

Flood Risk Management – Flood Prevention by Land Consolidation in the Rhine Catchment Area

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Key words: flood protection, land consolidation, nature conservation, risk management, spatial planning

SUMMARY

Over the past years, the rising waters of the river Rhine had a major impact on the daily lives of hundreds of thousands of people living along the bank. In consequence of the great damage caused by the flooding, there is a need of sustainable water management and the implementation of new strategies in flood risk management. In areas where land is heavily used, water will have to fit into the existing use of space and be combined with housing, recreation, landscape and nature conservation.

The article describes a couple of strategies and measures for flood protection and flood management in the catchment area of the river Rhine, mostly large-scale national model projects that innovatively combine creating new space for water with housing, working environments, recreational facilities, the landscape and nature conservation areas.

In this paper, the focal point of the considerations consists in the demonstration of good examples of spatial planning and flood prevention measures for damage and risk reduction such as

- Increasing the retention capacity by relocating existing dikes (dike relocation plans)
- Implementation of regional planning and urban development, agriculture and nature conservation measures to increase water storage capacity and to slow down the run-off peaks during high water periods
- Restoring the tributaries of the Rhine
- Land consolidation as a part of flood risk management
- Examples of conversion of the land to a conforming use

The two described measures at the river Rhine lead to an ideal combination of flood protection and better spatial quality (extensive farming practices, nature and landscape conservation and recreation). Hopefully, they will set an example to the implementation of flood protection measures all over the world.

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1. INTRODUCTION

Over the past years, Europe has suffered over 100 major damaging floods, including the catastrophic floods along the Rhine River in 1993 and 1995 and along the Danube and Elbe rivers in 2002. The assets at risk of the natural phenomena can be enormous. For example, more than 10 million people live in the areas at risk of extreme floods along the Rhine, and the potential damage from floods amounts to € 165 billion. The root causes of floods (rainfall and sea levels) are uncontrollable, but however, the course of the flood is very much influenced by human actions such as the clearing of forests in the upper catchment area, straightening of rivers and suppression of natural flood plains and most importantly, extensive building in high risk flood-prone areas. Flood risk management including the standard elements *prevention, protection, preparedness, emergency response* and *recovery* aims to reduce the likelihood and/or the impact of floods (Kötter 2004).

The article ought to give an overview about rural development by land consolidation in Germany, which is used as an efficient instrument implementing different long term flood prevention measures.

Traditionally, the purpose of realigning agricultural land holdings is to promote efficient agriculture and forestry by assembling economically viable units of land in rural areas. The consolidation process includes all the measures needed to improve the basic conditions for economic operations, to reduce unnecessary labor and to facilitate economic activity. Over the years, the original purpose of realigning agricultural land holdings has been reappraised and modified. Land consolidation, today seen as an integral means of reordering plot boundaries in rural areas, has effects on planning and on the general concept of land reallocation which extend well beyond the agricultural sector. Nowadays land consolidation may be undertaken for purposes of landscape conservation and nature protection, village-renewal projects and – as already mentioned - flood protection (Magel 2001).

2. FLOOD PROTECTION BY LAND CONSOLIDATION

In Europe exist a lot of different spatial planning instruments for preventive flood management. Especially in Germany – as a consequence of the enormous economic damage of recent floods – various legislative regulations, instruments, strategies and measures have improved the general conditions for flood protection and flood management (Friesecke 2004).

Land consolidation (“*Flurbereinigung*”) can be an effective instrument in rural development for preventative risk reduction by spatial planning. On the one hand, it can facilitate the creation of competitive agricultural production arrangements by enabling farmers to have farms with fewer parcels that are larger and better shaped, and to expand the size of their holdings. But, on the other hand, because of the growing importance of flood protection, land consolidation has become an increasingly important instrument in increasing water storage capacity, redeveloping flood plains and renaturalizing of rivers.



Figure 1: Hellinghauser Mersch: Example of flooding in North Rhine-Westphalia
(Source: <http://www.abu-naturschutz.de/projekte/naturent/b25.jpg>)

2.1 Concept of Land Consolidation in Germany

Rural development by land consolidation is used in several countries worldwide, especially in Europe. There are differences in the objectives and procedures of land consolidation depending on the country, as the development of the procedure has been influenced by the historical trends, culture, tradition and legislation of the countries (Vitikainen 2004).

