通过“交换策略”实现城市韧性：土耳其伊斯坦布尔市阿亚马马河廊道与阿塔图尔克废弃机场复兴计划

Swap Strategy for Urban Resilience: Reviving the Ayamama River Corridor and Ataturk Decommissioned Airport in Istanbul, Turkey

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摘要

自20世纪50年代以来，伊斯坦布尔阿亚马马河廊道因城市化发展不断退化。受全流域土地开发与气候变化的共同影响，洪水事件越发频繁，威胁着洪泛区中居民的生命财产安全。气候变化导致的极端降雨事件频率不断增加，且强度和持续时间都有所加剧，我们亟需采取措施降低易受损资产遭遇城市洪涝的风险。然而，伊斯坦布尔的开发密度极高且开放空间匮乏，既要为处于风险地区的建筑找到适宜的搬迁地点，又要为周边街区提供便利设施并非易事。已停用的阿塔图尔克机场或可提供机遇，帮助探究如何通过城市闲置地改造来提升城市的洪水适应能力。尽管当前的机场再开发方案提出要建设一个大型公园并添加全新的文化设施，但这一公园不仅缺乏能够与周边社区互动的基础设施，也难以帮助阿亚马马河应对严峻的环境挑战。本文提出了一种基于城市闲置地的“交换策略”，建议利用阿塔图尔克机场废弃场地来缓解阿亚马马河的开发压力。交换策略可在搬迁、复兴与再连接基础设施的同时，修复受损的洪泛区。随着气候变化影响的日益显著，这一城市发展的新概念期望推动规划师与设计师就废弃基础设施与大型城市闲置地的再利用达成共识，帮助减轻洪泛区的压力。同时由于搬迁距离短，该策略可在不降低搬迁居民生活质量及不影响企业生产活动的前提下，为河流修复项目提供空间。

关键词
城市洪水；气候适应；废弃基础设施；气候变化；河流修复；搬迁；适应性再利用

ABSTRACT
The Ayamama River in Istanbul has been substantially degraded due to urbanization of the river corridor since the 1950s. Development throughout the watershed and climate change contribute to increasing severity of flash flooding events that threaten life and property in the floodplain. As the intensity, duration or frequency of extreme rainfall events continue to increase with climate change, it is imperative to reduce the risk of urban flooding to vulnerable assets. However, as Istanbul is a city famous for its density and lack of open space, finding suitable relocation sites for at-risk structures, while maintaining access to recreational amenities for the surrounding neighborhoods is a daunting task. The decommissioned Ataturk Airport provides a unique opportunity to re-imagine the utility of urban voids in helping cities adapt to increasing flood impacts. While the current airport redevelopment proposal includes the construction of a massive park and new cultural amenities, such a park lacks sufficient connective infrastructure to its surrounding neighborhoods and does little to alleviate the significant environmental challenges of its neighbor, the Ayamama River. In this paper, we explore the use of the decommissioned Ataturk Airport site to relieve development pressure from the Ayamama River by implementing a novel swap strategy for urban voids. The proposed swap strategy design methodology relocates, regenerates, and reconnects decommissioned infrastructures and degraded floodplains simultaneously. As the impacts of climate change become more prominent, this novel urban concept seeks to initiate a conversation amongst planners and designers around the use of decommissioned infrastructure and large-scale urban voids to help relieve pressure from urban floodplains. Meanwhile, it can make room for river restoration projects without decreasing the quality of life of relocated residents or negatively impacting relocated economic activities by identifying redevelopment sites in close proximity.

KEYWORDS
Urban Flooding; Climate Adaptation; Decommissioned Infrastructure; Climate Change; River Restoration; Relocation; Adaptive Reuse

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1 引言

气候变化并非遥不可及——世界各地的人们正在经历愈发频繁、强烈和持久的极端天气，人类的生命财产安全和生物多样性均深受影响。[1]如今的城市不仅要应对贫困、居民生活不稳定及位于风险区域的非正式住区等城市地理环境层面的问题，更要承受加剧了这些缺陷的全球环境变化[2]（如城市热岛效应[3]、由海平面上升和严重天气事件导致的沿海洪灾）。21世纪以来，洪水风险已成为决策者和城市规划师在环境、社会与经济问题中面临的最普遍的挑战之一。[4]引发城市洪水的因素众多，其中最主要的是影响了自然水文循环的土地利用变化。[4]频繁的土地开发形成大量不透水表面，阻碍地表水渗流至地下。在此情况下，受污染的暴雨雨水不断积聚，极易在建设较早的河道周边与洪泛区的低洼地带形成骤发洪水。当地的地貌、土地利用模式与洪泛区中建筑物的数量及类型等均可能影响洪水风险的严重程度。[5]

在降低洪水风险、提升开放空间可达性及恢复城市水文功能方面，河流修复策略的作用日益重要。[5]然而，河流毗邻区域高密度的城市开发活动导致可用于修复的空间匮乏，许多城市河流修复方案仅停留在设想阶段。本文认为，将易受损的资产迁离洪泛区，既可实现河流修复，又可保障这些资产和居民未来免遭洪水侵害。但拆除建筑和重新安置居民并非易事，尤其是一些区域缺少可二次开发的公共空间，难以用作搬迁目的地。

本文建议使用交换策略来修复退化的城市洪泛区，提升城市韧性。该策略将易受影响区域及不易受影响区域中的开放空间进行交换，同时对废弃机场场地实施再开发战略。本文以土耳其伊斯坦布尔市的阿亚马马河与阿塔图尔克机场为研究对象，以期为城市设计师提供一种概念模型，辅助他们更好地开展城市中心洪泛区修复项目，降低建筑资产与基础设施所面临的风险，以及更有效地保障搬迁个体与企业的权利。

2 应对气候变化的河流修复：机遇与挑战

在以丘陵地貌为主的城市中，相对平坦的洪泛平原为工业发展提供了良好的地形基础——工业区一般需大量空间来建设大型建筑及道路、停车场和用于运输贮藏的装卸码头等配套交通基础设施。然而，建

1 Introduction

Climate change is no longer a distant threat. People around the world are experiencing more frequent, intense or prolonged extreme weather, putting human lives and real properties, as well as the biodiversity at risk.[1] Cities today not only have to grapple with the existing vulnerabilities of urban geographies, such as urban poverty, precarious livelihoods, and informal settlements located in hazardous areas, but are increasingly exposed to global environmental changes that exacerbate these vulnerabilities[2] such as urban heat island effect[3] and coastal flooding caused by sea level rise and extreme weather events. Amongst all of the environmental, social, and economic challenges, flood risk may be one of the most ubiquitous and challenging for policy makers and planners in the 21st century.[4] Flood risk in cities is caused by a variety of factors, chief among them being land use changes which have affected the natural hydrological cycle.[4] Development creates impermeable surfaces that prevent water from permeating into the ground. When rain is unable to permeate into the ground, contaminated stormwater can cause torrential flash floods in low-lying neighborhoods located near historic river channels and floodplains. Local geomorphology, land use patterns, and the number and types of structures in the floodplain all also play a role in the severity of flood impacts.[5]

River restoration is seen as an increasingly important strategy for reducing flood hazard, increasing access to open space, and restoring hydrological functionality simultaneously.[5] However, many urban river restoration initiatives are limited in their potential by a lack of space for restoration due to high density urban development in the surrounding areas. We argue that relocation of vulnerable assets from floodplains is one way to enable more transformative river restoration projects while permanently eliminating risk to flood-vulnerable assets and people. However, removal of structures and relocation of people is not straight forward, especially due to a lack of suitable relocation sites in areas that lack open space for redevelopment.

This article highlights the opportunity to restore degraded urban floodplains while increasing urban resilience using a swap strategy that replaces a proposal for open space in a low-vulnerability area with open space in a high-vulnerability area as part of the redevelopment of a decommissioned airport site. Using the Ayamama River and the Ataturk Airport site in Istanbul, Turkey as a case study, this approach provides a conceptual model for urban designers interested in maximizing floodplain restoration projects in urban centers, reducing risk to built assets and infrastructure, and more effectively ensuring the rights of relocated individuals and businesses.

