still enough space for expansion of livestock and poultry farming in the Northeast and Northwest regions. In the North China region, Southwest region, the Middle and Lower Reaches of the Yangtze River, and the Southeast region, manure generated can be accommodated without any expansion in livestock breeding quantity. While livestock industry in Sichuan, Yunnan, Beijing and Tianjin need to be strictly controlled because of the grade of IV and V.

链接:

[http://agri.ckcest.cn/file1/M00/0F/A9/Csgk0F5OtIOAAH2HAA3\\_alxQCVc014.pdf](http://agri.ckcest.cn/file1/M00/0F/A9/Csgk0F5OtIOAAH2HAA3_alxQCVc014.pdf)

## **9 . Impact of climate change on allowable bearing capacity on the Qinghai-Tibetan Plateau**

文献源: Advances in Climate Change Research,2020

摘要: Climate change has a substantial impact on infrastructures in the permafrost on the Qinghai-Tibetan Plateau (QTP). In this study, the mean annual ground temperature (MAGT) and permafrost evolution were investigated in both the historical (1950-2005) and projected (2006-2099) periods. Then, an allowable bearing capacity model was used to discuss the allowable bearing capacity change on the QTP. Results show that the MAGT increased by 0.36°C during 1950-2005. The MAGT will increase by 0.40 (RCP2.6), 0.79 (RCP4.5), 1.07 (RCP6.0), and 1.75 (RCP8.5) °C during 2006-2099. In addition, the permafrost area has decreased by  $0.195 \times 10^6$  km<sup>2</sup> in 1950-2005. The permafrost area will decrease by  $0.232 \times 10^6$  (RCP2.6),  $0.468 \times 10^6$  (RCP4.5),  $0.564 \times 10^6$  (RCP6.0), and  $0.803 \times 10^6$  (RCP8.5) km<sup>2</sup> during

20062099. With the degradation of permafrost, the allowable bearing capacity in permafrost zones would decrease accordingly. The decreasing trend is 6 kPa per 10 years in 19502005, and will be 0.6 (RCP2.6), 5 (RCP4.5), 7 (RCP6.0), and 11 (RCP8.5) kPa per 10 years during 20062099. The most remarkable trend would be observed under RCP8.5. Meanwhile, some scientific advices for the design, construction, operation and maintenance of permafrost engineering in the context of climate change were provided.

链接:

<http://agri.ckcest.cn/file1/M00/0F/A9/Csgk0F5OspSAAHoPADU6tsnpZRE476.pdf>

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