Land Consolidation in sense of the German **Land Consolidation Act (LCA)** is a procedure with view to improving the production and working conditions in agriculture and forestry as well as promoting the general use and development of land and rural areas by re-arrangement of agricultural land (FlurbG 2001).

Thus, land consolidation contents on the one hand land re-adjustment measures, but goes beyond concerning its programmatic objectives; land consolidation is a mix of agrarian special planning and land re-adjustment (Thomas 2004).

The German Land Consolidation Act distinguishes between different procedures, which will be specified consecutively.

Comprehensive Land Consolidation Procedure (Sections 1-37, LCA)

The so-called “*Regelflurbereinigung*” has the most far-reaching planning approach and will be implemented for an “integrated rural development”. By this type of procedure holdings can be re-arranged in view of improving the production and working conditions in agriculture and forestry as well as promoting the general use and development of land (cf. Section 1). The land consolidation area, which may cover one or more communities or parts thereof, will be reshaped with due regard for respective structure of the landscape to serve the interests of the parties concerned as weighted against each other to further general use and development of land and to benefit the general public. The area in question shall be rearranged and scattered or uneconomically shaped parcels shall be consolidated to meet modern managerial requirements, and reshaped to obtain units of a more favorable location, shape and size. Ways, roads, water bodies and other common facilities shall be provided, soil conservation, soil improvisation and landscape measures can be taken as well as any other measures improving the basic conditions of the farming enterprises, reducing the amount of work and facilitating farm management.

A comprehensive land consolidation represents a long-term solution to agrarian structures.

Simplified Land Consolidation Procedure (Section 86, LCA)

On the basis of the German Land Consolidation Act measures can be implemented to eliminate or to minimize the detrimental impacts on the agricultural structure caused by public request to land use. Classic examples are transport planning, communal land use planning, water management planning or planning concerning nature protection, flood protection and landscape. Because of numerous simplifications (e.g. omission of a road and water resources plan with accompanying landscape conservation plan) the Simplified Land Consolidation Procedure (“*Vereinfachtes Flurbereinigungsverfahren*”) represents an efficient instrument to resolve conflicting interests concerning the use of land rapidly and effectively.

Land Consolidation Procedure in Case of Permissible Compulsory Acquisition (Section 87, LCA)

If, for special reasons, it is permissible to acquire land by compulsory purchase and if such a measure would affect agricultural land on a large scale, the authority responsible for the compulsory acquisition may apply for the initiation of a land consolidation procedure, if the loss of land to be incurred by the parties concerned is to be apportioned among a large number of owners or if disadvantages that the project may bring about for the general use of the land are to be avoided. The so-called “*Unternehmensflurbereinigung*” can be initiated to acquire land for huge civil works such as motorways, railway and navigation lines, dams etc.. Weiß (1991) accurately points out in his article several possibilities of Section 87 procedures, including some historical and legal aspects.

Furthermore, there exist two more procedures, by name

- **the Accelerated Land Consolidation Procedure** (“*Beschleunigtes Zusammenlegungsverfahren*”), Section 91 LCA and
- **the Voluntary Land Exchange** (“*Freiwilliger Landtausch*”), Section 103a LCA, which will not be mentioned in the following examples (see chapter 3).

Concerning the different types of procedures in Germany the Comprehensive Land Consolidation is of major importance, closely followed by the Simplified Land Consolidation. The

Comprehensive Land Consolidation Procedure tends to decline, the Simplified Land Consolidation Procedure tends to increase. In sum both procedure types are about constant (Thomas 2004).

2.2 Flood Prevention Measures

Land consolidation can be regarded as an efficient instrument to implement flood prevention measures. In former times, as already pointed out, the main objectives of traditional land consolidation were

- improving the land division and promoting the appropriate use of real estates,
- improving the working and production conditions in agriculture and forestry and
- promoting the general use and development of land.