2 River Restoration in Response to Climate Change: Opportunities and Challenges

In cities with hilly terrain, floodplains provide prime real estate for industrial development due to their relative flatness on the landscape. Industrial areas generally require space for buildings with large footprints and supporting transportation infrastructure such as roads, parking spaces, and loading docks for shipping

造过程中会产生大量不透水表面，导致暴雨径流加剧。为进行雨水管理进而保护工业企业的资产，许多城市开始营建坚固的工程系统，包括下水道、路缘及边沟系统、涵洞和硬化河道，以期控制水流方向与速度。这些系统尚且可以应对常见的局部洪水灾害；而一旦发生极端或持久降水事件，当河道承接的雨水量超过其极限承载能力，就会引发暴洪。如今，由于气候变化可能引发或加剧极端降水事件，“从而影响水文与河流状况”，人们逐渐认识到，“在此情况下，仅依靠局部的工程构筑物是难以持久应对洪水的。”[6]鉴于此，为尽可能降低洪水风险，许多传统的工程解决方案逐渐被绿色基础设施或基于自然的解决方案（NBS）代替。NBS等措施不仅可以应对局部洪水灾害，还能通过增加植被覆盖率、减少城市热岛效应及提供绿色空间与休闲设施等改善城市生态系统健康、增进社区居民福祉。[7]其他用于缓解城市洪水、构建更加可持续的雨水管理系统的策略包括可持续城市排水系统建设、自然保水措施[8]、水敏性城市设计及海绵城市[9][10]。

尽管绿色基础设施可广泛应用于多种场地背景及尺度中，以解决局部洪水灾害与水质污染问题，但仍需探索具有多重效益的NBS措施。城市河流修复措施便是这样一种洪水缓解策略[11]。由于其具有多种生态、物质及社会效益，且有助于“保护生物多样性、提供游憩活动、实施洪水管理与景观开发”，[5][12]此方法日益受城市规划者关注。目前有关上述效益的研究逐渐增多，包括开发“城市河流修复指数”，以及评估城市河流修复项目的设计、决策与优化过程及其为城市带来的益处。[5]但由于缺少开放空间且存在大量建筑资产，可用于河流修复的土地十分有限，此类项目在城市区域的实施路径困难重重[13]。值得一提的是，学界对于“修复”非静态河流系统的具体含义尚无定论（尤其是在气候变化的背景下），因此将研究重点聚焦于社会效益可能为河流修复决策提供有效的指引。[14]

尽管河流修复相关举措的预期成效显著，但目前鲜有能够明确指出如何考量并进行城市区域建筑搬迁的河流修复措施及相关项目。荷兰的“还地于河”政策是以流域为基础提出的跨尺度河流综合治理策略，期望在减少洪水风险的同时提升空间品质[15]；但仅通过迁移高密度城市街区的建筑资产成功进行河流修复的案例少之又少。从仅有的几个案例来看，社会经济挑战是项目实施过程中不可避免的。以韩国首尔清溪川

and storage, all of which increase impermeable surfaces and lead to increased stormwater runoff. To protect these assets and manage stormwater, many cities have implemented robust engineering systems such as sewers, curb and gutter systems, culverts, and concrete river channels to control and divert water in a predictable direction and as quickly as possible. While these systems often reduce localized flooding under normal conditions, extreme or prolonged precipitation events can cause flash flooding when these channels create torrential rivers that overtop their bank-full capacity. Today, as climate change may increase the likelihood, duration or frequency of these extreme precipitation events, it is increasingly recognized that “local engineering structures alone will not provide the long-term protection as hydrology and river dynamics change in response to climate variability.”[6] As a result, many traditional engineered solutions are increasingly being replaced with green infrastructure or Nature-Based Solutions (NBS) to minimize flood risk. In addition to reducing localized flood impacts, NBS can improve ecosystem health and maximize community benefit in urban areas by increasing tree cover, reducing urban heat island effect, and providing access to green space and recreational amenities, among other benefits.[7] Other strategies for mitigating urban flooding and building strategies for more sustainable stormwater management systems include Sustainable Urban Drainage Systems, Natural Water Retention Measures[8], Water Sensitive Urban Design, and Sponge Cities[9][10].

While green infrastructure can be implemented in diverse contexts and across many scales to address localized flooding and water quality challenges, sometimes more substantial NBS are worth exploring. One flood mitigation strategy of increasing interest to urbanists is urban river restoration[11]. River restoration projects can have a wide variety of ecological, physical, and social benefits in urban areas “in support of biodiversity, recreation, flood management, and landscape development”.[5][12] These benefits are of increasing study, including the development of an Urban River Restoration Index, to evaluate the design, decision-making, and improvement of urban river restoration projects and their urban benefits.[5] However, river restoration is especially challenging in urban areas due to a lack of open space and the significant number of built assets that limit land available for restoration processes[13]. It is also worth mentioning the exact meaning of “restoration” of dynamic and non-static fluvial systems, especially in the context of climate change, remains of debate—thus, focusing on social benefits can provide a guiding light in decision making around river restoration.[14]

Despite the clear benefits of such initiatives, until now there has been little explicit examination of exactly how river restoration initiatives and projects consider and implement relocation of structures in urban areas. While the Room for the River initiative in the Netherlands takes a Basin-wide approach to integrated management across multiple scales in order to reduce flood risk and to increase spatial quality,[15] there are fewer examples of river restoration initiatives explicitly exploring urban river restoration by relocating built assets in dense urban neighborhoods. The few examples that do exist have had many social and economic challenges. For example, in the case of The Cheonggyecheon Restoration Project

修复项目为例，在工业发展鼎盛时期大量人口流入此地，但为使溪流重获自然，政府进行产业调整，将许多从事制造业的居民迁至城市远郊。[16]若要解决城市中的公平正义性及环境与生态问题，需厘清河流修复的对象和目的，以更好地制定居民安置方案。

3 基于土地的搬迁与设计策略：减少危险暴露，满足搬迁与再开发需求

在受气候变化影响、极端天气频发的背景下，尽管相关措施缺乏最佳实践参考，将人员与财产从易受损的洪泛区转移并重新安置已成为切实可行甚至必要的解决方案。[17]人们已经普遍认识到，为应对气候变化而进行搬迁可能是确保人员安全的有效手段。遗憾的是，面临逐渐上升的风险，当前多数政府缺乏可将受影响的居民或社区搬离该地区的切实搬迁政策或制度框架。[18]

由于许多开发项目采取强制搬迁措施，长期累积的负面影响导致搬迁规划阻碍重重。这些搬迁规划往往假借经济增长与再开发的名义，给居民和社区带来不利后果。为解决上述问题并捍卫社会正义与公民权利，政府出台一系列以保护个人与社区利益为目标的搬迁政策。[19]~[21]已有研究表明，搬迁居民的需要有足够的安置房[22]，但对于高洪水风险区域混合利用街区（包括工业与商业活动）内的搬迁企业或商户而言，现阶段仍缺少有针对性的搬迁安置条例。搬迁企业通常需考虑投资与交通成本、资源可用性及与市场的距离来选取安置点，除非有合适的场地，否则工业类企业的搬迁较难施行，尤其当安置地点位于鲜有土地可用于工业开发的区域时。考虑到“决定可达性、社会支持网络、就业、商业、信誉与市场机遇”[21]的关键因素，安置地点距原始地点越近越好。

当前较为普遍的有关土地用途变更的政策制度包括土地整备、开发权转让、土地交换、海岸线重造、社区土地信托与产权收购，可帮助重新划定资产土地边界、调整城市街区的空间布局。但应用这些策略将易受损资产搬离洪水危险区域的案例较少。尽管本文的重点并非剖析上述每种政策的细节，但其中的一些关键因素与挑战仍值得探究。土地整备

in Seoul, residents who had moved to the area for manufacturing jobs during a heavy period of industrialization, were erased for the sake of “re-naturalization” of the stream and relocated to an outer suburb of the city.[16] The question of what is restored, for what end, and where relocated people are resettled remains imperative for addressing equity and justice concerns as well as environmental and ecological considerations in urban areas.

3 Land-Based Relocation and Design Strategies: Addressing Hazard Exposure, Relocation, and Redevelopment Needs

Although examples of best practices are limited, as extreme weather events are likely to increase due to climate change, resettlement of people and assets from high vulnerability floodplains and flood zones is increasingly seen as a viable, or even inevitable solution.[17] There has been an acknowledgement that climate-induced relocation may be necessary to ensure people are safe from harm. However, most governments currently lack policies and institutional frameworks to help interested communities and individuals in relocating away from areas of increasing risk.[18]

Relocation planning is fraught with complexity due to long histories of forced relocation in development projects. These relocation plans have often led to negative consequences for residents and communities under the guise of economic growth and redevelopment. Demands for social justice and human rights have led to a series of best practices for rights-based relocation policy to protect individuals and communities, which guide resettlement programs and ensure the rights against forced displacement.[19]~[21] Despite significant documentation on the qualities of adequate housing requirements for relocated residents[22], there is currently a lack of guidance for cities on how to approach the relocation of high-risk mixed-use neighborhoods that may include industrial and commercial activity. As firms usually choose their locations based on input and transportation costs, resource availability, and distance to market, relocation of industrial assets may not be feasible without a comparable or suitable relocation site, especially in areas that have limited terrain suitable for industrial development. Appropriate resettlement sites are critical because “they ultimately determine access to land, social support networks, employment, business, credit, and market opportunities.”[21] Thus, resettlement sites as close to the original location as possible are considered more suitable.

