Understanding drought risk in China and improving drought monitoring and early warning

探求中国旱灾风险，提升干旱监测预警能力

DROUGHT IN CHINA   中国干旱

Drought affects 29 million people each year
每年平均因旱影响人口可达2900万人

Drought causes annual average crop yield losses of 16.3bn kg
每年平均因旱粮食损失达163亿公斤

Drought causes severe socio-economic and environmental impacts
干旱灾害造成严重的社会经济以及环境影响

The uneven distribution of population, water resources and agriculture between the north and south of China can intensify the impacts of drought
人口、水资源以及农业在中国南北地区的分布不均加重了旱灾影响

SUNRISE

大范围干旱监测预报与灾害风险防范技术和示范

UK Centre for Ecology & Hydrology

China Institute of Water Resources and Hydropower Research

WHY Linking indices to impacts

为什么做指标与影响关联分析

There are many drought indices used by decision makers to monitor the current drought situation, and to assess risk for long-term planning. Drought impacts can be widespread in space and across sectors, as well as severe, often resulting in economic losses.

干旱监测与旱灾风险评估通常采用的干旱指标多种多样，干旱影响波及范围大，严重的旱灾往往带来较大的经济损失.

LINK
关联

Although drought impacts are often not systematically collected around the world, China has a rich history of drought impact information. This presents an opportunity to understand the link between drought indices and impacts to better understand risk and vulnerability, and inform drought monitoring, forecasting and management.

世界上系统完整的收集干旱影响数据较少，而中国拥有一套长序列历史干旱影响数据，为干旱指标与影响关联分析研究奠定了坚实的基础，使之更好的服务于旱灾风险与脆弱性的评估、干旱监测预报与管理工作.

Objectives:

- To exchange knowledge and best-practice between UK and Chinese researchers and water managers

- To understand and identify gaps in drought monitoring and forecasting research

- To link indices to impacts to inform improved drought monitoring and early warning and to assess drought risk and vulnerability

目标：

- 旨在促进中英研究人员与水资源管理人员之间知识与实践交流

- 旨在理解和识别在干旱监测预报研究中的不足

- 旨在建立干旱指标与影响相关关系的基础上提高升干旱监测预警能力与旱灾风险评估水平。
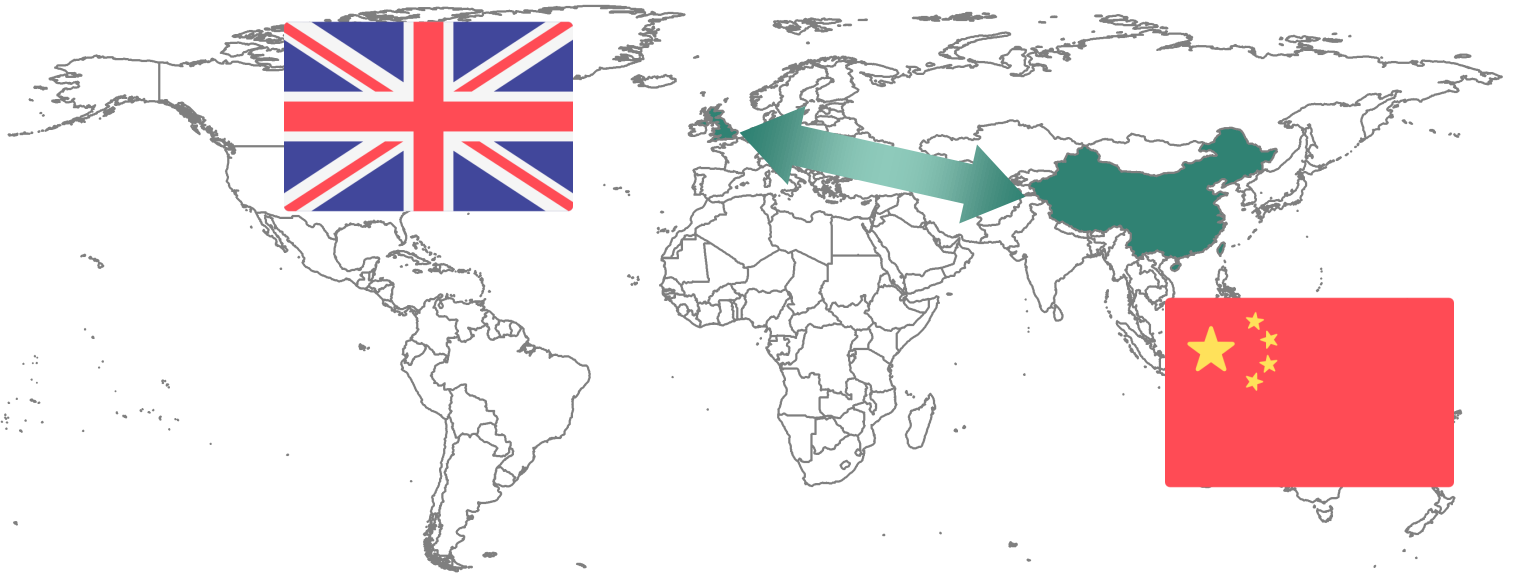
Icons made by Freepik from www.flaticon.com | 图标来自www.flaticon.com，由Freepik, Roundicons and mynamepong制作