Today, land consolidation is often used to realize the following goals:

- Rural development, measures concerning the renewal of rural settlements;
- Creation of new and improvement of existing physical rural infrastructure such as roads, railway lines, hedges, biotopes etc.;
- Environmental protection, nature protection and landscape conservation projects.

In reference to flood risk management, efficient and long-term land consolidation combines water management, regional planning and rural development, agriculture and nature conservation measures in an interdisciplinary concept. Concerning flood prevention, the “new” objectives are

Land Consolidation as a Tool of Flood Risk Prevention
Increase of water storage capacity
Relocation of dikes
Redevelopment of flood plains
Renaturalization of rivers, restoration of small streams
Restriction or limitation of sealed surfaces
Change of land utilisation
Restoration and creation of additional retention area to cause a diminution of the high water levels

Table 1: Fields of action for preventative flood management by land consolidation

There is a growing realization that the mentioned flood mitigation measures must be combined in an integrated approach to flood disaster management. A balance between structural and non-structural measures to manage floods is required, where the main focus is shifting from large structural solutions to non-structural approaches such as avoiding or stopping building development in flood plains (Berendt 2004). Chapter 3 gives some examples of land consolidation projects.

2.3 Geodetic Fields of Application

Concerning the process of land consolidation, the field of application of a Surveyor is manifold. The Surveyor as an engineer, land manager, urban (in this case: rural) planner, evaluator and expert in Geographic Information Systems can account radically for the success in integrated rural development. The varied areas of activities and responsibilities assumed by a surveyor are summarized in the following table.

Contribution of a Surveyor concerning the Land Consolidation Process
Surveying, Photogrammetry and Remote Sensing (land registry office, land survey office, publicly appointed surveyor, photogrammetric operator)
<ul style="list-style-type: none"> ▪ Establishment of fixed boundary marks along the perimeter of the land consolidation area
<ul style="list-style-type: none"> ▪ Photo flight of the land consolidation area including (automated) interpretation of the imagery data
<ul style="list-style-type: none"> ▪ Determination of new property boundaries (renewal of cadastre) with <ul style="list-style-type: none"> ⇒ Tacheometry ⇒ GPS Technology, SAPOS (= <i>German National Satellite Positioning Service</i>)
<ul style="list-style-type: none"> ▪ Drawing of new cadastral maps, drawing up of planning material for the drawing up of Land Consolidation Plans/ Road and Water Resources Plans
<ul style="list-style-type: none"> ▪ Establishment of digital stereo photogrammetry (geometric fixation and coordination of the boundary lines of the common and public facilities by a digital stereo model)
<ul style="list-style-type: none"> ▪ Updating of the public records (updating of the land register/ cadastral land register)
Data Processing/GIS (Surveyor as an expert in geoinformatics)
<ul style="list-style-type: none"> ▪ Creation and installation of Geographic Information System(s) – GIS <ul style="list-style-type: none"> ⇒ input, store, retrieve, manipulate, analyze and output geographically referenced data or geospatial data
<ul style="list-style-type: none"> ▪ Digitalization of land register maps
<ul style="list-style-type: none"> ▪ Editing geodata adapted for the use as geoinformation data for specialized users
Rural Planning/Land Development (Surveyor as rural planners and land managers; consolidation authority; engineering consultants)
<ul style="list-style-type: none"> ▪ Moderation/mediation: instruction of the parties concerned, informing bodies representing public interests
<ul style="list-style-type: none"> ▪ Reshaping the land consolidation area (in consideration of the requirements of spatial planning at Federal/land level and of controlled rural development)
<ul style="list-style-type: none"> ▪ Development of the land consolidation plan
<ul style="list-style-type: none"> ▪ Determination of the compulsory land compensation

Table 2: The role of a Surveyor in the land consolidation process (selection)

Especially GIS, GPS and the digital data transfer can make an important contribution to simplify and to shorten the land consolidation procedure. It is safe to say that the share of Surveyors during this process results in a more cost-effective land consolidation!