Existing land-based policies such as land readjustment, transfer of development rights, land swaps, managed realignment, community land trusts, and property acquisitions are well-known tools for addressing the challenges of reconfiguring property boundaries and adjusting the spatial layout of urban neighborhoods. However, there are limited examples of these strategies being used for the explicit relocation of vulnerable assets out of hazardous areas. While the specifics of each of these methodologies are not the focus of this paper, a few critical opportunities and challenges of these solutions are worth highlighting. Land readjustment refers to “a procedure in which the structure of boundaries and facilities with the chosen area is transformed, but the old owners still keep the land”[23]. Land

是指“对划定区域的边界与内部设施进行调整，但土地所有者仍保有其所有权”[23]，这种方法通常用于非正式住区的重新设计、基础设施的升级改造[24]，以及社区在地震[25]与海啸[26]等灾害后的重建。土地整备在某些危险情况下能够有效提升城市韧性，但也存在局限性。在本文讨论的语境下，与其余搬迁政策的主要不同之处在于，土地整备是一种“就地适应”策略，即在保障居民与商业活动区域基本维持不变的前提下，对城市布局进行调整。因此，土地整备不适用于应对由气候变化导致的洪水等日益加剧的风险。

同时，另有部分政策计划将建筑永久搬离洪泛区，如美国联邦应急管理局的不动产自愿收购（控制股权收购）项目。在该项目中，联邦政府与地方政府共同承担收购全部产权的费用（以房屋或企业的灾前估值为准）。在理论上，以此方式，房屋所有者可安置到别处，而搬迁之前的土地则作为限制使用的开放空间。尽管这类项目作为适应性策略越来越受欢迎，但实质上却无法帮助搬迁人员找到合适的安置点；且在项目实施后，开放空间的效益也通常难以显现。开发权转让（TDR）是另一种既能帮助社区适应气候影响，又不侵害产权的策略。[27]过去，TDR常应用于开放空间与农业用地保护项目中——通过建立“发送”与“接收”区域，合理分配适宜与不适宜开发的地区。近年来，有研究开始探究TDR是否适用于社区尺度的海平面上升应对项目。[28]尽管TDR项目可以通过某种土地用途变更政策帮助社区适应各类灾害，但其自身也存在局限性。例如，TDR项目的实施有赖于完备的分区规划与土地利用法规、高水平的城市治理，以及买卖双方对开发权的自愿交易。因此，这类项目能否指导易受气候影响区域（尤其是那些位于土地利用与产权制度仍有缺失区域）的大规模搬迁措施，仍有待检验。

无论采用哪种策略，都应当与搬迁居民和企业深入沟通，了解社区层面的搬迁意愿及居民对安置点的需求。上述许多策略并未明确指定搬迁地点，或在土地重新开发时一味追求生态效益。尽管土地交换项目能够满足已划定的易受损安置区域的需求[29]，但由于缺少适合用于安置的备用土地，目前尚无可借鉴的相关案例。由此可见，找到位置适宜的安置地点是搬迁项目成功的关键。下文着重介绍了一种基于位于城市中心位置废弃基础设施闲置场地的概念性“交换策略”，它可帮助确定适用于大规模搬迁的安置地点。

readjustment has been used to redesign informal settlements, to enable infrastructure upgrades[24], and to help communities rebuild after disasters such as earthquakes[25] and tsunamis[26]. While highly effective at increasing resilience to certain hazards, land readjustment programs face some limitations. In the context of this discussion, the primary difference is that land readjustment is an “adapt in situ” option, which means that residents and businesses essentially remain in the same area but with a reorganized urban layout. Therefore, it may not be an appropriate tool for addressing increasing risks or hazards like flooding due to future climate change.

However, there are examples of policies which are designed to permanently remove structures from flood zones, such as the United States Federal Emergency Management Agency’s Voluntary Property Acquisitions (Buyout) programs. In this case, the federal government and local government share the cost of buying out homeowners at the pre-disaster assessed value of a home or business. In theory, this purchase enables homeowners to relocate, and the land is left behind as deed-restricted open space. While these programs are gaining in popularity as an adaptation strategy, they do little to help participants find adequate rehousing and do not generally maximize open space benefits after implementation. Transfer of development rights (TDR) is another strategy being considered to help communities adapt to climate impacts without infringing upon property rights.[27] TDR programs have historically been implemented as a way to conserve open space and agricultural land by establishing “sending” and “receiving” areas that direct development allocations from less desirable to more desirable areas. More recently, TDR programs are being examined for potential application in helping communities adapt to sea level rise.[28] While TDR programs provide one possible land-based policy mechanism for helping communities adapt to hazards, they face their own limitations. TDR programs, for example, rely on well-established zoning and land use regulations, high levels of governance, and the existence or establishment of willing buyers and sellers for development rights. As a result, it remains to be seen how effective they will be in enabling large-scale retreat from areas of climate vulnerability, especially in areas with weak or limited institutional land use and property rights regimes.

Whichever strategy is used, deep engagement with affected residents and businesses is necessary to understand community perspectives on desire for relocation and whether or not resettlement sites are suitable for resident needs. Many of the strategies above do not explicitly identify relocation sites or attempt to maximize ecological benefit in the context of redevelopment. Although land-swap programs could address the need for pre-identified low-vulnerability resettlement areas[29], few best practice examples currently exist, often due to a lack of proximate land banks that could be made available for relocatees. Thus, the availability of land in a suitable location for resettling residents and businesses is imperative to enable a success relocation project. The following section highlights a conceptual strategy for identifying suitable sites that could enable larger-scale relocation: a swap strategy for urban voids created by centrally-located, decommissioned infrastructure sites.

4 通过“交换策略”提升城市韧性：废弃机场场地的适应性再利用

正如上文所强调的，确定合适的搬迁地点是搬迁项目成功的关键。随着城市的扩张（或收缩），城市中的基础设施或过于老旧或闲置，又或因针对社会、经济与环境等方面的规划而改作他用。[30]本文认为，废弃机场等基础设施进行适应性再利用建设后，可成为适宜的安置区域——它们通常位于市中心，与现有基础设施联系紧密，不易受气候变化影响。随着城市的发展及人们对可持续发展的不断关注，适应性再利用的相关话题越发受到欢迎，“填充式”开发模式为城市发展带来了新的机遇[31]。但笔者认为，人们对于适应性再利用方法的关注还远远不够，且由于在全球范围内超过半数的国家机场即将关闭或前途未卜[31]，通过改造废弃机场场地来应对环境问题在未来有较大的施展空间，然而现有的成功案例尚少。

废弃机场再开发项目通常着眼于改造场地中的建筑等构筑物的结构[32]。近年来，应用于机场再开发项目中的景观设计途径可归纳为适应、保护、转化、开发与复兴等策略。[30][33]其中两个著名案例是德国柏林滕珀尔霍夫机场[34]和厄瓜多尔基多苏克雷国际机场[35]。二者均将废弃机场改造为大型开放空间，为城市提供了重要的公园设施，但改造程度有限。而废弃的美国丹佛斯泰普尔顿机场场地则被用于房地产开发，成为城市填充式开发的范本[36]。尽管现有的废弃机场再利用策略已关注到城市在住房与开放空间方面的需求，但此类适应性项目尚无专门针对废弃场地可否在气候变化的背景下作为搬迁规划的备用土地的判断。因此，废弃机场再开发策略仍处于概念雏形阶段，且缺少实践应用，那么面对气候危机下的空间问题——即当人员和财产遭遇不可逆转的气候变化影响，需要确定合适的搬迁地点时，这些策略是否可行尚未可知。本文提出了“交换策略”（swap strategy）这一概念——即将不易受损区域与城市泄洪道等易受损区域的大型开放空间进行交换——这也是机场再开发等干预措施的主要目标，希望通过对此类项目的探究，搭建研究与实践之间的桥梁。本文将以土耳其阿亚马马河流域与伊斯坦布尔阿塔图尔克机场再开发项目为例，重点阐释这一概念。

5 案例研究：阿亚马马河流域与阿塔图尔克机场

除地震外，洪水是土耳其最常发生且破坏力极大的自然灾害。[37]自20世纪中叶以来，伊斯坦布尔经历了迅速的城市化发展，乡村人口为谋

4 Swap Strategy for Urban Resilience: Adaptive Reuse of a Decommissioned Airport Site

As highlighted above, identifying appropriate relocation sites can be a major barrier to a successful relocation project. As cities grow (or shrink), their infrastructure assets may become outdated, unused, or reconsidered to accomplish other social, economic, and environmental objectives.[30] The authors believe that adaptive reuse of decommissioned infrastructure sites such as airports provide a critical resettlement opportunity because they are generally centrally located and have strong connections to existing infrastructure, as long as they are not located in areas vulnerable to climate impacts. The subjects of adaptive reuse have grown in popularity as cities and concerns about sustainability grow, and much attention has been given to the opportunities that infill development present[31]. However, we believe that this topic warrants increasing attention, as globally, more than half of national airports are in the process of closure or “have an uncertain future.”[31] Relative to the scale of the opportunity, best practices of utilizing decommissioned airport sites to specifically address environmental changes are limited.

Airport redevelopment often looks specifically at the reuse of airport structures like buildings[32]. Recent examples of landscape approaches to airport redevelopment have identified categories of strategic reuse, including adapt, conserve, convert, develop, and regrow.[30][33] Well-known case studies of airport reuse include Berlin Tempelhof Airport[34] and the Marisol Sucre International Airport in Quito, Ecuador[35], both of which preserved decommissioned airport sites as massive open spaces, resulting in the creation of critical urban park amenities with limited additional improvements. Other airport projects, including the Denver Stapleton Airport Redevelopment, have created new areas for real estate and housing development, essentially serving as a “large scale urban infill” redevelopment project[36]. While existing reuse strategies respond to urban needs such as housing and open space, adaptive reuse programs have not yet *specifically* examined the potential of decommissioned sites as a land bank that can support planned relocation for climate adaptation initiatives. As a result, existing conceptualizations of airport redevelopment opportunities are not being sufficiently utilized to address the spatial challenges associated with the climate crisis, namely the need to specifically identify sites for the relocation of assets and people who will be affected by irreversible climate impacts. The authors hope to contribute to this conversation by proposing what we are calling here a “swap strategy.” We propose the conceptual terminology “swap strategy” because the primary objective of the intervention is to replace large open spaces in low-vulnerability areas with large-open space in areas with high vulnerability to flooding, such as urban floodways. We will highlight this concept through an exploration of the Ayamama River Watershed and Ataturk Airport Redevelopment Site in Istanbul, Turkey.

