ROOM FOR THE RIVER: INTERNATIONAL RELEVANCE

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World-wide the frequency and impacts of flooding exhibit a steep increasing trend[1]. The key drivers are the world's population growth and the increase of socio-economic activities (development) in flood-prone areas, and society's growing interdependency on flood protection and drainage infrastructure of which a significant part is of unknown or poor condition[2, 3]. It is more and more recognized that flood risk management approaches should be able to respond to changes in the natural and socio-economic environment. Moreover they should perform well under various potential futures as there is inherent uncertainty about the magnitude of the drivers of flood risk.

Specifically river basins are highly dynamic and complex systems. The challenges for flood risk management strategies of river basins are manifold, as water safety issues interact with a wide range of environmental and socio-economic sectors including health, agriculture, biodiversity, industry, navigation and tourism. In addition, in transboundary river basins differences in legal frameworks, historical and cultural backgrounds add to the complexity[4]. Flood risk management of river basins requires a programmed approach including the supporting capabilities such as integrated and adaptive policy frameworks and the institutional capacity at multiple levels and across different jurisdictions and countries to exploit these interactions by creating synergies or avoiding undesired outcomes[5,6].

In the Netherlands, such an integrated and programmed approach referred to as the Room for the River Program is currently being implemented in the Dutch Rhine River Basin[7]. This program is considered the first in the Netherlands to adopt a multi-level governance approach in which NGO's and private stakeholders in different disciplines (e.g. water safety, planning, agriculture, nature) and at national, regional and local levels are actively collaborating to reduce the flood risk and to increase the spatial quality by creating more space for the river[8]. There is a growing international interest to exchange innovative concepts and best practices of these integrated programmed approaches such as used for the delivery of the Room for the River Program. However, transferring these to other countries is likely to be a major challenge as it calls for fundamental changes in institutional arrangements at various levels[9].

This paper draws upon the findings of previous research which has identified key features and conditional factors supporting effective development and implementation of the Room for the River Program in the Netherlands[7,10]. Using these findings, this paper attempts to assess the potential for effective transfer of the concept of Room for the River Program across other river basins around the world. In particular, this paper focuses on the transferability of the concept of Room for the River based on an analysis of the conditional factors of five different river basins: Mississippi River (US), Rhine (Germany, Netherlands), Seine (France), Brisbane River (Australia) and Huaihe River (China). The material for the five river basins was collected during interviews with local, regional and national stakeholders and at an international conference (November 2012) dedicated to this topic as well as from the literature.

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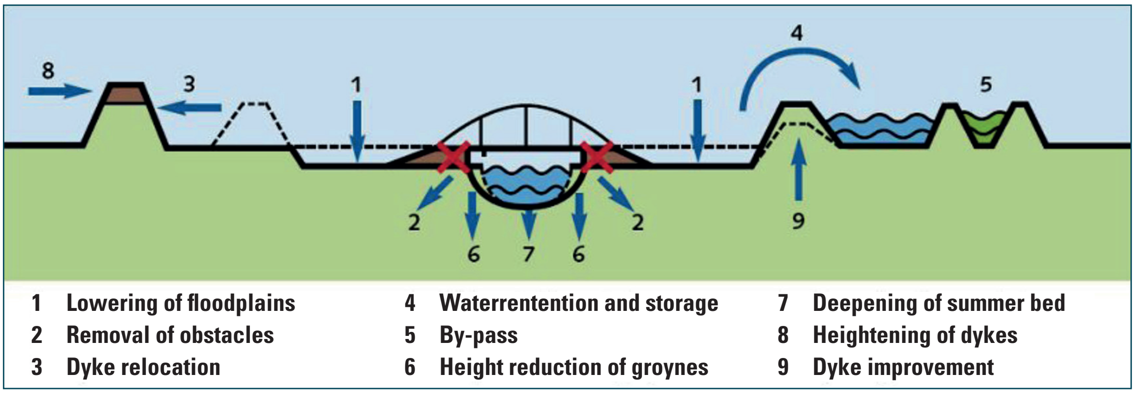

Figure 1.