Collaboration

This collaboration between the Centre for Ecology & Hydrology (UK) and the China Institute of Water Resources and Hydropower Research over the last four years has been built on a Memorandum of Understanding between the two institutions. Activities have included workshops in China and the UK, co-hosting a PhD student and working on analyses and publications together in order to achieve the objectives listed on the opposite page.

合作

英国生态水文中心与中国水利水电研究院在四年前签署合作备忘录，并在其指导下开展了一系列合作交流，具体包括双方共同举办研讨会、合作培养博士生、协同研究并发表文章、出版专著等.

UK Centre for Ecology & Hydrology

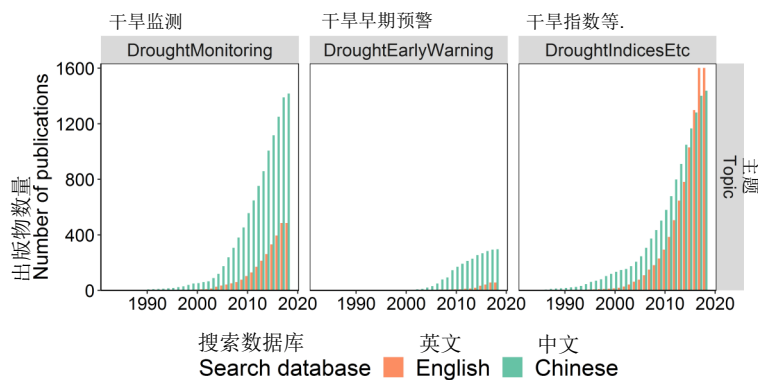China Institute of Water Resources and Hydropower Research

REVIEW Drought monitoring and early warning in China in the academic literature

中国干旱监测预警文献综述

To assess state-of-the-art methods for drought monitoring and drought forecasting, we reviewed papers in the academic literature (both in English and Chinese).

Chinese and English language publication databases were searched using search terms e.g. "Drought monitoring China". There were big increases in the numbers of publications from the year 2000.

为了评估干旱监测预报的最新研究进展，我们对所有已发表的中英文学术文献中进行回顾和整理.

使用"中国干旱监测"等检索词来搜索中英文献数据库. 从2000年起，出版物的数量大幅度增加.

Results of literature database search (cumulative number of publications)

文献数据库检索结果（累计出版物数量）

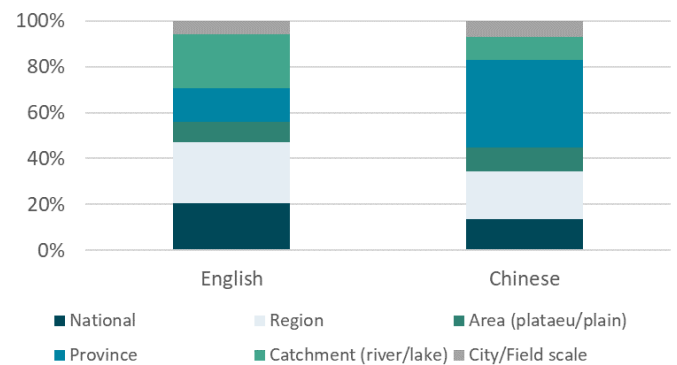Spatial scale assessed in reviewed papers in English and Chinese