5 Case Study: Ayamama River Watershed and Ataturk Airport

After earthquakes, flooding is the second most common, expensive, and deadly

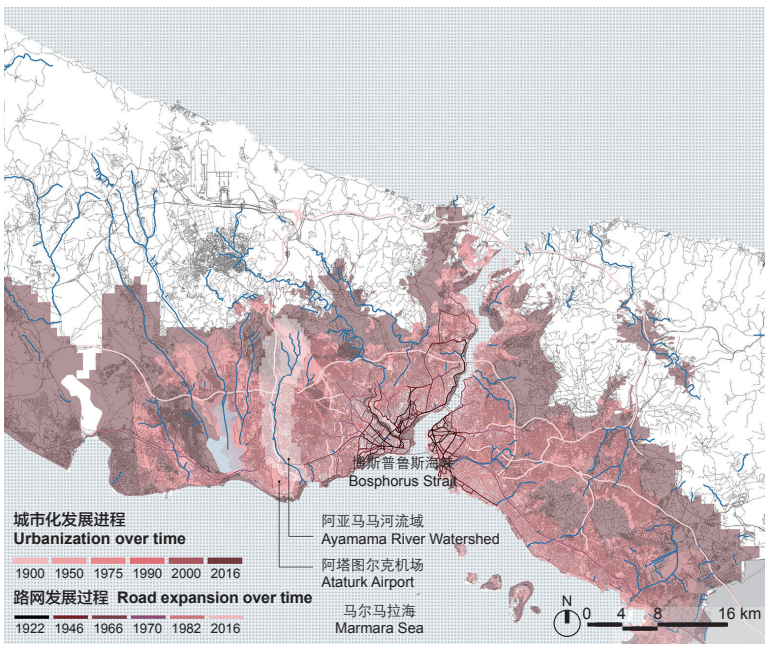
求工作、发家致富，逐渐向都市区域迁移并定居于城市中风貌独特的丘陵与山谷之上。伊斯坦布尔迅速向着远离滨水区域的自然景观深处扩张（图1），对自然系统造成严重破坏，甚至重构了该区域的地下水文条件，使整座城市处于反复遭受洪水的风险中。[38]

在阿亚马马河流域中，一条长约21km的河道（共有8条支流）流经伊斯坦布尔人口最密集的工业区、居住区及商业区，穿过了巴克尔柯伊区、库库切克梅杰区、巴切利耶夫勒区、巴吉拉尔区和巴萨谢希尔区等城区。阿亚马马河流域见证了农业用地向人口高度聚集的城市中心迅速转变的过程，是城市发展导致水文环境退化的典型案例。[39]

5.1 阿亚马马河流域城市化进程

20世纪60年代，伊斯坦布尔提出了6个大尺度区域发展规划，决定了沿海马尔马拉地区的未来发展方向，针对阿亚马马河流域的开发由此开启。这些发展规划旨在调控城市工业与商业发展程度，将工厂从历史悠久的城市中心迁至郊区，鼓励工人从事农业生产[33]。20世纪70年代以来，以往占主导地位的农业用地快速转变为工业、商业与居住用地（图2），在此过程中建造了大量违章建筑，包括工人自行建造且无监管的非正式房屋。也正是从这一时期开始，毗邻阿亚马马河的6个城区的人口从1960年的102 617人增长到1985年的1 238 342人[40]，并于2019年再次翻倍（2 838 503人）。[41]

随着城市的扩张，庞大的交通系统网络逐渐建立，将伊斯坦布尔与世界各地串连起来。阿塔图尔克机场是推动阿亚马马河廊道地区发展的首批基础设施之一。该机场最初作为军用机场于1912年开放，1953年改为承接国际航班的商用机场。20世纪60年代后期，机场扩容；1972年，跑道扩建；1983年，新国际航站楼开放，机场旅客吞吐量增加了500万人。1995年，阿塔图尔克机场再次扩容，迅速成为重要的国际航空枢纽之一。



1

natural disaster in Turkey.[37] The city has grown rapidly since the middle of the 20th century as rural populations began relocating to metropolitan areas for employment and other economic opportunities, settling on the hills and valleys of Istanbul's unique topography. Rapid urbanization away from the waterfront and into the landscape's deep interior (Fig. 1) has resulted in sweeping infringement on natural systems that have re-shaped the region's underlying hydrology and increased the city's vulnerability to chronic flooding.[38]

The Ayamama River Watershed, a 21-kilometer-long waterway with eight tributaries, flowing through the industrial, residential, and commercial activities of some of Istanbul's most populated neighborhoods of Bakırköy, Küçükçekmece, Bahçelievler, Bağcılar, and Başakşehir districts, is an archetypal example of the rapid transformation of agricultural lands to heavily populated urban centers resulting in hydrological degradation.[39]

5.1 Urbanization of the Ayamama River Watershed

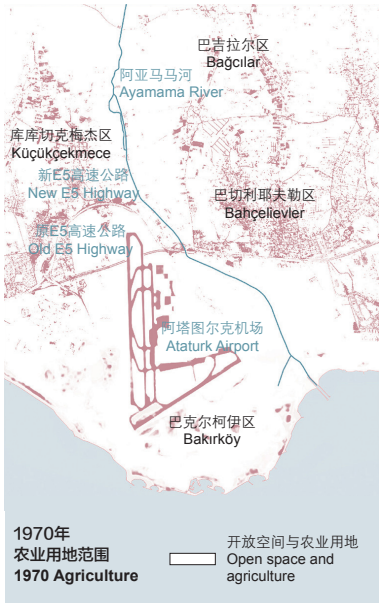
This development of the Ayamama River Watershed began with six large-scale regional development plans of the 1960s that defined the coastal urban Marmara region's future development. These development plans aimed to regulate the city's industrial and commercial development, shifting industries from the historic city center to its fringes, attracting workers to the surrounding farmlands[33]. Rapid conversion of agricultural land, which was the dominant form of land use until the 1970s, into industrial, commercial, and residential use (Fig. 2), resulting in the creation of large communities of *gecekondu*, informal housing constructed by workers with poorly regulated construction. Starting from the 1970s, the population of the 6 districts bordering the Ayamama River riverbed increased from 102,617 people in 1960, to 1,238,342 in 1985[40], to 2,838,503 in 2019.[41]

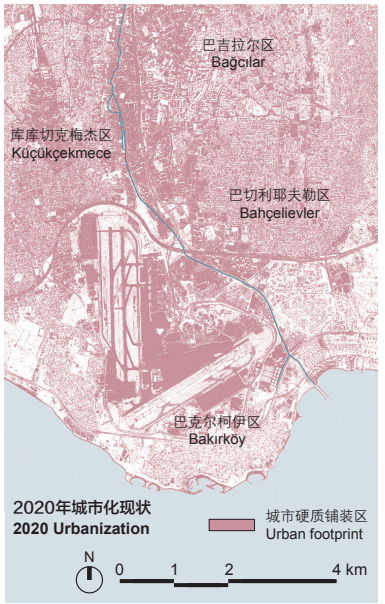
As the city expanded, massive transportation systems were built to connect the growing city to Europe, Asia, and the rest of the world. One of the first pieces of infrastructure driving development in the Ayamama River corridor was the Ataturk Airport, which first opened in 1912 as a military airfield and was converted to a commercial airport with international flights in 1953. The airport's capacity increased in the late 1960s, expanded its runways in 1972, and in 1983 a new international terminal opened with an additional capacity of 5,000,000 passengers per year. With a further expansion in 1995, Ataturk Airport quickly became one of the most critical hubs for international aviation.

Road networks from Europe to Asia also heavily influenced the development of the Ayamama River Watershed. These include E5 Highway, opened in 1973[42], which connects the two sides of the Bosphorus Strait, and the Trans-European

1. 图中展示了伊斯坦布尔周边的流域自1900年以来的城市化和1922年以来的路网发展进程（由尼尔·图兹库和马里索尔·里瓦斯·布里托绘制，尼斯·道古森·亚历山大提供指导）。

1. The map shows the urbanization of Istanbul's watersheds since 1900 and road its networks since 1922. The map is prepared by Nil Tuzcu and Marysol Rivas Brito under the supervision of Nese Dogusan Alexander.





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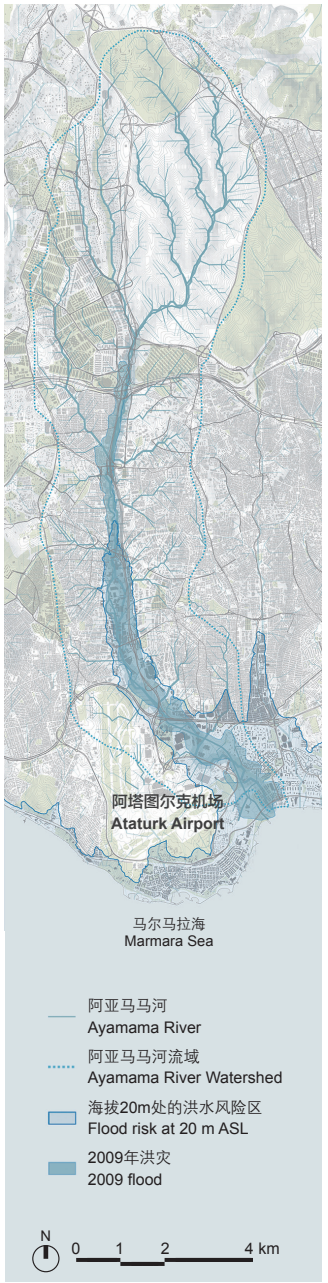
3-1



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3-2

2. 航空影像展示了伊斯坦布尔由农业用地向工业用地转型的过程。1970年，只有机场与少数违章建筑为硬质铺装区，阿亚马马河流域的大部分区域未被开发。到2020年，几乎整个流域与周边区域都已经历城市化（航空影像来源：“伊斯坦布尔市大都会区”网站）。

3-1. 阿亚马马河流域的交通设施，包括E80跨欧洲高速公路、0-7流域快速路和E5高速公路，它们都可通往阿塔图尔克机场。南北向的水文系统与东西向的主要交通干线垂直相交。

3-2. 2009年洪水量估值与20m等高线范围，图中其他色块为建筑及三级公路。

2. Aerial imagery highlighting the transformation from agriculture to industry. In 1970, the airport and scattered gecekondu were the only paved areas, while the watershed for the river remained largely undeveloped. By 2020, almost the entirety of the watershed and surrounding areas have been urbanized (Aerial imagery source: Istanbul Metropolitan Municipality).

