Living With Urban Rivers: Restoring Social Connectivity and Natural Process



G.马蒂亚斯 康道夫教授, 加州伯克利大学 Prof G Mathias (Matt) Kondolf, University of California Berkeley

Natural River Processes 自然河流过程 Ecological values depend on natural riverine processes: Flow, transport of sediment, nutrients, and organic matter.



Connectivity:

Longitudinal (up-downstream) Lateral (channel-floodplain) Vertical (surface-groundwater) Habitat complexity depends on geomorphology, which depends on flow, sediment load, geologic setting, climate, etc Kondolf et al 2006 Process-based ecological river restoration Society & Ecology

Dynamic channel movement creates habitat 动态河道活动创造栖息地

Sacramento River channel migration, resultant habitats:





To reverse degradation of rivers, a global trend of river restoration 为逆转河流退化,河流修复的全球趋势 Roots in the 19th century: 19世纪的根源: *e.g., Boston's Emerald Necklace by Olmstead*



River Restoration became more widespread in US in 1980s-1990s, after improvements in water quality thanks to Clean Water Act (1972)

河流修复在80-90年代美国变得普遍, 受益于72年清水法案 An early (1980s) project to exhume (daylight) a formerly buried

urban stream: Strawberry Ck, Berkeley



Many US projects in 1980s-1990s to *stabilize* banks, contrary to dynamic process supporting ecology. 80-90年代美国项目旨在固定河岸,与动态过程生态支持相反 Built symmetrical meanders, soon washed out.



←Project as constructed Nov 2005

↓After small (5-year) flood in Feb 2006

Uvas Creek Uvas 溪 Gilroy, California *A form-based project to build a* "C-4 stream" Within 4 months, washed out



Many small streams straightened for drainage have been re-meandered across Europe 遍布欧洲许多原为排水弄直的小溪被重新蜿蜒化 *The Boyerbach, Bavaria 巴伐利亚* A classic rural stream channelized in the 1960s, remeandered in 1980s *Banks allowed to adjust freely*



River Restoration became more widespread in Europe after adoption of the Water Framework Directive (2000) 欧洲河流修复在"水务框架倡议 (2000)" 后变得普遍 Restoration benefited from more up-to-date understanding of river ecology, many projects to restore natural *process*.





River Drau, Austria: dynamic channel processes restored

Source: Habersack & Piegay 2007 River restoration in the Alps and their surroundings: past experience and future challenges. In Rinaldi et al *Gravel-Bed Rivers 6*.

Create a River Corridor within which the river can erode, deposit, flood, connecting channel, banks, floodplains, hyporheos

Known as Espace de Liberté or Erodible Corridor (France) Fluvial Territory (Spain), Elbow Room for the river (Bavaria) Channel migration zone or streamway (US) *Distinct from:* Room for the River (NL) for flooding (and attendant ecological benefits) rather than for geomorphic processes

A *river corridor* is for fluvial erosion and deposition, not just just floodwaters

Allow the river processes to restore channel complexity ("process-based restoration")



Design Criteria for Process-Based Ecosystem Restoration 基于过程的生态修复体系设计标准

Developed by Damion Ciotti, Jared McKee, and Karen Pope

1 – project results in net gain in fluvial process space

- 2 project uses natural energy (flow, vegetation growth) before resorting to outside energy sources
- 3 project uses geomorphically appropriate materials, does not overly stabilize banks or halt channel migration

4 – project does not construct habitat immediately, but sets recovery*icles* trajectory which restores habitat over time

Design Criteria for Process-Based Restoration of Fluvial Systems

DAMION C. CIOTTIO, JARED MCKEE, KAREN L. POPE, G. MATHIAS KONDOLF, AND MICHAEL M. POLLOCK

Process-based restoration of fluvial systems removes human constraints on nature to promote ecological recovery. By freeing natural processes, a resilient ecosystem may be restored with minimal corrective intervention. However, there is a lack of meaningful design criteria to allow designers to evaluate whether a project is likely to achieve process-based restoration objectives. We describe four design criteria to evaluate a project's potential: the expansion of fluvial process space and connectivity lost because of human alterations, the use of intrinsic natural energy to do the work of restoration, the use of native materials that do not overstabilize project elements, and the explicit incorporation of time and adaptive management into project design to place sites on recovery trajectories as opposed to attempts to "restore" sites via a single intervention. Applications include stream and infrastructure design and low-carbon construction. An example is presented in California's Sierra Nevada foothills.