Measures that are applied in the Room for the River Program **(Source: Room for the River Program Office)**

The Dutch Room for the River Program

In 1995, extreme river water levels nearly caused dike breaches and led to the evacuation of 250,000 people and 1 million cattle. This created enhanced awareness amongst the public, politicians, public administration and water professionals that nature cannot be controlled and that new ways of managing rivers are required; i.e. through creating more space for rivers to discharge their flows. Amongst others, this led to the initiation of the 2.2 billion Euro Room for the River Program, which started its detailed design phase in 2006 and is scheduled for completion by 2015. It has a dual objective of: 1) improving safety against flooding of riverine areas of the Rivers Rhine and Meuse by accommodating a discharge capacity of 16,000m^3/s for the Rhine and 3,800m^3/s for the Meuse; 2) contributing to the improvement of the spatial quality of the riverine area. At the start of the program, a set of 39 locations (projects) was selected to create more room for the rivers through, for example flood by-passes, excavation of flood plains, dike relocation, and lowering of groynes (Figure 1).

Compared to other large projects in the water sector and other sectors, the Room for the River Program performs well in terms of achieving project objectives and the overall process of delivery (satisfaction)[11,12]. It is on track to achieve its (local) project objectives without budget over-run or major time delay as well as the program objectives for flood safety and spatial quality[5]. The majority of individuals who were actively involved in the program (e.g. decision makers and project officers across all government levels) are satisfied with the process and output of the program[5, 13]. Furthermore, based on a survey (hereafter referred to as "the survey") that was held amongst participants (n=151) of the Room for the River Program, it was concluded that the program's governance arrangements were instrumental in the program's performance[5, 10]. However, conclusions about the program's effectiveness for achieving objectives should be finally considered when the realisation of the program is completed (completion is scheduled for 2015).

The Room for the River Program has adopted a new (multi-level) governance approach in which government agencies in different disciplines (e.g. water safety, planning, agriculture, nature) and at national, regional and local levels and other stakeholders are actively collaborating[8]. The program uses a mix of centralised (national) steering/decentralised (regional) decision making processes[14]. The decision frameworks for establishing improved water safety and spatial quality are set by the national government, whilst the plans and designs are formulated and decisions are taken by local and regional stakeholders in 34 regional projects. The national government has established a central program office to manage and monitor progress, evaluate quality of designs, and facilitate the regional projects through guidelines, providing expert knowledge, community building, and, where needed, applying political pressure. This approach provided the opportunity for decentralised governments to link local issues, such as new urban developments and the development of natural and recreational areas, with the water safety agenda[13].

At present, most of the initial 34 regional projects within the Room for the River Program have completed their planning phase and entered the realisation phase[15]. Meanwhile, the Room for the River Program is considered an *"exemplary project"* for adopting new governance approaches by the Ministry of Infrastructure and Environment[8]. For example, the recently established Delta Program (2009-2015) is using Room for the River as an example for governance and developing integrated strategies. The Delta Program is currently preparing Delta Decisions for securing water safety (against flooding) and fresh water supplies. These Delta Decisions will be ready in 2015 and will be implemented according to the Delta Act that provides a continuous funding stream of 1 billion Euros per year into a Delta Fund from 2020 and beyond. Hence, the lessons from the Room for the River Program have potential relevance for future water management in the Netherlands.

Key features and contextual factors of "Room for the River"

In this section the key features and the conditional factors for effective development and implementation of the Room for the River Program in the Netherlands[5, 10] will be briefly described.

Key features

The concept of Room for the River falls under the more widely applied practice of "Integrated River Basin Management (IRBM)." This typically refers to a comprehensive and coordinated approach to the management of river systems. Three different perspectives on integrated river basin management can be distinguished[5].

1. Integration is about alignment and balancing of *multiple objectives*. For river basin management, objectives such as providing safety, transport capacity, opportunities for recreation, enabling nature, water supply, facilitating economics, safeguarding aesthetics and water quality play an important role[16, 17, 18]). Integrated river basin management particularly takes into account the interplay between both water and land use functions[19, 20].
2. An integrated approach is a system approach that includes all relevant *spatial scales*[21, 22]. Relevant spatial scales for river basins could be catchment and sub-catchment scales[23, 24]; and international, national, regional and local scales.
3. IRBM includes comprehension of short and long term *time scales* in order to balance short and long term costs and benefits and anticipate (potential) future change[21, 22]. For example, the definition of the Global Water Partnership for integrated water resource management that is quoted above includes the word sustainability, which is about meeting present needs without compromising the ability to meet future needs[25].