中英文献空间尺度评估综述

In the papers reviewed, we found the following common themes:

- Many studies focussed on agricultural drought, with few concerned with hydrological drought

- Many different indices were used, with many papers developing new drought indices

- Many papers relied on remote sensing data

- Few papers considered drought impacts, despite the aims being to improve drought monitoring and management

在文献综述过程中，我们发现文献具有的共性如下:

- 大量研究关注农业干旱，少量关注水文干旱

- 使用了很多不同的干旱指标，很多文献提出了新的干旱指标

- 大量文献依赖于遥感数据进行分析

- 文章以改善干旱监测和管理为目标，但很少文献考虑干旱影响

WORKSHOP From drought research to drought management: sharing experiences between Europe and China

中欧干旱研究与管理国际研讨会

On the 10th November 2018 SUNRISE held a workshop with researchers and policy makers to share experiences of translating state-of-the-art research into practice from Europe and China between .

The workshop focussed on drought research that has either been applied in drought management or has the potential for application in drought management or monitoring tools and frameworks in the future.

Common issues were identified around the use of remote sensing, improving public awareness of drought and risk estimation.

Knowledge gaps in China and Europe were identified around short–term drought forecasting, flash droughts, the human influences on drought, and the links between drought indicators and drought impacts.

2018年11月10日，我们与研究人员和政策制定者举办了研讨会，分享中欧最新研究转化为实践的经验.

研讨会主题是干旱研究，包括已应用于干旱管理实践的研究，或有可能应用于今后干旱管理和监测的技术与研究框架等.

研讨会围绕遥感技术应用、公众对干旱和灾害风险的认识提升等主题展开交流.

中欧知识与技术差距主要体现在短期干旱预报、突发性干旱、人类对干旱的影响、干旱指标与影响关联分析研究等.
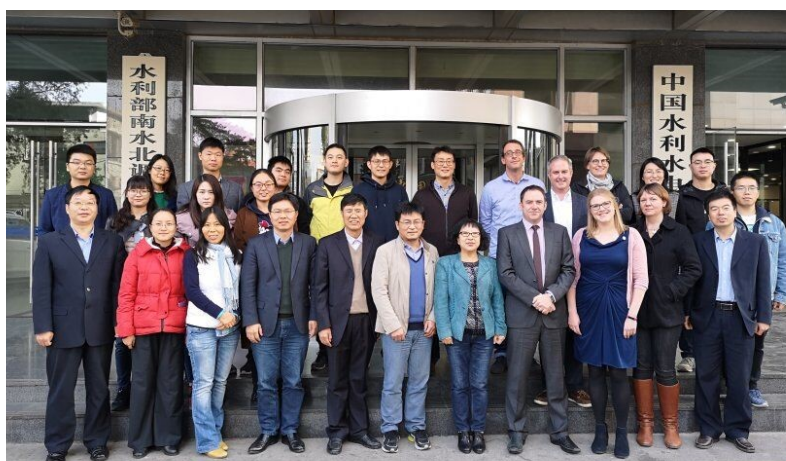


Attending organisations 参加单位

- China Institute of Water Resources & Hydropower Research 中国水利水电科学研究院

- Ministry of Water Resources 中华人民共和国水利部

- National Meteorological Centre, China 中国国家气象中心

- HOHAI University 河海大学

- UK Centre for Ecology & Hydrology 英国生态水文中心

- Environment Agency, UK 英国环境署

- University of Freiburg, Germany 德国弗莱堡大学

CASE STUDY Linking drought indices to drought impacts in Liaoning Province

案例研究 辽宁省干旱指标与影响关联分析

By linking drought indices (Standardised Precipitation Index, Standardised Precipitation Evapotranspiration Index (SPEI), Soil Moisture & Normalised Difference Vegetation Index) to drought impact data from the State Flood Control and Drought Relief Headquarters, we were able to identify which index best represented a range of impacts. We used vulnerability factors to asses which cities were vulnerable to which impacts.

