Vegetation dynamics of a meandering river (Allier, France)

G.W. Geerling[1,2], A.M.J. Ragas[1] & A.J.M. Smits[1,2]
[1] Department of Environmental Studies, University of Nijmegen, P.O. Box 9010, 6500 GL Nijmegen, The Netherlands; Gertjan.Geerling@sci.kun.nl
[2] Section Nature Conservation of Stream Corridors, University of Nijmegen, P.O. Box 9010, 6500 GL Nijmegen, The Netherlands.

Introduction

New riverine nature management strategies focus on managing river stretches rather than individual floodplains. They combine nature and safety management. For safety management the discharge capacity of fixed rivers has to be maintained at a certain level. The floodplain vegetation relates to the discharge capacity through its hydraulic resistance. Process knowledge of vegetation patterns and their dynamics in a natural setting seemed necessary for the design of a good management strategy. The meandering process of a river creates a diversity of landscape elements in different stages of ecological succession. By erosion in the outside bend older succession stages are removed while at the same time new pioneer stages are formed on the point bar in the inside bend. In the research at hand the main research questions are:

- Is there a relation between vegetation dynamics and scale? Is vegetation type distribution stable on larger scale?
- How does the meandering process influence the vegetation distribution? What are rejuvenation frequencies?
- What is the age distribution of succession stages along a meandering river?

Material & Method

The Allier is a gravel river south of the city Moulins in the centre of France, Fig. 1.

Figure 1. Oblique aerial photograph showing the research area.

It has braided and meandering sections. The summer discharge is 20 - 50 m^3s^{-1} and peak discharge can be up to 1,000 m^3s^{-1}.

To be able to study the vegetation types on the river stretch scale (several floodplains) a GIS system was used. The use of aerial photographs made it possible to reconstruct the history of this part of the Allier.
The photo series covers the years 1954, 1960, 1967, 1978, 1985 and 2000. The photos are of scale 1:20,000. Products of the mapping process are maps as shown in Fig. 2 (year 2000 map). The legend on the right shows the mapped vegetation types.

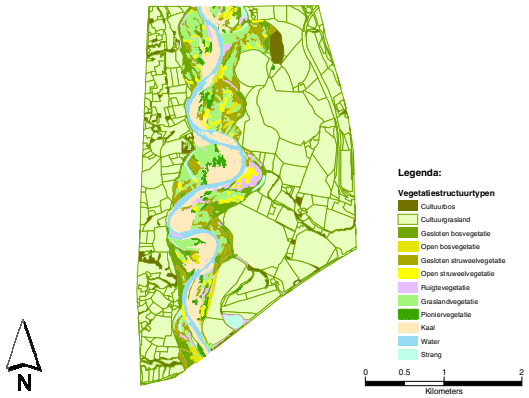

Figure 2. A produced map of year 2000.

Results

A map of floodplain age is created by overlaying in GIS the bare and water types of the different years, see Fig. 3. It shows the spatial distribution of stages of vegetation development, important for ecological diversity.

Changes seen in the landscape (Fig. 4) are quantified in change matrices.

Table 1 shows the matrix for the 1967-1978 transformation. In these matrices the rejuvenation can be read as the turnover in water & bare soil.

The surface area of vegetation types during the years is shown in Fig. 5. Especially the early succession stages grass and bare gravel are dynamic.

Sum of 67 - 78	Naar										
Van	Cultuur	Gesloten Bos	Gesloten Struweel	Grasland	Open Bos	Open Struweel	Pionier	Ruigte	Strang	Water & Kaal	Totaal
Cultuur (1023,3 ha.)	96,2	0,1	0,0	0,2	0,0	0,0	0,1	0,5	1,0	1,8	100
Gesloten Bos (46,7 ha.)	5,2	59,8	13,6	2,8	2,0	1,0	0,0	5,8	0,2	9,7	100
Gesloten Struweel (58,4 ha.	10,5	13,1	47,0	5,3	1,3	0,5	0,0	4,4	0,0	17,9	100
Grasland (170,5 ha.)	5,0	2,5	6,2	54,5	1,0	4,3	0,5	2,0	0,1	23,9	100
Open Bos (4,9 ha)	4,2	49,4	1,1	12,6	3,2	4,0	0,0	0,0	0,0	25,5	100
Open Struweel (21,9 ha.)	0,0	4,1	36,0	19,6	3,6	12,6	0,1	3,9	0,0	20,1	100
Pionier (14,3 ha.)	1,7	2,6	2,3	36,7	4,4	0,8	2,7	0,0	0,0	48,7	100
Ruigte (11,5 ha.)	41,1	10,1	11,4	10,7	0,3	11,1	0,2	3,0	0,0	12,0	100
Strang (1,4 ha.)	5,9	0,0	0,8	38,6	0,0	0,0	0,0	0,3	35,2	19,2	100
Water & Kaal (186,5 ha.)	0,3	1,7	2,7	20,1	0,3	0,5	3,6	5,1	2,5	63,2	100