3. EXAMPLES OF LAND CONSOLIDATION PROJECTS

3.1 Dike Relocation: Project “Bislicher Insel”

In conformity with the International Commission for the Protection of the Rhine (ICPR) and based on the general concept of the Rhine in North Rhine-Westphalia (flood protection, ecology and navigation) as well as on the General Plan of Flood Protection at the Lower Rhine, feasibility studies concerning the ecological creation and restoration of retention areas are executed in eleven selected investigation areas. One of these investigation areas is the retention area of the Bislicher Insel. The area is located along a bend of the Old Rhine between Xanten and Wesel. When the course of the Rhine was straightened in 1788, this area became an island between the old and new branches of the river. The old branch has silted up, so that today Bislicher Insel is only surrounded by water during high water periods. In order to enhance the flood protection in the region of the Bislicher Insel, a dike has been relocated to enlarge the retention area. The dike shall be restored and relocated on a length of 6 km by a **Land Consolidation Procedure in Case of Permissible Compulsory Acquisition** (Merten 2003).

Land Consolidation “Bislicher Insel”	
Type of Land Consolidation Procedure	Section 87 LCA
Size of Land Consolidation Area	710 hectares
Land Consolidation Decision	1999
Valuation Procedure	1999 - 2001
Surveying; Photo flight of the land consolidation area	2001
Provisional Transfer of Possession	15.9.2003
Parties Concerned	130

Table 4: General Survey of the Land Consolidation “Bislicher Insel”

Figure 4 shows the land consolidation area which covers parts of the cadastral districts Birten (town of Xanten) and Buederich (town of Wesel).



Figure 4: Land consolidation area “Bislicher Insel”

The land consolidation procedure will result in substantial changes in land tenure arrangements and these actions are executed under the leadership of the *Bezirksregierung Düsseldorf* (higher consolidation authority) and the *Amt für Agrarordnung Mönchengladbach* (consolidation authority).

Figure 5 indicates the allocation of the old parcels, whereas figure 6 shows the new layout of the fields. In figure 6, the land consolidation area is rearranged and the uneconomically shaped parcels are consolidated to obtain units of a more favourable location, shape and size. The new relocated dike is marked in green colour. Furthermore, a series of far-reaching measures are taken, for example the removal of a number of farms.

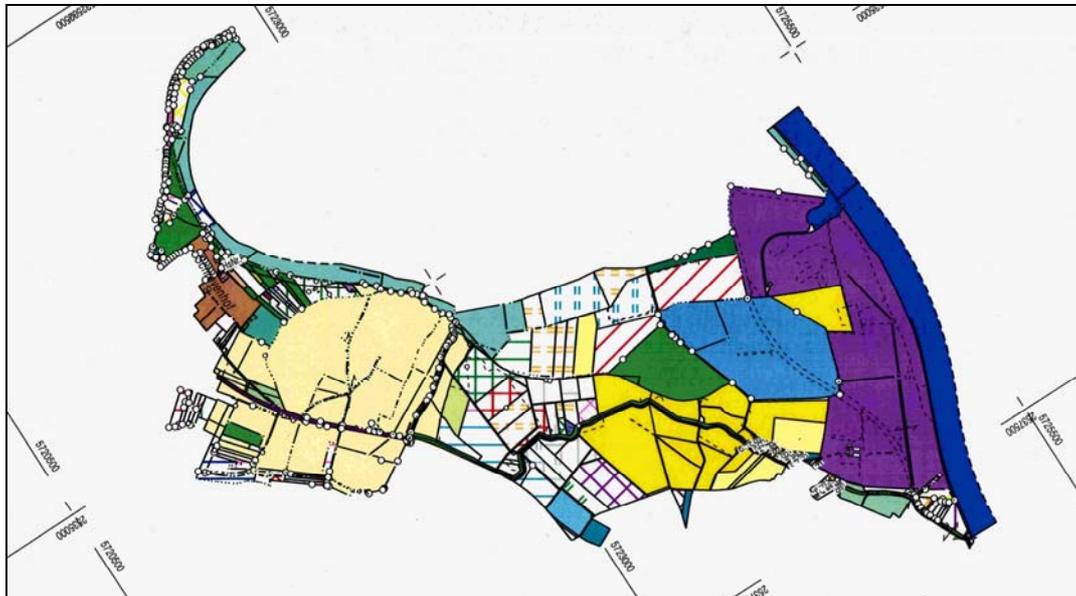


Figure 5: map of old parcels (“*Besitzstandskarte Altbestand*”)