Keywords: floodplain, meadow restoration, stream restoration, multithread channel, carbon emissions

Design Criteria for Process-Based Ecosystem Restoration 基于过程的生态修复体系设计标准

Developed by Damion Ciotti, Jared McKee, and Karen Pope

1 – project results in net gain in fluvial process space – *wider corridor*

2 – project uses natural energy (flow, vegetation growth) before

resorting to outside energy sources

3 – project uses geomorphically appropriate materials, does not overly stabilize banks or halt channel migration

4 – project does not construct habitat immediately, but sets recovery trajectory which restores habitat over time

Design Criteria for Process-Based Restoration of Fluvial Systems

DAMION C. CIOTTIO, JARED MCKEE, KAREN L. POPE, G. MATHIAS KONDOLF, AND MICHAEL M. POLLOCK

Process-based restoration of fluvial systems removes human constraints on nature to promote ecological recovery. By freeing natural processes, a resilient ecosystem may be restored with minimal corrective intervention. However, there is a lack of meaningful design criteria to allow designers to evaluate whether a project is likely to achieve process-based restoration objectives. We describe four design criteria to evaluate a project's potential: the expansion of fluvial process space and connectivity lost because of human alterations, the use of intrinsic natural energy to do the work of restoration, the use of native materials that do not overstabilize project elements, and the explicit incorporation of time and adaptive management into project design to place sites on recovery trajectories as opposed to attempts to "restore" sites via a single intervention. Applications include stream and infrastructure design and low-carbon construction. An example is presented in California's Sierra Nevada foothills.

Rivers need width 河道需要宽度

Restoring true river process usually requires giving the river some space in which to actively flood, erode, deposit, and migrate.

This may be difficult to achieve in dense urban environments, conflicts with goal of maximizing urban area. Engineered channels have been built to maximize urban development, often with buildings and infrastructure right up to the edge of the channel.

To provide the river with more space requires removing some buildings. Very expensive!



But...The service life of concrete channels is typically 75 years. Most built 1950-1990: 但混凝土河道的寿命通常在75年。 大多数建于50-90年代

Freshly-constructed Grayson Creek, California flood control channel in 1957



Most projects will 'expire' mid-century (2025-2065) What to do about impending infrastructure failure? Contra Costa County (east of San Francisco) has committed to a goal of converting its concrete channels to natural channels over the next 50 years.

The 50-year plan adopted by the Contra Costa County Flood Control and Water Conservation District (May 2009)

Goal to turn concrete channels into natural channels by the end of their service lives, supports cities in integrating policy into land-use plans





Not really... 不大可能… Too much development right up to the top of the river bank.

Too expensive to restore a natural channel.

Current restoration efforts in specific places with large parcels next to river

Can the Los Angeles River be restored? 洛杉矶河能被修复吗



Efforts to Restore the Los Angeles River Collide With a Gentrifying City

L.A. paved over a riparian watershed; who benefits from its restoration?

A MULTILAYERED PHOTOGRAPH COMBINES SCENES FROM THE L.A. RIVER AROUND EAST COMPTON WITH OTHERS ALONG THE 51-MILE WATERWAY. | PHOTOS BY ELENA DORFMAN

BY JONATHAN HAHN | JUN

LATEST UPDATES

The Global Gag Rule Puts a Choke Hold



The Los Angeles River is constrained by roads and buildings right to the river edge. The proposed restoration projects are only where large parcels exist next to the river channel, such as Taylor Yard.

Set aside river corridors early on 预**留河流走廊**

The wider the river corridor possible, the greater the ecological benefits. Expensive to remove existing urban development, but relatively cheap to set aside river corridors before new districts have developed. Such corridors provide multiple benefits as parkland (human recreation, wildlife habitat), filtering urban runoff, and flood risk reduction.