3-1. The Ayamama Watershed with transportation infrastructure highlighted, including the E80 TEM, the 0-7 Basin Express Road, and the E5 Highway, all of which connect to Ataturk airport. The hydrological system runs North-South, perpendicular to the major transportation arteries, which run East-West.

3-2. Estimated extent of the 2009 floods and the 20 m contour line including building footprints and tertiary roads.

连接欧洲与亚洲的道路网络极大影响了阿亚马马河流域的发展。1973年，E5高速公路开放[42]，它横跨博斯普鲁斯河及于20世纪80年代建成的跨欧洲高速公路（TEM）。而穿越阿亚马马河低洼地带的0–7流域快速路的建设，同样连接起这两处道路交汇点。E5高速公路与TEM均垂直穿越南北流向山地流域的自然地形（图3），该地区交通网络与水文系统之间的冲突导致在暴雨期间极易发生交通瘫痪，因为涵洞过小容易积聚雨水，甚至形成上游洪水。

出于调控水源、优先工业与居住用水供给的需求，阿亚马马河的大部分河段都已被渠化。但讽刺的是，这些渠化河道使得内部水流速增加，反复漫溢。正如前文所述，上游流域城市大规模建设使得雨水径流增加，极端降水事件也日益频发——1995年、2002年、2009年[39]

Motorway (TEM), built in the 1980s. These two critical linkages are more recently linked by the 0-7 Basin Express Road, which currently runs through the low-lying areas of the Ayamama River. Both E5 Highway and the TEM run perpendicularly to the regions’ natural topography, which is defined by mountainous watersheds that run north-south (Fig. 3). This conflict, between transportation and hydrology, is one of the bases for severe transportation disruptions during heavy rains, as undersized culverts can cause backlogs and upstream flood impacts.

Large sections of the river have been channelized in concrete to “control” the water in the service of enabling industrial and residential activities. Ironically, these channels create high-velocity torrents and have been prone to repeated overtopping. As a result of increasing runoff from urbanization of the upper watershed and

及2019年，阿亚马马河流域低洼地带连续遭遇破坏性极强的骤发洪水。[43]如2009年9月9日的极端降水事件，1小时降水量达90mm，此次骤发洪水共造成32人死亡、50人受伤，经济损失超1亿美元（图4）。[44]自此，伊斯坦布尔市进一步渠化河道，并在加固后的堤岸上加设了自行车与行人便利设施。但渠化的河道加快洪水流速，导致径流增加与水体污染扩散（图5），进而威胁当地的生物多样性，造成“城市河流综合征”[45]，即持续可见的城市区域内溪流、小河和河流水道生态退化。[46]而城市径流携带的污染物也会加剧海洋粘性物质（又称“海洋鼻涕”）的生成——它们不仅不美观，还会导致生态系统失衡，因为浮游生物分泌的大量粘液阻挡了阳光，使水中鱼虾大量死亡，旅游业也因此受到极大影响。

针对阿亚马马河的洪水问题，可优先选择河流重现法与生物过滤法等NBS处理城市径流中的营养物质，提升水文系统的整体健康状况，进而缓解生态退化问题。[45]但成熟的河流修复策略或要求迁移关键的基础设施与资产（如居住区与商业建筑），以修复洪泛区的自然水文功能。如何才能通过缓解洪水风险来修复当地的水文环境并提高环境品质，同时又不影响洪泛区现有的泄洪体量与用途？

5.2 交换策略实例：阿塔图尔克机场再开发项目

在2019年停止使用前，阿塔图尔克机场每年输送国内航班旅客约2 000万人、国际航班旅客约5 000万人。[47]庞大的机场拥有直达新老城区的地铁线路，并与E5高速公路、0–7流域快速路及TEM相互贯通。此处地理位置优越——毗邻多个高密度住宅街区及马尔马拉海。因此，废

4. 2009年阿亚马马河遭遇的严重骤发洪水。
5. 无人机图像显示，阿亚马马河洪泛区已被渠化以控制洪水，但不断恶化的水质更容易引发骤发洪水（摄于2021年10月）。

4. Severe flash flooding of the Ayamama River in 2009.
5. Drone footage showing that the Ayamama River floodplain has been concretized and channelized to limit flooding, but it remains in a state of degraded water quality and is prone to flash flooding (photographed in October 2021).

increasingly extreme precipitation events, low-lying areas of the watershed have been hit by successive and increasingly destructive flash floods in 1995, 2002, 2009[39], and 2019.[43] The flash flooding on September 9, 2009, caused by 90 mm of rainfall in one hour, resulted in 32 deaths with 50 people injured and more than USD 100 million dollars in economic damage (Fig. 4).[44] Since then, the Municipality of Istanbul has taken initiatives to further channelize the river and add bicycle and pedestrian amenities to its reinforced banks. However, these types of concrete channels can increase flood velocity, contribute to runoff and pollution (Fig. 5), and threaten local biodiversity, causing a condition known as “Urban Stream Syndrome”[45], which is characterized by... the consistently observed ecological degradation of waterways (creeks, streams, rivers) draining urban areas.[46] Pollution from urban runoff is also one of many contributing factors leading to increasingly severe blooms of marine mucilage, also known as “sea snot,” which in addition to an unappealing aesthetic is leading to widespread ecosystem death as clouds of phytoplankton block out sunlight, creating dead zones and affecting tourism across the region.

Flood mitigation measures in the Ayamama River can help to address this ecological degradation by prioritizing NBS like stream daylighting and biofiltration that can extract nutrients from urban runoff and increase the overall health of the hydrological system.[45] However, a robust river restoration strategy would likely require the relocation of critical infrastructure and assets, including residential and commercial properties, in order to restore the natural hydrological function of the floodplain. How can mitigating flood risks restore the local hydrological system and improve environmental quality without leading to inequitable outcomes for the existing volume and program of uses in the floodplain?

5.2 Considering the Ataturk Airport Redevelopment for Swap Strategy

Before it was decommissioned in 2019, Ataturk Airport was serving almost 20 million domestic and 50 million international passengers per year.[47] With a metro station that serves as a connection hub to the city’s old and new centers, and close vehicular connections to E5 Highway and the 0-7 Basin Express Road to the Trans European Motorway (TEM), the massive airport site is a piece of prime real estate nestled between several high-density residential neighborhoods and

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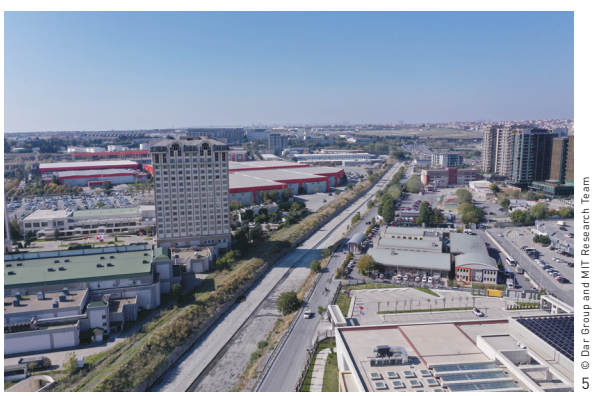