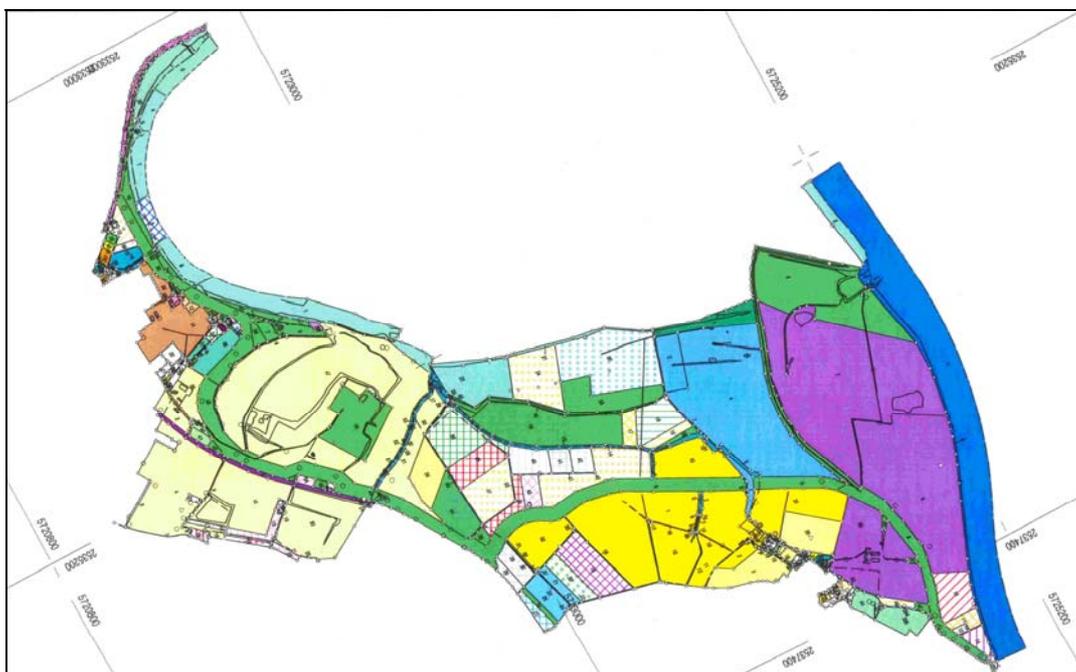


Figure 6: map of new lots (“*Besitzstandskarte Neubestand*”)

3.2 Technical Flood Protection Measures

During the flood emergencies of 1993 and 1995, the existing dikes along the Bislicher Insel looked set to collapse. The situation reached crisis point in an area which has more than 13.000 inhabitants and a great deal of livestock. Because of that critical situation, broadening the course of the River Rhine was the priority objective. The Rhine was given more space at Bislicher Insel by relocating a dike and constructing a new dike (length: 6.1 km; width: 65 m; elevation: 7.5 m). In case of flooding, the river will now have 1.100 hectares of extra over-flow area with a retention capacity of 50 million m³. This way the local and downstream water levels in the Rhine are reduced by several decimeters and the effects in high water periods will be experienced all the way to the Dutch border.

One major interest while drawing up the dike relocation plan/land consolidation plan and designs for the foreland was to ensure integration with other functions. A range of different alternatives was compared systematically, leading to an ideal combination of flood protection and improvement of spatial quality (shipping, farming practices, nature and landscape conservation).

3.3 Renaturation of the River Lippe: Project “Hellinghauser Mersch”

The stream known as the Lippe is a tributary stream of the Rhine. The Lippe has its source in Bad Lippspringe and takes course from the East to the West through North Rhine-Westphalia on its way to the Rhine. Its length is about 255 km. Whereas the upper reaches of the river pass through rural areas, the lower reaches flow through a more urban area on the edge of the Ruhr Basin.

The challenge of the project “Hellinghauser Mersch”, an eight kilometres stretch of the river Lippe, is to combine river restoration and river revitalization with flood protection. The following objectives for an effective flood risk management are intended to improve the ecological situation of the river Lippe:

- Preserving existing floodplains,
- creating new floodplains and
- improving existing flood protection measures from an ecological point of view.