Also help cities qualify as 'landscape garden cities' (China)

> American River Parkway Sacramento, California



Social Connectivity' "社会连结性"
= the communication and movement of people, goods, ideas, and culture along and across rivers.
From environmental sciences we apply a framework of

- -longitudinal,
- -lateral and
- -vertical connectivity. Social interactions are especially important in *urban rivers*



The social connectivity of urban rivers

G. Mathias Kondolf *, Pedro J. Pinto University of California Berkeley, United States



CrossMark

Recreation Uses of Rivers 河流的休闲用途 (depend on water quality) (取决于水质)

Rio Curaray, Curaray, Ecuador

Isar River, Munich





Canoeing and kayaking increasingly popular in urban rivers 在城市河流中泛舟划艇越发流行 (*creates demand for improved longitudinal connectivity*) (创造改善河流纵向连接性的需求)



The Milwaukee River, Milwaukee

And the new trend: urban swimming 新趋势: 城市泳道



The Aare River, Bern, Switzerland

Requires longitudinal, lateral, and vertical connectivity, and good water quality 需要纵向、两侧和垂直连接性,以及优秀水质

Wingfield Park, in the center of Reno, Nevada 内华达州雷诺市中心的Wingfield公园



Built as a whitewater park, used most heavily by lower-income groups. Over 70 such 'urban river parks' in North America & Europe



A 'quaternary sector' use: urban streams now consumed as recreational space, displacing homeless, marginal uses

Vertical connectivity in human uses: Activities in-stream vs on banks 垂直连结的人类用途:水中活动 与 岸上活动



Another axis: passive to active uses 另一轴: 被动和主动使用



Require vertical connectivity, good water quality

The Seine, Paris 巴黎塞纳河

Lateral connectivity banks-channel sacrificed for navigation by 1850. Restored in 2000s: riverside expressway closed, Paris 'beach' created.

1609





994



Challenges to restoring vertical connectivity: water quality 侧翼连结恢复了 - 垂直连结性呢?

	S En direct Le journal	LE FIGA Premium Actualité Economie	RO • <i>fr</i> Sport Culture Lit	€) Suivre Rech	
	Quel mix pour recharger son téléphone ?				
	LE FLASH ACTU 16:13 Syrie: 11 civ	vils tués dans des raids aériens		 Tout le fl 	
	Actualité > Sciences & Environnement				
	Se baigner dans la Seine : rêve ou réalité? Par Etienne Jacob I Mis à jour le 26/07/2017 à 22:30 / Publié le 26/07/2017 à 21:37			CONNAÎTRE LES AGENTS DU SECTEUR PUBLIC, C'EST MIEUX LES ACCOMPAGNER	
			1	DÉCOUVREZ NOS OFFRES	

mate 1

COLUMN TO DE COLUMN

Swimming in the Seine? 在塞纳河里畅游? Since 1923 illegal to go in the water in Paris (15eu fine!) Mayor Jacques Chirac promised to make the Seine swimmable Mayor Betrand Delanoe: Paris *plages*, swimming pools Mayor Anne Hidalgo:

Bassin de la Villette on Canal St Martin – already open

How to manage *e coli* bateria from boats, leaking sewer pipes, etc?

Big challenge at basin-scale



Restoring Vertical Connectivity on the Rhone, Geneva Swimming platforms 游泳平台

provide access to Rhone waters over 500m, from Pont du Sous-Terre down to Avre River confluence. Note different color of Avre, reflecting cold, sedimentladen meltwater from Mont Blanc, in contrast to clear, warmer (still cold!) waters of the Rhone draining from Lake Geneva.



The two downstream-most platforms: 两个最下游的平台:





Swimming was not previously possible in the Rhone in Geneva due to vertical stone walls. Since 2011, wooden platforms provide access to the water and riverside gathering spaces. 虽然早期受石墙限制, 但自2011年以来木制平台了提供亲水和河岸聚会的空间 With many events set along the newly reconnected river. 许多活动沿着新连接的 河流展开。





Lyon: Reconquering the Banks of the Rhone 里昂:重新征服罗纳河岸

270 km downstream of Geneva, in Lyon, France, a major urban renovation project was undertaken along the banks of the Rhone in the

early 2000s.