通过将多种干旱指标（标准化降水指数、标准化降水蒸散指数 （SPEI), 土壤湿度和归一化植被指数）与防办系统统计的干旱影响数据建立关系，优选哪个指标最能代表当地干旱影响，并使用脆弱性因子来评估哪些城市容易受到旱灾影响.
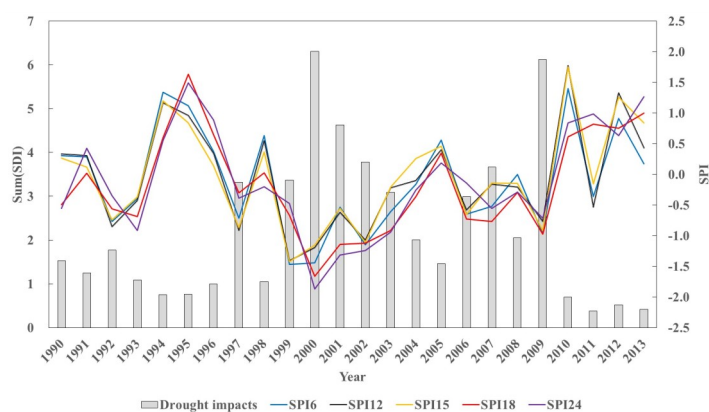
Liaoning drought indices (lines) and drought impacts (bars) 1990-2013

1990−2013年辽宁干旱指标（线）和干旱影响（柱）
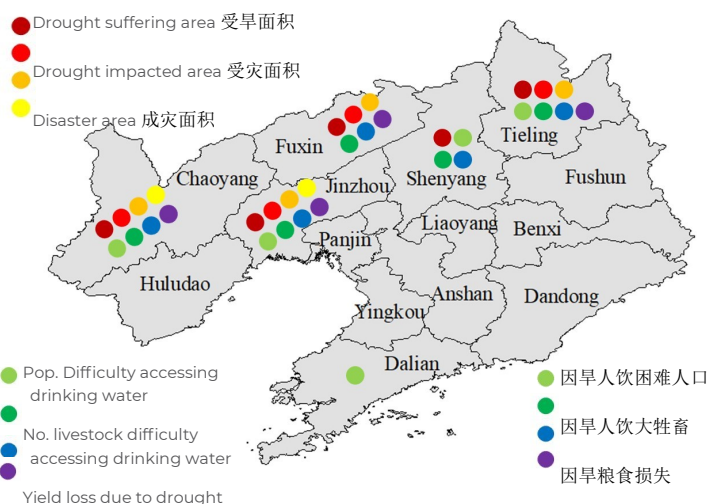
Map showing which cities in Liaoning are vulnerable to which drought impacts

图表显示辽宁省哪些城市易受旱灾影响

1　Events in 2000-2001 and 2007 were found to be the most severe in Liaoning

2　SPEI over six months was found to link best to a range of drought impacts

3　Chaoyang, Fuxin, Jinzhou and Tieling were the most vulnerable cities to a number of drought impacts

4　Population and crop cultivated area were the most important factors in determining vulnerability

1　辽宁省发生严重干旱的年份是2000-2001和2007年

2　SPEI6与干旱影响数据相关性最好

3　朝阳、阜新、锦州和铁岭市旱灾影响脆弱性最高

4　人口和作物种植面积是决定脆弱性最重要的因素

KNOWLEDGE EXCHANGE
Liaoning Province

辽宁省 交流

In October 2019, the UK team visited China and made the journey from Beijng to Liaoning Province in North-East China to meet with provincial and city water managers in Chaoyang, in the north-west of Liaoning.

Liaoning Province

Liaoning Province is in the north-east of China and to the east borders North Korea. It has a temperate monsoon climate with less than 700mm annual average rainfall which is unevenly distributed the province. The west is drier than the east and water resources are similarly unevenly distributed, with more freshwater in the south-east. This uneven distribution of rainfall and water resources means that the province has severe water shortages. Agriculture in Liaoning Province is highly productive—spring maize is the dominant crop, and drought can result in significant impacts on yields.

2019 年 10 月，英国团队访华，从北京出发前往中国东北的辽宁省，在辽宁西北部的朝阳市会见省市水务管理人员.