Summarising the above, we define IRBM as a comprehensive water management approach that aligns multiple objectives in a river basin across different spatial scales and temporal dimensions. The Dutch Room for the River Program is an example of IRBM as it aligns multiple objectives across different spatial scales and temporal dimensions. Based on the above, Table 1 summarizes the three key features of the concept of Room for the River.

Table 1. Key features of the concept of Room for the River.

1. Cross-disciplinary scope: safety & spatial quality,
2. Long term lens (climate change, population, …)
3. A (river basin) systems approach across all relevant spatial scales

Contextual factors

The results of the survey (n=151) have been used to identify the most relevant preconditions or *contextual factors* affecting the success of the Room for the River Program in terms of effective delivery of the program objectives (c.q. projects within budget and time). These preconditions are:

Geographical context: availability of space

Making room for rivers in a strict physical sense requires available space to expand a floodplain by setting back the dikes, or diverting water into a bypass area. The presence of dense urban communities or critical infrastructure may preclude the ability to expand a river floodway because relocating these elements would be cost-prohibitive or socially unacceptable and calls for adopting a (river basin) system approach.

Historical context: flood history (sense of urgency)

The new paradigm of *making room for the river* has set the stage for the Room for the River Program in The Netherlands. However, it took another decade, after the high waters in 1993 and 1995 on the Rhine, to acquire the political will to approve the governmental decision for the Room for the River Program (PKB Ruimte voor de River).

Cultural & socio-economic context: legitimacy for integrated river basin management

Historically up to the 1970s, there has been a weak link between river and land management in the Netherlands. The Dutch have maintained "dry feet" for centuries, due to successful engineering interventions along the rivers and coast. Driven by the recognition of protecting areas of landscape beauty and the realization that there are limits to heightening river dikes, the first integrated river management plans were developed in the 1980s. These plans were well received by the local stakeholders and the public. They embraced the basic principles of the concept of *making room for the river* which marked the offset of a transition to a new paradigm in river basin management. In turn this provided the legitimacy for the national government to initiate and further develop the Room for the River Program.

Institutional context: multi-level and cross-sector collaboration

In the Netherlands the *Polder model* of compromise prevails, along with a strong top-down government to oversee and encourage a coordinated system-wide approach. The engagement of the three governmental levels (national, regional and local) in combination with central leadership are assumed to be vital institutional conditions for initiating and implementing the Room for the River Program.

The transferability of the concept: a comparison of five international rivers

There are some 270 transboundary river basins around the world, covering 45% of the land surface on earth, and many more that cross sub-national jurisdictional boundaries[26]. Trends such as climate change, continued population and economic growth, and aging infrastructure are placing greater needs for cooperation across jurisdictional boundaries within these river basins. This will require new forms of water governance such as the multi-level governance approach which has been adopted by the Room for the River Program.

The concept of making space for rivers is also being used in other countries[27]. For example, in the US the first projects aimed at making space for the river emphasized expanding river capacity on the Mississippi (1928) and Sacramento Rivers (1933) to *safely* convey flood discharges[28, 29]. New projects aim to achieve multiple benefits including enhancing ecosystem function[30] and water supply reliability as mandated by new state policy for flood risk reduction interventions[31]. In Greece, France and Hungary the approach's focus is on engineering: physical interventions aimed at enlarging the river bed or restricting or (re)allocating obstacles from the river bed such as buildings. In the UK and the Netherlands the concept is based on a holistic, integrated approach embracing a multi-functional river in which flood safety is considered in combination with other values such as landscape, environmental and cultural values[27].

Despite the success of this holistic, integrated approach in the Netherlands, its process of delivery should not be translated one-on-one to other contexts. Different contextual factors may impede the applicability and/or effectiveness of the Dutch approach. Therefore, we have analyzed and compared the five river basins on the basis of the four categories of contextual factors identified in the previous section (see Table 2). These categories comprise the geographical context, the historical context, the institutional context and the cultural & socio-economic context.

Geographical context

The Mississippi in the United States is the longest river in the study, at 3,734km. It is more than 10 times longer than the shortest, which is the Brisbane River in Australia, 344km long. All of the river basins included in the study have been heavily modified and managed, and they cover both rural and more developed densely populated landscapes. The initial channelization was for navigation purposes, but ultimately building embankments, reservoirs, and drainage infrastructure became critical for flood management and agricultural and economic interests on adjacent lands.