The Rhone has always been central to the identify of Lyon. The city was founded by the Romans (on the ruins of a Gallic settlement) at the confluence of two large rivers: the Saone and the Rhone



Lyon au début du XIXe siècle Source : Grand Lyon By the 1960s, the banks of the Rhone had been converted into parking lots. Prostitutes and drug dealers frequented the area. 60年代时,罗纳河岸边被改造成停车场,吸引暗娼和毒贩子常驻



Lyon en 2000 : des parkings en surface sur les berges Source : Grand Lyon

By 2010, the banks had been transformed into pedestrian spaces. A key to the project was building enough alternative parking (underground) nearby. 到2010年,水岸被改造成人行空间。项目关键是在附近提供足够的(地下)停车空间



L'aménagement des berges rendues aux piétons

Source : Grand Lyon

Isar River, Munich 伊萨尔河, 慕尼黑

Restored natural processes, ecological and social connectivity - despite highly urban setting.

恢复自然过程, 生态和社会连结 - 哪怕是在高度城市化环境中



Rock walls removed, gravel margins allow the river to erode, deposit, and flood, and allow human access (increased social lateral and vertical connectivity). Gravel also added to the channel upstream Like many urban rivers, the Isar had: 类似许多城市河流, 伊萨尔河曾有: Straightened, diked channels 垂直,岸堤河道 Unnatural flow regime (dams, runoff changes) 不自然的流动规律(大坝等) Poor water quality 低水质 Disrupted lateral connectivity: from floodplains, side channels 洪泛区、测河道 Lack of human access to river banks and water (loss of social connectivity) 缺少社会连接功能

Isar River prior to restoration 伊萨尔河恢复之前



The Isar River channel was formerly stabilized by stones along the base of its banks. A physical model was constructed to confirm the stones could be safely removed.



View from the Tower of the "Deutsches Museum"

Model of the Present Situation in Obernach





The result is a dynamic river, with shifting gravel banks and natural river forms. 结果是一条充满活力的河流,有着砾石河岸和自然河

流的形态

Managing flood risk was another important objective of the project. 控制洪水风险也是该项目另一重要目标

To increase flood conveyance capacity, the river cross section was enlarged (1), the height of the dikes was increased (2), and sediment removed from 'floodplain'(3).





And gravel was added to the river upstream of the city, to provide the river gravel with which to build bars. 砾石被加到城市上游的河中来增加 河中砾石,构造拦截

Rock was removed from banks, allowing for naturally eroding banks.

...and the channel widened from 50 to 90 m. 石头从河岸移除,使自然侵蚀河岸成为可能…及 河宽从50米增长到90米



To protect infrastructure, 'sleeping riprap' was installed back from the active bank, as 'insurance' against excessive future erosion

为保护基础设施,"休眠石 堆"被装回河岸,作为防止 未来过度侵蚀的防范措施



Installing 'sleeping riprap'



Rigid channel-wide grade controls were replaced with irregular rock weirs that allow fish to pass.

死板的全河道层级控制被不规则 石堰取代,使得鱼类可以通过







Gravel bar habitats are favored by wildlife and humans, with both ecological and social connectivity enhanced. (Human contact requires good water quality.)



8 km long, construction 2000-2011, cost: 35 M euro (funded by State of Bavaria and City of Munich)

American River, Sacramento, California: 美利坚河项目,加州萨卡拉蒙托市 An *espace de liberte* within an urban setting 都市环境中的一场自由逃离





First proposed in 1915, the concept was laid out in a plan by Frederick Law Olmstead in 1929. Plan adopted by Sacramento County in 1960.

Initial budget of \$12.6M used to purchase land, starting in 1960. Last parcel acquired in 2008.