辽宁省

辽宁省位于中国东北部，东部与朝鲜接壤. 属温带季风气候，年平均降雨量不足700毫米，全省分布不均. 西部比东部干燥，水资源亦分布不均，东南部淡水资源较丰富. 这种降雨和水资源分布不均意味着该省严重缺水.辽宁省农业产量高，以春玉米为主，干旱对产量影响较大.

KNOWLEDGE EXCHANGE
Visit to Liaoning Province

交流访问辽宁省

The SUNRISE team met water resources managers for the Liaoning Province and the prefectural city of Chaoyang. They visited Baishi Reservoir on the Dalinghe River. Bashi Reservoir is the third largest in the province and provides water for the cities of Fuxin and Beipiao.

SUNRISE 团队拜会了辽宁省和朝阳市的水资源管理人员. 他们参观了大凌河上的白石水库. 白石水库是全省第三大水库，为阜新市和北票市供水.

Following a presentation of the work done by Wang et al., (2020), the possible applications of this research were discussed, as well as drought monitoring and management in the Province.

It was thought that the approaches applied and developed in SUNRISE could be applied within drought warning plans and be used to inform drought management actions to reduce vulnerability, for example water transfers or issuing guidance to farmers on planting drought resistant crops.

Understanding which drought indices link best for impacts was useful in the context of developing a provincial scale drought early warning system using the existing drought warning information, which includes the SPI.

在介绍 Wang 等人（2020）所做的工作之后，讨论了这项研究的可能应用，以及该省的干旱监测和管理.

与会者认为，在 SUNRISE 中应用和开发的方法可以应用于干旱预警计划，并用于为干旱管理行动提供信息，以降低干旱脆弱性，例如调水或向农民发布种植抗旱作物的指南.

在使用包括 SPI 在内的现有干旱预警信息开发省级干旱预警系统的背景下，了解哪些干旱指标与干旱影响最具相关性是有用的.

Key Findings

- Collaboration between the UK and China results in the exchange and sharing of knowledge, new research and recommendations for water managers
- More research is needed on how to monitor hydrological droughts in China
- Impact data collated by the State Flood Control and Drought Relief Headquarters can be used to assess drought risk and vulnerability, and can inform drought monitoring in China
- The relationship between drought indices and impacts was used to map drought risk and vulnerability in Liaoning Province

Key Recommendations

- Use SPEI-6 for monitoring drought and risk assessment in Liaoning Province
- Develop guidance for planning and provide greater relief and financial support for those impacted
- Impact data should be continued to be collected, with potential for data to be collected more regularly or more impact types to be collected

Next Steps

- Use high temporal resolution drought impact data to link with drought indices
- Map drought vulnerability in other provinces of China
- Analyse the links between indices and impacts in other provinces and using higher resolution data to develop knowledge of when impacts occur and enable additional risk assessments to be undertaken
- Assess how findings can be applied in drought monitoring systems in China

主要成果

- 中英两国合作为水资源管理者带来了新的研究和建议
- 中国水文干旱监测领域亟需加强研究
- 国家防汛抗旱总指挥部的干旱统计上报数据可用于评估旱灾风险与脆弱性，为中国干旱监测结果提供参考作用
- 基于旱指标与影响的关联关系对辽宁省旱灾风险和脆弱性进行了定量分析

建议

- 在辽宁省建议用6个月的标准化降水蒸散指数SPEI-6作为干旱监测与旱灾风险评估的指标
- 制定规划指南，为受灾群众提供更大的救济和财政支持
- 干旱影响数据应在原有常规收集的基础上，增加不同类型干旱影响的数据收集

未来工作

- 使用更高时间分辨率的旱灾影响数据分析与指标之间的关系
- 分析中国其他省份的干旱脆弱性
- 基于中国其他省份干旱指标与影响关联分析研究，使用更好分辨率数据，探求干旱影响发生时间，并进行风险评估
- 评估研究结果在中国干旱监测系统的应用价值

Acknowledgments

 UK Centre for Ecology & Hydrology

致谢

 China Institute of Water Resources and Hydropower Research

Gauging station on the Dalinghe River in Chaoyang, Lioaning Province, China

中国辽宁省朝阳市大凌河水文站