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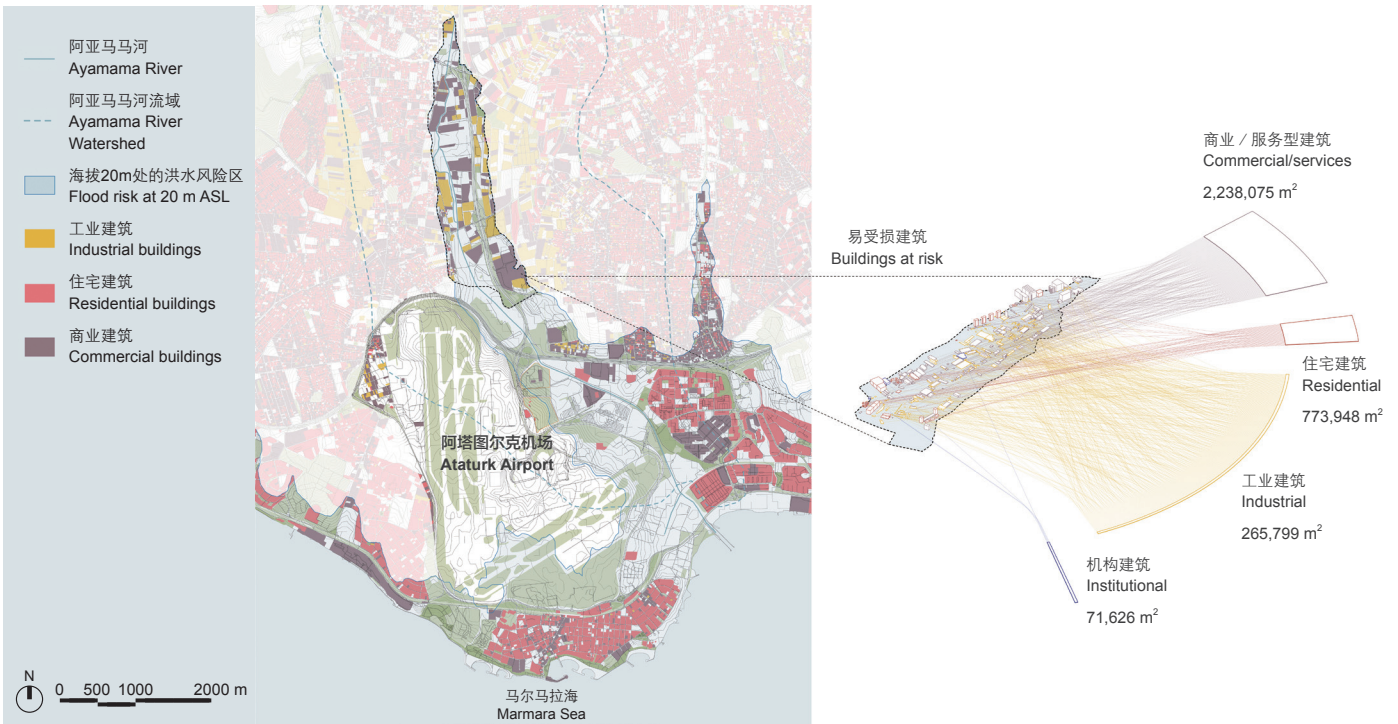
弃机场场地可以解决伊斯坦布尔开放空间长期不足的问题[48]，使数百万居民享受到重要的游憩设施，并欣赏海岸景观。2019年，库库切克梅杰区的人均绿地面积为3.1m^2，远低于世界卫生组织人均最小9m^{2}绿地的要求[49]。此场地中正在实施一项由埃姆拉克—科努特房地产投资信托基金和土耳其环境、城市与气候变化部合作的再开发项目。该项目提出将机场场地改造为一个大型的“全民花园”，设计方为希尔米—古纳建筑设计公司[50]，它借鉴了国际上的一些改造案例，如柏林滕珀尔霍夫机场[34]和厄瓜多尔基多苏克雷国际机场[35]。据土耳其《自由日报》报道，机场现有面积为850万平方米，其中61%将改造为休闲空间、青年活动中心、博物馆、运动区、展览区、住宿区、生活中心与应急避难区，30%为通用航空区，其余9%用作军事区。[51]

虽然现有项目目标明确，但本研究认为仍有可提升之处（图6）：第一，机场周边有大量交通基础设施，阻隔了机场场地与毗邻街区。第二，尽管机场再开发项目计划建造开放空间便利设施，但既不能解决因机场停用对市政当局带来的经济利益损失，也无法增加周边居民的就业机会。第三，一项针对该流域的分析报告指出，虽然机场场地位于伊斯坦布尔一处山顶上，洪水风险较小，但该项目未对阿亚马马河洪泛区应当如何降低洪水风险提出建议。鉴于此，本研究认为当前项目难以有效

close access to the Sea of Marmara. As a result, the decommissioned site offers the potential for vital recreational amenities and access to the coastline for millions of Istanbul residents for whom access to open space is one of the most pressing urban challenges[48]. In 2019, green space per person in the Küçükçekmece District was 3.1 m^2, compared to the minimum requirement of 9 m^2 per person by the World Health Organization[49]. The current redevelopment strategy, led by Emlak Konut Real Estate Investment Trust in coordination with the Ministry of Environment, Urbanization and Climate Change, proposes converting the airport site into a massive park, called Millet Bahçesi (Nation’s Garden) designed by the architectural firm Hilmi Güner Mimarlık[50], taking inspiration from global precedents like the Tempelhof Airport in Berlin[34], Germany and the Marisol Sucre International Airport in Quito, Ecuador[35]. According to the news in Hürriyet Daily News, of the airport’s existing 8.5 million square meters, 5.2 million square meters will be converted to a recreation zone, youth center, museum zone, sports zone, exhibition zone, accommodation zone, living center and disaster gathering area. Within the land, 30 percent will serve as general aviation and 9 percent as military zone.[51]

While such a project has clear ambition, our analysis reveals several key missed opportunities (Fig. 6): First, the airport site is cut off from the surrounding neighborhoods due to massive transportation infrastructure elements on all sides. Second, while the airport redevelopment proposal creates critical open space amenities, it fails to address the economic loss of the airport for the municipality and the loss of jobs for nearby residents. Third, a watershed analysis highlights that the airport site is located high above the flood zone on top of one of Istanbul’s many hills, but the proposal does not address the opportunity to relieve flood risk in the Ayamama floodplain. For these reasons, we argue that the project fails to



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6. 一项关于阿亚马马河洪泛区中段建筑类型的分析表明，受洪水威胁的主要为工业与商业用途的建筑，少部分居住区与机构建筑也面临风险。这一分析为交换策略的提出提供了依据。

6. An analysis of buildings located in the middle section of the Ayamama River floodplain, reveals primarily industrial and commercial use, with some residential and institutional buildings also at risk. This analysis forms the basis of the program for informing the swap strategy redevelopment.

提升周边场地的韧性以应对未来的洪水风险，进而提出了既能复兴阿亚马马河又可为伊斯坦布尔居民提供高品质开放空间的新方案。

5.3 交换策略：搬迁、复兴与再连接

由于阿塔图尔克废弃机场的地势高于洪泛区，可将位于阿亚马马河流域的高洪水风险区域的资产搬离洪泛区，提升城市韧性。目前，机场场地周边地势平坦的开放空间面积达5km^2，并拥有良好的基础设施网络可保障与现有工商业活动之间的紧密联系。由于该场地靠近2009年洪水受灾区，在此处实施交换策略可改变河流廊道周围建筑资产的密度与用途，即将闲置的城市空间转化为功能多样的高品质开放空间，充分挖掘场地在区位以外的优势，利用交换策略下的搬迁、复兴与再连接方法，笔者期望为阿亚马马河流廊道创造更具韧性的未来（图7）。

5.3.1 搬迁

废弃机场地势高，适合在此安置搬迁居民与企业。搬迁后，阿亚马马河洪泛区与马尔马拉海之间的洪泛区可得到修复。重迁新址的企业经过重组，能够优化经济结构与空间利用效率，同时充分利用E5高速公路带来的便利。企业将厂址搬迁至阿亚马马河洪泛区好处众多：首先，搬迁距离短，不会影响企业的投入成本、交通成本及到市场的距离。其次，长远来看，由于原本位于易受损区域的企业可能遭遇洪水威胁，搬迁到新址可为其避免可能的数百万美元的经济损失。

5.3.2 复兴

一旦企业厂房搬离，就可将阿亚马马河流廊道的渠化河道修复至自然状态。修复后的河流不仅可以降低洪水风险，更可为周边缺少开放空间的高密度街区提供游憩设施。此外，河流修复还可提升居民的整体生活水平、缓解城市热岛效应，以及利用植物对水中营养物质的吸收，净化汇入马尔马拉海河水的水质。阿塔图尔克机场是这座城市的重要经济来源，人们十分关切机场的停用是否会对周边街区带来更严重的经济损失。而将工业企业搬离阿亚马马河洪泛区，则可通过构建全新的创新区——在现有搬迁企业的基础上开拓新产业，重振当地经济生产，提供更多的就业机会。因此，将企业搬迁至废弃机场既保障了未来经济发展资产的安全，也提供了新的发展机遇。

5.3.3 再连接

在机场重建时，E5高速公路也经历了改道，横穿位于机场北部的库库切克梅杰区（图2），形成一个大弯道，加剧了交通堵塞[52]。本研究建议将E5高速公路改造为初始形态，同时在该地区构建一处更具社会包容性的、混合用途的住宅区，该住区也能更有效地应对地震与洪水风险。在此策略中全新构建的绿色廊道（面积约550hm^2）穿过废弃机场

maximize local resilience of the surrounding area to future flood risks and propose an alternative strategy to revitalize the Ayamama River and improve access to quality open space for Istanbul's residents.

5.3 Swap Strategy: Relocate, Regenerate, Reconnect

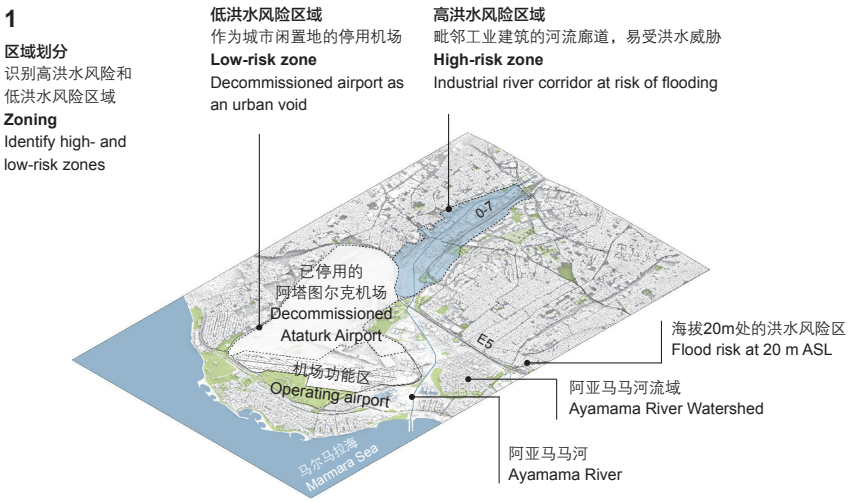
Because the Ataturk Airport is located high above the flood zone, the decommissioned site provides a unique opportunity to contribute to a more resilient future for the Ayamama River Watershed by relocating high-risk assets out of the floodplain. Currently, the site includes 5 km^2 of flat, open space surrounded by infrastructural connections with existing commercial and industrial activity. Due to the proximity of the site to the impacted areas from the 2009 floods, implementing a swap strategy in this area presents an opportunity for strategic reorganization of assets' densities and uses around the river corridor, transforming the airport site from an urban void in situ into a repository of valuable open space that can be leveraged to fulfill resilience objectives beyond its own site location. Using the swap strategy to implement the principles of relocate, regenerate, and reconnect, we create a more resilient future for the Ayamama River Corridor (Fig. 7).