Many dense cities like Rotterdam, Paris, St Louis and Beijing developed alongside the Lower Rhine, the middle Seine, the middle Mississippi, and the Huaihe River in China, but the majority of the Brisbane River basin is sparsely populated, with the exception of the City of Brisbane. Through St. Louis, the Mississippi River would be constrained, as is the Seine as it passes through Paris. However, on the lower-middle Mississippi River, the rural New Madrid Floodway acts as an emergency spillway to protect 3,000 residents in Cairo, Illinois when water levels are high. The lower reaches of the Seine watercourse are significantly less developed, supporting agriculture which is a land use compatible with flooding. Widening the river here may be possible.

Historical context

Where history demonstrated a need for new policy and flood risk reduction interventions, political will for taking action has been higher. Major floods resulted in heavy investments in infrastructure on all rivers in the study, with the most recent large floods along the Mississippi and Brisbane Rivers in 2011.The Brisbane and Huaihe Rivers have flooded the most frequently in comparison with others in the study, though in Brisbane, frequency has been largely reduced since the construction of the Wivenhoe dam in 1974. There have been no major recent floods along the Rhine or the Seine (1910). High waters (1993 and 1995) on the Rhine resulted in evacuation of people, cattle or property, but no severe damages or disruption occurred.

In some cases, frequent or catastrophic flooding resulted in an institutional change as well, and the creation of water management bodies, for example the Mississippi River Commission. Where the US federal government previously concerned itself with navigation only, the Great Mississippi Flood of 1927 and the subsequent Flood Control Act of 1928 made flood control a federal responsibility as well.

Cultural and socio-economic context

Where communities or authorities do not perceive a flood threat, they would be less likely to invest the high capital costs required for interventions. People (and maybe experts) can tend to think that dikes and dams will protect them from all floods[32, 33], and they do not see a need to take individual action. Studies have shown that the presence of flood control structures reduces the perception of flood risk[33]. This could perpetuate a societal expectation that lands behind dikes and dams are safe and immune to failure.

The city of Paris, France, has not experienced such a flood since the early 1910s thanks to heavy investment in infrastructure. As such, implementation of Room for River projects along the Seine may be difficult. In Brisbane and along the Huaihe, however, they experience frequent flooding, so the perception of a need to address the flood problem is likely higher. High flows along the Mississippi River in 2011 keep discussions about management in the spotlight even today.

Because it is rare that one entire river system lies within one jurisdiction, or one level of government, the concept of Room for the River most likely requires cross-jurisdictional cooperation. The costs, benefits, and physical footprint of the individual Room for the River projects are distributed *unevenly* over a large area

Table 2. Characterization of the five river systems based on the four categories of contextual factors.

RIVER BASINS	GEOGRAPHICAL CONTEXT (general)	GEOGRAPHICAL CONTEXT (interventions)	
Mississippi Basin: 2,981,076 km^2 Length: 3,734 km	Urbanised river basin with very low population density in some areas, and high population density and critical infrastructure in others: such as St. Louis, MO, and New Orleans, LA. Heavily managed river with channel modifications and dike systems and flood storage reservoirs and detention basins.	Major modifications of the Mississippi River began in late 1800s directed under Engineer General Humphreys. Initial policy was "levees" only (Barry 1997). After the 1927 flood, the Mississippi River and Tributaries project (MR & T) was proposed in 1928 (Jadwin Plan) on the lower Mississippi – It was a series of channel improvements, outlets, and spillways (MRC 2011).	
Brisbane River Basin: 13,600 km^2 Length: 344 km	Largely rural river basin with high population density in some areas (Brisbane).	The Brisbane river is dammed by the Wivenhoe Dam, forming Lake Wivenhoe, the main water supply for Brisbane. The dam was built in response to flooding in 1974 and now serves as Brisbane's main water supply.	
Huaihe Basin: 187,000 km^2 Length: 1,076 km	Heavily managed river with scattered concentrations of densely populated areas (560 people/km^2) in some parts and large rural areas in other parts (17% of China's grain production).	Around 3600 reservoirs and 2100 km of channels have been constructed during the last two decades.	
Rhine (Germany and the Netherlands) Basin: 185,000 km^2 Length: 1,233 km	Heavily managed river with channel modifications and flood storage reservoirs. In the Upper Rhine region the population has a low density, the land-use is predominantly agriculture and the land to significantly increase flood storage capacity by installing flood storage reservoirs is available. In the Lower Rhine the river basin is largely urbanised with concentration of highly populated and industrialized areas.	The Upper Rhine region was changed significantly by a Rhine straightening program in the 19th century. Like the Upper Rhine, the Lower Rhine used to meander until engineering constrained the river into a solid river bed. Because the dikes are at some distance from the river, at high tide the Lower Rhine has more room for widening than the Upper Rhine.	
Seine Basin: 78,650 km^2 Length: 776 km	The Seine is a heavily managed river with flood storage reservoirs and locks and an important commercial waterway within the Paris Basin in the north of France. It is navigable by ocean-going vessels as far as Rouen 120 km from the sea.	In the City of Paris, the Seine is constrained between high stone embankments. The water level reaches 24 m above sea level, 445 km from the mouth of the river, making it slow flowing and thus easily navigable. In the North beyond Rouen there is a section that has 4 large multiple locks until the mouth of the River Oise. Until these locks were installed in the 1800's to artificially raise the water level for navigation, the levels did fluctuate, but today, the depth is tightly controlled.	

