Planning a green river as a solution to increasing discharge in an urbanizing area on the River Rhine

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Introduction

Future land management in the upper part of the Rhine delta, The Netherlands, will face two problems in the near future. The urban fringes of the two medium-sized cities of Arnhem and Nijmegen will expand strongly, and urban sprawl may be a threat to the quality of the environment. At the same time, more space is needed for the safe discharge of river floods, which are expected to increase in the near future due to climatic change. Since the River Rhine floods of 1993 and 1995, this is a political issue of high urgency.

We investigated whether a new, large river by-pass, called floodway in the USA or green river in The Netherlands, will provide a solution to both problems mentioned (Wolfert et al., 2004). Our example was the Mississippi delta, where the Morganza and the Bonnet Carre floodways were constructed following the Great Flood of 1927 to pass floodwaters from the Mississippi River to the Gulf of Mexico, thus safeguarding the city of New Orleans from flooding.

The planning of such a green river in a cultural landscape will involve major land use changes and many people will be involved in the decision making. Therefore, aims of the study were: (1) to indicate possibilities for new types of land use and to visualize the future landscape and (2) to demonstrate the impact on the water levels in the river system during flood events. The results were compared with the effects of retention polders in the same area, which is another option of which examples exist along the Upper Rhine in Germany.

Plan design

The Green River Lingewaarden comprises two reaches (Fig. 1). The upstream Rijnstrangen reach is surrounded by old dikes as these 3200 ha of land were regularly flooded until the 1960s. The downstream, new Lingewaarden reach is planned in the former floodbasin in between two embanked Rhine distributaries, the Rivers Waal and Neder-Rijn. In the lowest part of this floodbasin, 2900 ha of green river is designed with a minimum width of 500 m near important highway and railway crossings in order to reduce construction costs, but much wider where there are no built-up areas at present or envisaged in the very near future, in order to allow some backswamp restoration in this area.

Figure 1. The green river, planned along the present Rhine distributaries (present embanked floodplain in blue). Area shows measures ~45 km in width; north is up.

For each of the two options water levels and dikes heights required were calculated. Water depth was calculated using data on present water levels – assuming the green river will prevent maximum water levels to rise – and data on altitude. In case a green river is preferred, new dikes have to be up to 8 m

high, while a choice for the option of retention basin requires dikes of more than 10 m high. As a green river, the area will discharge water as soon as the present embanked floodplains are flooded and thus will function approximately once in one or two years as a floodway. As a retention basin part of the discharge of extreme floods events is stored in the area, and released as soon as the water levels in the river system get lower, an event which is estimated to occur only once in approximately 600 years.

Future landscapes

Future land use was explored based on the qualities of the present landscape, spatial developments in land use, and future flooding frequencies and water levels. It was assumed that the frequent presence of water in a green river will induce land use changes, but that the rare inundation of a retention basin will not lead to changes. Thus, the option of a green river will enhance functions such as nature and recreation. The frequent presence of water may attract building high-quality residences along the new dikes. The new dikes may be used for new types of recreation infrastructure such as long distance footh pats and cycle tracks, that enable citizens to enjoy their surroundings more than before.

Based upon the local qualities of various parts of the area, new land use combinations were described to occur in the various parts of the green river (Fig. 2). In the Rijnstrangen reach emphasis will be on agriculture with nature, in the eastern part of the Lingewaarden reach development plans with urban parks may be anticipated (Fig. 3, see page 19), while in the western part of the Lingewaarden reach continuation of agricultural use will conserve the highly esteemed openness of the present landscape.

River management

When the so-called design discharge will increase from its present 16.000 m^3/s to a future 18.000 m^3/s, the new green river will discharge 2000-3000 m^3/s, which will lead to a drop in water levels of approximately 60-100 cm along the present dikes. In the case of a green river, there is no impact on water levels in the downstream river reaches in the delta, as would be the case when retention polders were constructed. However, that option would only lead to a 35-40 cm drop in water levels in the study area, which is not sufficient in the long run. The new design discharge would require a retention basin of 8-10 times the size of the area investigated here.

The construction of a green river does not change the discharge distribution over the various Rhine distributaries profoundly, but more research is needed on this. An advantage of the option of a green river is that it does not require any operational management during the rise of the water levels. In contrast, a retention basin must be opened and closed with precision on the right moment, otherwise it will not effectively reduce the flood peak water level in the river system. The decision on whether to open the basin or not are seen as a great risk of failure.

Conclusions

Compared to the option of retention basin, construction of a green river will be the best in order to stop the present process of urban sprawl, because of the frequent inundations. These inundations will also induce new types of land use contributing to the environmental quality of the urban areas, and will enhance development plans with high-quality residences. Realization of the latter may contribute to the financing of the construction of new dikes. Besides we argued that a green river is not only a sufficient but also a robust solution to the increasing river discharges, as it relies on natural functioning without management procedures, resulting in a much lower risk of failure during floods.
We concluded that a green river is a rigorous solution, but deserves the attention of decision makers, because it provides long-lasting opportunities for an environment which is safe and pleasant to live in.

Figure 2. New land-use combinations in the various parts of the green river

Reference

Wolfert, H.P., L.C.P.M. Stuyt, A.G.M. Hermans, J. Kruit, R.J.W. Olde Loohuis & F. Klijn, 2004. Bergende stroming KAN. Alterra-rapport 973, Alterra, Wageningen, 23 p.

Figure 3. The future landscape in the urban part of the Lingewaarden reach