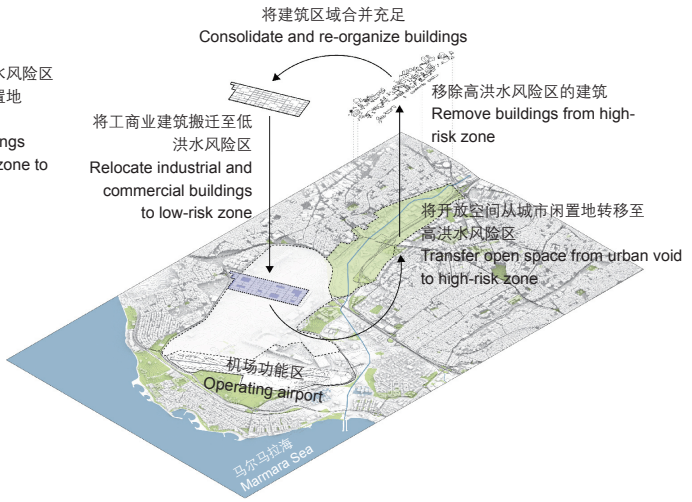
5.3.1 Relocate

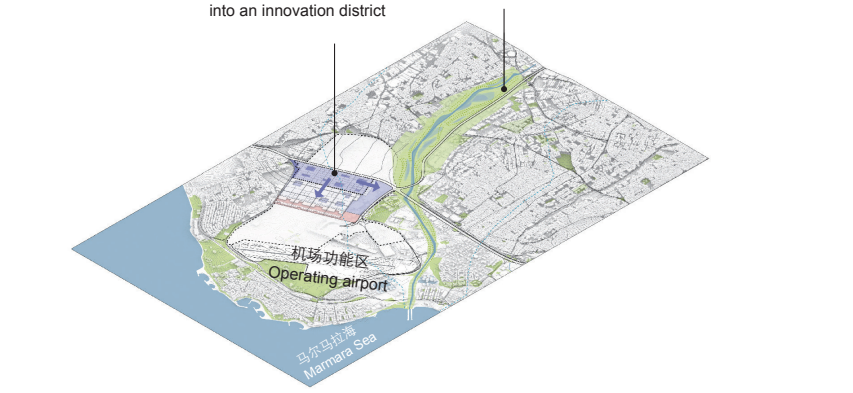
The decommissioned airport sites creates the possibility for residences and industries to relocate onto higher ground. Relocating enables restoration of the floodplain from the Ayamama floodplain to the Marmara Sea. Relocated industries are re-sited and re-organized on the site to maximize their economic and spatial efficiencies and improve connections to the E5 road network. Relocation incentives for industrial development located in the Ayamama floodplain provide multiple benefits. First, the relocation is close enough that the industrial owners do not lose their input costs, transportation costs, or distance to market. Second, incentives from local planners to relocate to the airport site can also reduce economic costs in the long run, as they save businesses millions of dollars of future losses from flood damage.

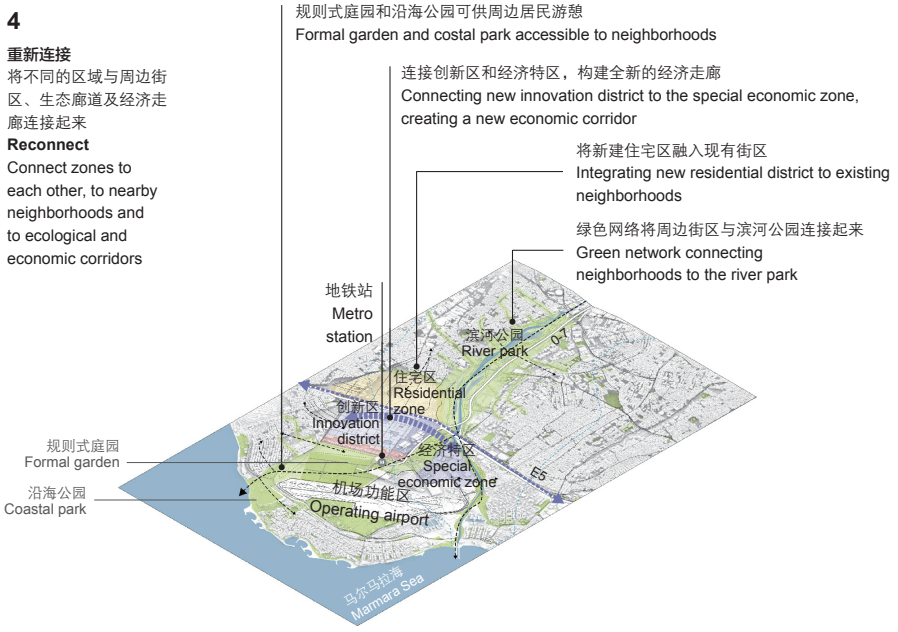
5.3.2 Regenerate

Once industrial buildings are relocated, the Ayamama River corridor can be regenerated by restoring the river from a concrete channel into a naturalized floodplain. The river restoration mitigates flood risk while creating an accessible amenity for the surrounding dense neighborhoods currently lacking open space. The restoration can also contribute to overall well-being, alleviate urban heat island effects, and improve water quality flowing into the Marmara Sea through vegetative nutrient uptake. As the Ataturk Airport was a prominent economic source for the city, the decommissioning of the airport has brought concerns about greater economic loss to the surrounding neighborhoods. By relocating the industrial assets from the Ayamama floodplain, we can regenerate local economic activity and create more jobs through a new Innovation District, with new industries alongside existing, relocated uses. This siting allows the safety of future economic development assets and provides important new development opportunities.









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场地，形成了丰富的景观序列（图8）——它的起点是一座线性河流公园，公园延伸至一处规则式庭园，庭院中保留了阿塔图尔克机场中具有历史意义的建筑遗产，绿色廊道的终点是一座串联起伊斯坦布尔与马尔马拉海的滨海公园。

上述三种方法——资产搬迁、城市的生态与经济复兴，以及重新连接修复后的河流廊道与新建创新区——需分阶段协同实施（图8）。该交换策略具有较强的灵活性，并非地理意义上的简单平移，而是在城

7. 交换策略流程示意图：1）识别高洪水风险和低洪水风险区域；2）将易受损资产搬离洪泛区；3）复兴废弃机场场地和阿亚马马河流域；4）重新连接洪泛区及基础设施场地与周边城市空间。

7. Swap strategy diagrams: 1) identification of high- and low-risk areas; 2) relocation of vulnerable assets from the floodplain; 3) regeneration of decommissioned airport site and Ayamama River Watershed; and 4) reconnect floodplain and infrastructure site to the surrounding urban contexts.

5.3.3. Reconnect

The E5 Highway was redirected when the airport was rebuilt, cutting off the Küçükçekmece District to the north of the airport (Fig. 2) and creating a large bend in the highway that causes significant traffic slowdowns[52]. By proposing to reroute E5 Highway back to its original location, we enable a new a residential district with mixed-use housing typologies that are socially inclusive and are resilient to earthquake and flood risk. The proposed new green corridor (approximately 550 hm^2) passes through the former airport site creating a sequence of landscape typologies, starting with the linear river park passing through a formal garden where architectural heritage of the Ataturk Airport building is celebrated (Fig. 8). The green corridor ends at a coastal park connecting the city to the Sea of Marmara.