HISTORICAL CONTEXT (flood history)	INSTITUTIONAL CONTEXT
1849 and 1850 floods caused widespread damage on the Mississippi River Valley, and demonstrated national interest in river modification and "control". The 1927 Great Flood caused enormous devastation, (over 600,000 evacuated) economic damage and life loss. It catalyzed institutional change. High discharge in 2011 activated MR & T project (floodways and spillways for high Mississippi river flows). There were no deaths, and the action prevented $110 Billion in damages (MRC 2011). Additional major floods were in 1927, 1937, 1993, 2011.	1879 Created Mississippi River Commission –first comprehensive river planning agency in USA. After the Great Flood, 1928 the Flood Control Act made flood control a federal responsibility. Previously they were responsible for only navigation. The US Army Corps of Engineers is the federal agency responsible for the design and construction of flood protection works along the Mississippi. The Great Mississippi Flood (1993) had a significant impact on US flood management Policy which distributed management and responsibilities among federal, state and local authorities (IFMRC 1994).
The Brisbane River floods frequently, although the occurrence and magnitude of flooding has diminished following the construction of the Wivenhoe dam. The most significant flood events were in 1974 and in 2011. In 2011 major flooding occurred throughout most of the Brisbane River catchment, most severely in Toowoomba and the Lockyer Creek catchment (where 23 people drowned), the Bremer River catchment and in Brisbane, the state capital of Queensland.	The State Governments are responsible for natural resource and emergency management. Following the January 2011 floods, Brisbane City Council commissioned an independent Board to undertake a review of their performance during the flood disaster. Legislative responsibilities are currently distributed among different local and state organizations,. Consequently, there is a lack of coordination on waterways issues, authorities and water utilities.
From 246 BC to 2010, a total 340 basin-wide flood and droughts disasters have occurred (on average a frequency of around 6.6 years). In the last two decades large flood and drought disasters have happened more frequently.	The management of waterways in China is highly centralized and based on policies of the Five Year Plan developed by the State Council. The management of China's five biggest rivers is the responsibility of a specially formed river commission, of which the Huaihe River Commission is one of them. There is no public involvement in decision making and local authorities are considered as service providers for the central government
In 1993 and 1995 extreme peak discharges . although no dike breaches have occurred in the Netherlands. Severe flooding in the city of Köln, Germany, and 250,000 people were evacuated in the Netherlands.	In Germany and the Netherlands, River Basin Management is the responsibility of the States (Laender) and the central government (c. Rijkswaterstaat), respectively. In the Rhine basin institutional stability has created the conditions for transboundary cooperation. In the Integrated Rhine Programme the riparian countries have cooperated for many decades, resulting in an integrated river management programs in order to compensate for some of the adverse effects of channelling and confining (raising dikes).
A very severe period of high water in January 1910 produced extensive flooding throughout the city. The Seine again rose to threatening levels in 1924, 1955, 1982 and 1999–2000. After a first-level flood alert in 2003, about 100,000 works of art were moved out of Paris, the largest relocation of art since World War II.	In France legislative responsibilities for water management are historically distributed among different authorities. The EPTB Seine Grands Lacs is a French local authority responsible for the management of flood risk caused by overflowing of the Seine and its tributaries affecting Paris and 3 surrounding departments (Hauts-de-Seine, Seine-Saint-Denis and Val-de-Marne). EPTB Seine Grands Lacs manages 4 reservoir-dams located in derivation of the Seine, the Marne, the Aube and one on the Yonne, to control the water levels and to maintain sufficient flows of the Seine and its tributaries. Apart from flood control EPTB is also responsible for the preservation and management of wetlands in her territories.

