# 引言

**环境公平性(Environmental Justice)**研究环境资源在不同群体间的分配结果是否存在差异,主要关注环境利益与环境风险在不同种族之间的不平等配置问题[1].随着我国社会经济发展,不同收入人群的环境福祉分配差异日渐显著,环境公平性问题突出[2][3][4].我国城市发展历史特殊、城市人口密集、城市化进程迅速,这三大特征使得人群获取城市生态系统服务效益的差异成为环境公平性研究的重要方面[5].因此，研究城市环境公平性对于缩小不同人群中环境资源配置不均衡性具有重要意义。

**城市生态系统服务**是指城市生态系统及其组份维系与支持人类生活的条件与过程[6]. 主要包括城市公园、居民花园、绿色屋顶、水体与行道树等城市绿色空间(Urban Green Spaces, UGSs)[7]提供的缓解气候压力,休憩娱乐等环境效益[8]。**近年来**，**城市生态系统服务概念框架已被广泛应用于环境公平性研究中。**研究表明，城市或村镇中低收入地区的人群获取城市生态系统服务的机会相对少[21][22][23][24][25]. 富裕地区如澳大利亚阿德莱德地区的居民获取城市生态系统服务的可能性约为其相邻欠发达地区的两倍[21].城市生态系统服务的主要效益常常被白人或富裕群体获得,且在不同年龄段,性别的人群中差异较大[22]. 不同人群对于生态系统服务可达性的差异已成为环境公平性研究关注的重点[8][27]. 以上研究为我们从生态系统服务视角理解城市环境公平性问题提供了重要基础。

然而，目前基于生态系统服务的环境公平性研究大多集中于分析生态系统服务供给，而对于生态系统服务需求考虑较少。**生态系统服务供给与需求**分别对应生态系统基于其生物物理特性提供服务的潜力以及社会对于某种生态系统服务的供给在数量与质量上的需求[13].评估生态系统服务供需在空间上的匹配程度,探索其空间分布特点,也是揭示环境公平性分配的重要方面[18].此外,相关研究大多来自于美国、英国和澳大利亚,针对我国国情的研究相对较少.中国在改造城市绿地方面的经验可以为全球北方(gobal north)的城市提供重要的借鉴[8].上海作为我国经济中心之一,城市建设水平领先,评估其生态系统服务供需匹配,探索城市生态系统布局模式,对其他城市生态系统服务规划具有重要意义[39]。

综上所述,本文针对上海市文化生态系统服务供需,结合遥感影像与社会经济数据,评估上海市文化生态系统服务供给能力与需求潜力;利用空间叠加分析等地理信息技术完成上海市文化生态系统服务制图,揭示其空间匹配现状,探索环境公平视角下,城市文化生态系统服务的规划现状,展望未来发展模式.

# 2.数据方法

## 2.1 研究区介绍

## 2.2 上海文化生态系统服务供给制图

文化生态系统服务聚焦于以自然景观为载体的户外娱乐设施,包括供给城市居民散步,奔跑,骑行,野营,探索植物,亲近自然等服务的文化生态系统(baro2016mapping-paracchini 2014). 三大维度确立文化生态系统服务供给能力,第一,人类影响程度越小,文化生态系统服务潜力越高;第二,设立自然保护区,将提高景观服务供给能力;第三,水体能够提升生态系统娱乐服务供给. 本文基于上海市土地利用类型,通过不同景观特征评估文化生态系统服务潜力,细分为如下五大方面:(1)自然性;(2)娱乐设施数量;(3)水体;(4)景观多样性指数;(5)自然保护区.通过专家打分及领域分析等方法统计各指标,并以等权重加和获取文化生态系统服务供给指数,所以指标均通过最大最小值标准化至0-1区间内,

## 2.3 上海文化生态系统服务需求制图

文化生态系统服务需求计算参照**(Baro et al. 2016)**基于娱乐服务设施可达性的制图方法.假设研究区内居民对文化生态系统服务均具有相同程度的需求,但他们得到满足的程度取决于距离文化生态系统服务的距离.据此建立混淆矩阵量化文化生态系统服务指数,并将其标准化至(0-1)区间. 人口密度栅格由土地利用及人口统计数据获取,假设人口均匀分布于统计单元内.

## 2.4 上海文化生态系统供需匹配性分析

为评估上海地区文化生态系统服务供需匹配程度,本文对文化生态系统供给及需求栅格进行空间叠加分析,以供给减去需求作为城市文化生态系统服务匹配指数.该数值位于(-1-1)之间, 正数表示供大于求,负数表示求大于供,且数值越大,表示供需不平衡程度越高.

## 2.5 上海不同人群中文化生态系统服务供需匹配度比较

通过比较供需不平衡指数及社会经济指标评估不同人群配置文化生态系统服务的环境公平性问题.主要考虑年龄及收入两大维度,以统计单元内不同年龄段人口的比重以及年家庭收入作为基本指标,方法参照(**Herreros-Cantis and McPhearson, 2021)**首先,通过空间热点分析探索上海城市文化生态系统服务不平衡指数的空间聚类模式.第二,基于该聚类模式,通过ANOVA比较不同热点及冷点区域之间的人口年龄,收入组成是否存在显著差异,以探索上海市城市文化生态系统服务供需配置的环境公平性.热点分析已被广泛用于生态系统服务研究,是分析生态系统服务供需配置空间分布的常用手段.anova

本项目拟定流程如下:首先,将附属社会经济数据重采样,使其栅格分辨率与土地利用类型数据统一;第二,通过文献搜集确定文化生态系统服务供给及需求评估指标,经专家打分,领域分析等方法,获取单一网格指标指数,并对其进行最大最小值标准化,统一其量纲;第三,对各个指标进行空间叠加分析,计算文化生态系统服务供给及需求指数,并考虑其差值作为供需匹配性指数,完成文化生态系统服务制图;最后,通过空间热点分析探索不同人群中文化生态系统服务供需配置的环境公平性,评估上海市文化生态系统配置现状.

由于生态系统服务供需制图研究数量较多,重复性工作较多,流程化,自动化的的脚本能够大大降低空间分析过程中消耗的时间与精力,使得研究人员能够更专注于解释生态系统服务供需匹配的分布特点.因此,本文拟基于Arcpy与ArcMap中的模型构建器,实现土地利用数据及栅格数据重采样,邻域分析,空间叠加分析,生态系统服务供需制图,生态系统服务供需匹配性热点分析等一系列空间分析流程,高效完成生态系统服务供需建模,体现地理空间分析思维.

# 问题总结

* 本研究的空间尺度能达到什么程度:以街道为基本统计单元?栅格数据分辨率?
* 文献[29]已经做过上海类似的研究,我们的创新和改进能从哪些方面去考虑?(以内环外环作为市区与郊区的分界,改进简单单一中心城区为市区的划分方式?加入不同年龄段人群的需求分析,针对老龄化现状?)
* 依据什么标准,选择文化生态系统服务供给和需求的评价指标?能否考虑市区/郊区的差异?距离市中心的梯度?

**研究结果：**

1. **文化服务空间匹配性**
2. **基于文化服务供需不平衡的环境公平性**

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