The American River Parkway 美利坚河公园大道

- Includes over 100 km of trails (for bicycles, horses, pedestrians) along its
 37-km distance from the dam to the Sacramento River.
- 包括超过100公里步道(骑行,马道,行人)沿着37公里的河流距离
- Receives 8 M visitors annually 年访问量八百万
- Generates >\$364M for local economy 为当地创造>3.64亿美金的收入



The American River provides spawning habitat for salmon, and is an important area for recreational fishing. 美利坚河项目提供了三文鱼繁殖栖息空间,也是休闲钓鱼重要区域 <u>https://www.youtube.com/watch?v=SqXbU2JkxTE</u>



The American River is also very popular for recreational kayaking and canoeing. 泛舟划艇在该河中也非常流行



Despite the current homeless crisis, the American River Parkway provides high quality salmon habitat, public space, and recreation for urban Sacramento, and the large width of the corridor allows it to safely convey the design flood.

The Aire River,

Geneva: 艾尔河, 日内瓦 An example of a limited *espace de liberté* in an agricultural valley within a densely populated urban area

高密度都市区域中一个农 业谷的有限"自由逃离" 的案例

Documented in: *River Conservation and Management*, P. Boon & P. Raven, editors. John Wiley & Sons, Chichester, 2012 Superpositions: Revitalization of the River The River Aire, Geneva Aire

CHAPTER 18

The *Espace de Liberté* and Restoration of Fluvial Process: When Can the River Restore Itself and When Must we Intervene?

G. Mathias Kondolf Department of Landscape Architecture and Environmental Planning, University of California, Berkeley, USA

Introduction

As the sciences of fluvial geomorphology and river ecology have progressed, the dependence of alluvial river channel form upon fluvial process has become better understood. In place of the still exert strong influence in much of North America, reflected in the paradigm of designing a stable, single-thread, meandering channel as an ideal goal in river restoration that is still widely accepted in many regions of America (Kondolf, 2006). By the time river restoration became widespread in Europe especially in response to the



The River Aire descends from the French Alps, down an alluvial fan through a glacial valley that is dominantly preserved for agriculture but adjacent to the city and thus under intense human pressure. 艾尔河自法国爱尔贝斯山流下,通过一个农业区冰川峡谷形成冲积扇,毗邻城市且面临高度人类活动压力。



3 kilometres were "corrected' in the 19th century 19世纪中3公里河道被"矫正"



The result was a 3-km-long straight, trapezoidal channel that efficiently moved flood flows downstream. 成果是一条3公里笔直, 梯形的河道, 有效把水流带到下游



To restore a natural river (as required by the 1997 water law), the designers proposed not to remove all traces of the 19th-century canal, but rather to retain the 19th-century canal as a focal point for recreation, and to create an *espace de liberte* for the Aire from adjacent agricultural fields to the south.

To accelerate the development of a natural channel, the designers created a multi-channel template in which the Aire could choose its own course, by excavating the channels and leaving "islands" behind, termed "lozenges".



The concept was that the river would choose its own course through a set of potential channels. 理念是河流会通过一系列潜在河道来自己决定轨迹



To explain the concept to the public, the designers used the analogy of a bar of Swiss chocolate...

为向公众解释这一概念,设 计师使用一块瑞士巧克力做 类比…





The 'lozenges' were excavated into the former agricultural land (floodplain and former channel bed) in spring 2014



One year later, after some small floods (RI < 2y), lozenges were eroding, especially the gravel banks (April 2015)

The first 2 years of channel evolution on the Aire River





August 2014



October 2014



November 2014



August 2015



April 2015



May 2015



October 2015



May 2016





July 2014



April 2015



Ν

May 2016

Kondolf et al 2021. Restoring dynamic fluvial processes in urban rivers: learning from the Aire and Isar Rivers. *Landscape Architecture Frontiers*



Summary:

Urban rivers offer both potential for ecological value and social value "Social connectivity" framework (longitudindal, lateral, vertical) Look for ways to restore human access *and* natural processes in urban rivers: more constraints but many unrealized opportunities to restore process Ideal: Before development, set aside a river corridor within which the river can flood, erode, and deposit, creating complex fluvial forms and habitats Next best: - create a river corridor from available land, restore flow & sediment - restore social connectivity (trails, riverside parks, access to water) Where possible, let the river design its own form



Thank you! 谢谢! kondolf@berkeley.edu https://riverlab.berkeley.edu