and are borne by more than one community or level of jurisdiction. Therefore, the collaborative nature (or lack of it) of a given region could determine the success or failure of project implementation.
In the United States, strong local governments and individual property rights infringement prevail as critical factors in the planning process. Implementing projects for system-wide benefits across a region full of individuals can be more challenging because it will always be perceived that there are “winners” and “losers.” The beneficiary of one floodway, for example, may not be in the same region where that floodway is constructed. In May 2011, high waters on the Mississippi River threatened 3,000 lives in Cairo, Illinois. The necessary federal action to save Cairo was to activate the Bird’s Point New Madrid Floodway and flood farmlands in Missouri[28]. The State of Missouri unsuccessfully fought on behalf of landowners to prevent activation of the floodway for fear of property damage[34].
While not impossible in these cases, it takes strong leadership amongst regional governments and unlikely partnerships between many different stakeholders to identify and support common objectives. Since the costs, benefits and physical footprint of room for the river projects are experienced at different scales and across multiple jurisdictions, these projects will likely be easier implemented in situations with either a strong river management governance based on catchments, or with strong federal government.
Increased stakeholder participation could either hinder or enable project implementation. In regions with strong local government and many stakeholders, this could delay the planning process until all parties agree, or it could result in political stand-still through litigation or other means. In regions with stronger top-down governments, stakeholder involvement up front could prevent discrepancies down the line, where ultimately the decision-maker will have the final say anyway.

Institutional context

Management of the Mississippi River in the United States and the Huaihe River in China are federal responsibilities with specially designated authorities in charge of the entire river course: the Mississippi River Commission (within the US Army Corps of Engineers) which was established in 1879, and the Huaihe River Commission. The 1993 Great Flood along the Mississippi, however, affected policy to redistribute authority amongst federal, state, and local authorities. In Australia, responsibilities for management of the Brisbane River are similarly shared amongst various local and state organizations. The 2011 catastrophic floods catalyzed a review of performance. In contrast, the Rhine River is managed exclusively by States (Landers) in Germany, and by the Federal Government (Rijkswaterstaat) in the Netherlands. An integrated Rhine Program promotes cooperation between the two to ensure compatibility. Lastly, The EPTB Seine Grand Lacs is a local authority responsible for managing the Seine River near Paris.

Conclusions

The results of this study substantiate the need to exchange innovative concepts and best practices of holistic, integrated programmed approaches for flood risk management of river basins across the globe.
The Room for the River Program is considered as an “exemplary project” in this respect both in the Netherlands as well as internationally. This study reveals that transferring the Dutch concept and best practices to other countries is likely to be a major challenge as there is no blueprint and each river basin has its unique features requiring customized programs for strategic institutional change.
Although the motivations and practical interpretations may differ, the implications for governance and management have commonalities between countries. This is partly because the denominator of the concept is the interface between flood risk and urban development, agriculture, ecological restoration or recreation. The need to have a cross-disciplinary perspective is supported by the responsible authorities of the five river basins. The institutions, however, representing the “disciplines” and necessary to provide authority do exist in the river basins, but generally lack the incentives and capacity (and possibly the acceptance at the national level) to engage and participate in this cross-disciplinary governance process. Additionally, while interventions are built on a local project level, program boundaries may cross multiple jurisdictions, and planning, construction, and operations and maintenance costs are usually distributed across local, state and/or federal agencies (multi-spatial levels). Coordination and implementation of these integrated multi-level programs require dialogue and interaction amongst all involved stakeholders. To address the complexity and dynamic nature associated with these governance processes new, institutional structures and arrangements are required. The Room for the River Program as an internationally recognized vanguard in multi-level governance, has gained highly relevant experience to provide guidance on how to shape these institutional arrangements.

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ABSTRACT

This paper focuses on the transferability of the concept of Room for the River based on an analysis of the conditional factors of five different river basins: Mississippi River (US), Rhine (Germany, Netherlands), Seine (France), Brisbane River (Australia) and Huaihe River (China). There is a growing international interest to exchange innovative concepts and best practices of holistic, integrated programmed approaches for flood risk management of river basins such as used for the delivery of the Room for the River Program. However, transferring these to other countries is likely to be a major challenge as there is no blue print and each river basin has its unique features requiring customized programs for strategic institutional change.