Table 1. Example change matrix for the years 1967-1978. The turnover is given in percentage area per vegetation type. The absolute area is given between brackets in the first column.

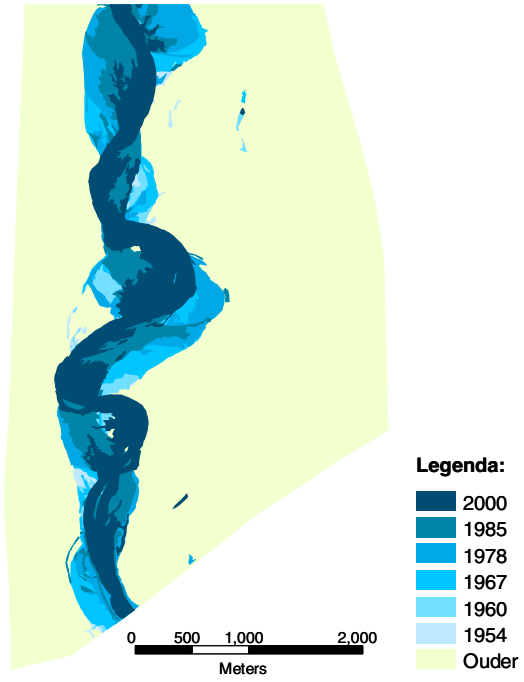

Figure 3. The age distribution of Allier floodplains.

Discussion & Conclusions

Along a natural river one will find patches of vegetation and side channels of various ages and in different stages of succession. Important is to notice that the spatial heterogeneity on the small scale may look like chaos, but seen on the larger scale the system is quite stable. Continuous succession and disturbance ensure that no place remains

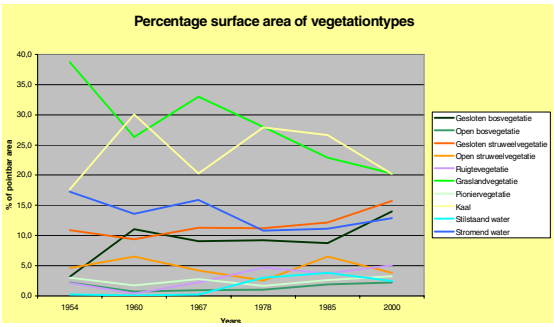

Figure 5. Percentage coverage of vegetation types of all the researched years.

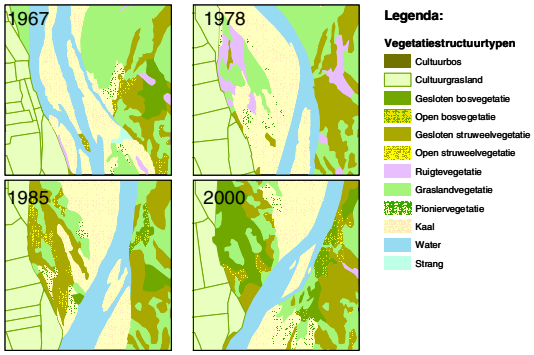

Figure 4. Detail of map sequence showing the development of one point bar.

stable for long, although one will always find pioneer stages, full grown softwood forests or closed side channels on the river stretch scale. In the ideal situation, the overall vegetation composition (and hydraulic resistance) is constant or fluctuating between upper and lower boundaries, although it might be irregularly fluctuating on the floodplain scale. As a consequence, the scale on which management by rejuvenation will work is that of a river stretch because only then enough natural elements are present for a dynamic, stable and ecologically rich system.

Future research

The results presented here are preliminary. To obtain satisfying answers to the raised questions the data will be further analysed. An article will be prepared in spring 2004.

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Note

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