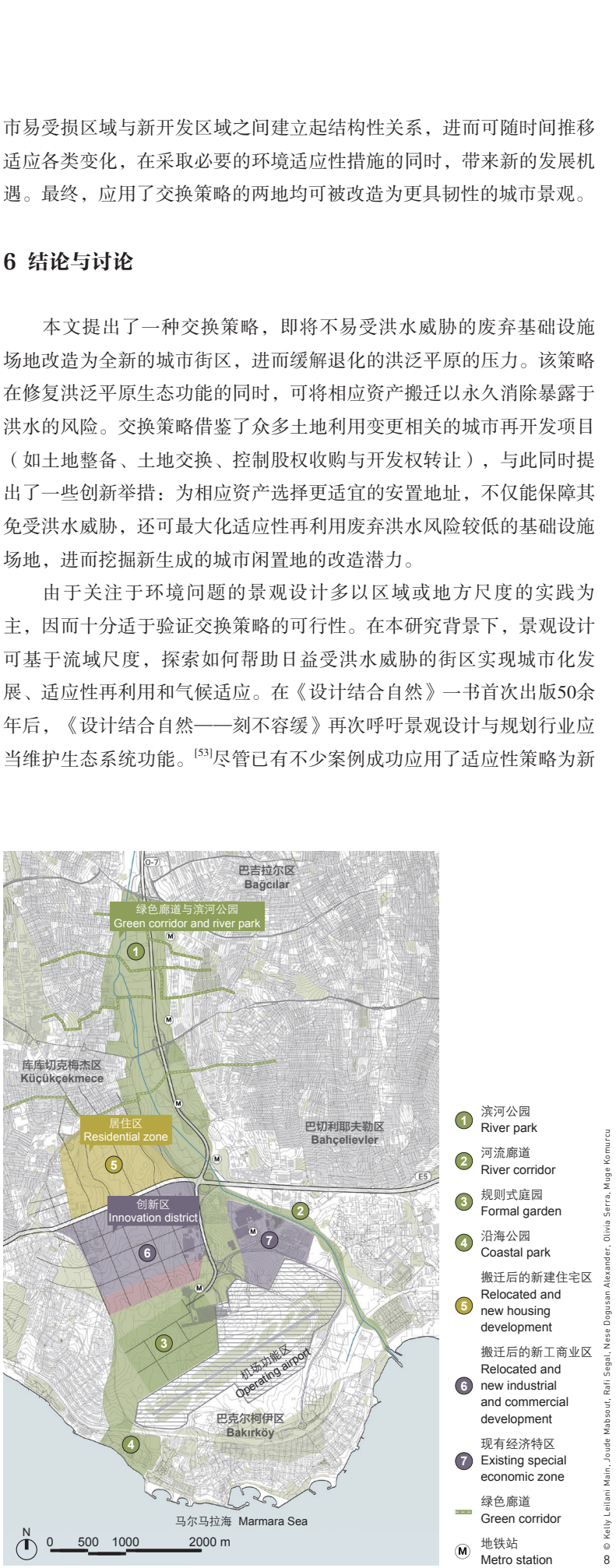
These three design actions of relocating assets, regenerating ecological and economic zone, and reconnecting both the revitalized river corridor and newly established Innovation District, work in tandem under a phased design strategy

市易受损区域与新开发区域之间建立起结构性关系，进而可随时间推移适应各类变化，在采取必要的环境适应性措施的同时，带来新的发展机遇。最终，应用了交换策略的两地均可被改造为更具韧性的城市景观。

6 结论与讨论

本文提出了一种交换策略，即将不易受洪水威胁的废弃基础设施场地改造为全新的城市街区，进而缓解退化的洪泛平原的压力。该策略在修复洪泛平原生态功能的同时，可将相应资产搬迁以永久消除暴露于洪水的风险。交换策略借鉴了众多土地利用变更相关的城市再开发项目（如土地整备、土地交换、控制股权收购与开发权转让），与此同时提出了一些创新举措：为相应资产选择更适宜的安置地址，不仅能保障其免受洪水威胁，还可最大化适应性再利用废弃洪水风险较低的基础设施场地，进而挖掘新生成的城市闲置地的改造潜力。

由于关注于环境问题的景观设计多以区域或地方尺度的实践为主，因而十分适于验证交换策略的可行性。在本研究背景下，景观设计可基于流域尺度，探索如何帮助日益受洪水威胁的街区实现城市化发展、适应性再利用和气候适应。在《设计结合自然》一书首次出版50余年后，《设计结合自然——刻不容缓》再次呼吁景观设计与规划行业应当维护生态系统功能。[53]尽管已有不少案例成功应用了适应性策略为新



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(Fig. 8). This strategy prioritizes flexibility as it does not rely on single large moves but can accommodate various degrees of change over time as it sets in motion a structured relationship between vulnerability and new development in the city, introducing new opportunities alongside the urgent environmental action needed, ultimately transforming both sites to a more resilient urban landscape.

6 Conclusion and Discussion

This paper has proposed a swap strategy that considers the potential of transforming a low-vulnerability, decommissioned infrastructure site into a new urban neighborhood that relieves pressure from a degraded floodplain. In doing so, it creates an opportunity to restore floodplain function and permanently eliminate exposure to affected assets through relocation. The swap strategy takes many critical lessons from other land-based urban redevelopment programs such as land readjustment, land swaps, buyouts, and TDR programs, but attempts to resolve what most other programs do not: improving the siting of relocated assets to not only keep them safe from flooding, but also to maximize the reuse potential of new "urban voids" created through the decommissioning and adaptive re-use of lower-risk infrastructure sites.

Landscape architecture, not only because of its attention to environmental conditions but also its practice of regional and landscape-scale orientation, is uniquely suited to examine possibilities for the swap strategy outlined here by taking a watershed-scale approach to urbanism, adaptive reuse, and climate change adaptation for neighborhoods affected by the increasing threats of urban flooding. More than 50 years after *Design with Nature* was first published, *Design with Nature Now* calls on the design and planning professions to work with ecosystem function, rather than against it.[53] And while the *suitability* approach has been utilized (to varying degrees of success) for siting *new* projects, addressing risk to assets already built and ecosystems already degraded is a daunting task. Given that some of the highest risks now exist in highly developed areas that did not evolve with ecological systems in mind, how can we restore these systems? And what happens to the people who live and work in those places? The challenge of planning for internal migration caused by increasing climate risk is not unique to Istanbul. In fact, "as many as 216 million people could move within their own countries due to slow-onset climate change impacts by 2050."[54] If current trends continue, most of these internally displaced persons are likely to move to cities[55], in search social services and economic opportunities, or relocate within cities, if they already live there. Because cities already face significant risks including extreme heat and urban flooding, finding

8. 最终形成的交换策略概念规划：受洪泛区易受损资产再利用项目的启发，该策略计划针对阿亚马马河流域与已停用的阿塔图尔克机场的居住、工商业与水文要素，实施搬迁、复兴与重新连接等举措。

8. Final conceptual swap strategy plan: taking inspiration from the program of vulnerable uses in the floodplain, the proposed swap strategy results in the relocation, regeneration, and reconnection of residential, industrial and commercial, and hydrological elements of the Ayamama River Watershed and the Decommissioned Ataturk Airport.

项目选址，但保护建筑资产免受洪水侵袭和修复已退化的生态系统仍颇具挑战。一些极易受洪水威胁的高度发达地区尚未认识到保护生态系统的重要性，那么我们该如何修复这些系统？工作居住于此的人们又将遭遇什么？由于气候变化造成的影响越发严峻，已不仅伊斯坦布尔需要实施人口迁移规划。有研究表明，到2050年，全球变化下的“气候移民”人口或高达2.16亿。[54]如果情况未能改善，农村人口将可能搬迁至城市去寻找更好的社会服务与就业机会[55]，而城市人口则可能在城市内部流动。但事实是，城市已面临极端高温、洪水等重大风险，需要最大程度地降低洪水风险并提供更多的开放空间。

本研究以阿亚马马河为例呈现了仍处于概念探索阶段的交换策略，我们期望以此为契机持续探索不可逆转的气候变化影响、城市中心区域的洪水适应能力，以及城市规划师与设计师如何重新利用废弃基础设施场地。随着地方与全球气候特征的改变，规划设计师应当与气候科学家及水文学、生态学等学科的学者协作，制定完善的洪水风险应对方案，并基于具体数据精准实施河流修复策略。河流修复项目可带来众多效益，包括改善水质、修复栖息地并提供高品质便利设施，但由于土地资源稀缺，此类项目往往难以推进。要想腾出更多空间用于河流修复，就需要将部分资产搬离洪泛区，但重点问题在于如何保证搬迁过程的社会公平公正。因此，规划设计方案还应全面考虑搬迁居民及受影响社区的需求。

20世纪以来，快速的城市化与工业化已极大削弱了水文系统的功能，寻找新的适应性策略与发展模式刻不容缓。通过将洪泛区中的资产搬迁至附近地势较高的城市闲置地，同时在地势低洼处建设开放空间便利设施，在降低洪水风险的同时，应对城市化导致的生态与水文系统退化、城市热岛效应及便利设施匮乏等问题。气候变化正在引发愈发频繁的人口迁移潮，而“交换策略”能够促进全球范围内针对城市河流修复、适应性再利用、城市新区开发与合理搬迁项目的研究。**LAF**

ways to minimize flood exposure and increase access to open space are imperatives.

We have presented our conceptual swap strategy case study in the Ayamama River as an example to support what we hope will be the continued exploration of linkages between irreversible climate impacts, flood adaptation in urban centers, and the need to thoughtfully reconsider how urban planners and designers plan for adaptive reuse of decommissioned infrastructure sites. As local and global climate patterns change, it is imperative that the design and planning fields work with climate scientists and other affiliated fields such as hydrology and ecology to develop sound solutions to flood risk and restoration opportunities based in the best available data. While river restoration projects have the potential to improve water quality, restore habitat, and improve access to high quality amenities in cities, they are currently limited by a scarcity of land available to restore riverine functions. Creating more land for restoration projects will inevitably require the relocation of assets out of the flood zone, making equitable and just relocation processes an imperative. As a result, planners and designers should also be committed to mindfully incorporating the needs of residents and affected communities into any proposals.

The degradation of hydrological systems caused by rapid urbanization and industrialization are a defining feature of the 20th century, but new paradigms for adaptation and development are imperative for the 21st century. By relocating assets in floodplains to nearby urban voids on higher ground and creating open space amenities in the lowest-lying areas, we can not only eliminate exposure to flood hazard, but also attempt to address some of the wicked problems associated with urbanization such as ecological and hydrological degradation, urban heat island effect, and lack of open space amenities for urban residents. As the reality of extensive climate displacement looms large, swap strategy can initiate new conversations on the relationship between urban river restoration, adaptive reuse, new development, and rights-based relocation programs globally. **LAF**

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