Since March 1990, several stakeholders deal with **ecologically orientated flood protection** in the context of the “*Gewässerauenprogramm*” (program for the improvement of floodplains in North-Rhine Westphalia).



Figure 2: Hellinghauser Mersch (Source: Helle, R.)

To achieve the defined objectives, a **Simplified Land Consolidation Procedure** (Section 86, LCA) on the basis of the German Land Consolidation Act was implemented. In this case, all activities are coordinated by two statutory corporations, namely the *Staatliches Umweltamt Lippstadt* and the *Lippeverband*. Table 3 gives a survey of the most important steps of the land consolidation process.

Land Consolidation “Hellinghauser Mersch”	
Type of Land Consolidation Procedure	Section 86 LCA
Size of Land Consolidation Area	986 hectares
Land Consolidation Decision	1992
Drawing up of Land Consolidation Plan	01.06.1996 – 31.10.1996
Provisional Transfer of Possession	01.04.1997
Updating Public Records	10.11.1999
Parties Concerned	108

Table 3: Land Consolidation “Hellinghauser Mersch” at a glance

In 1991, a long time before public works were planned, the *Staatliches Umweltamt Lippstadt* charged the *Amt für Agrarordnung* to acquire land in the context of several procedures pursuant to the Land Consolidation Act. Until today it has been possible to obtain about 290 hectares of arable land and grassland for the project. Some of these parcels were for sale. The major part (about 75 percent) was received in exchange (Witte 1999; Helle 2004).

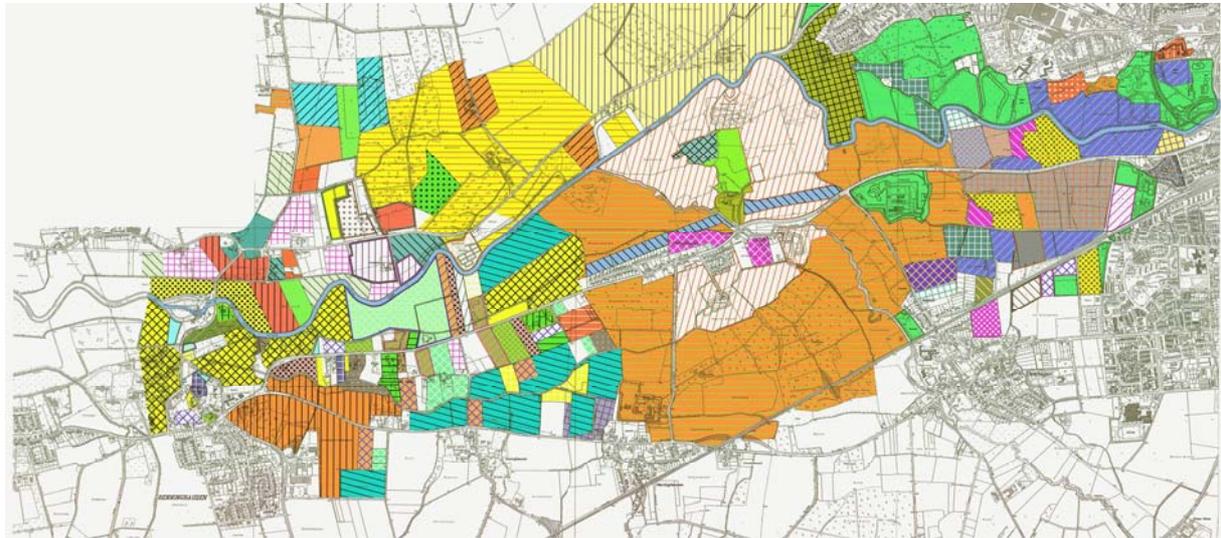


Figure 3: Land tenure structure before land consolidation process (Source: AfAO Soest)

Meanwhile the *Staatliches Umweltamt Lippstadt*, as project executing organisation, has completed the first objectives in the context of ecological and sustainable flood protection:

- Renaturation of the Lippe, meandering of the stream
- Unsealing measures
- Safeguard against the natural diversity of the native fauna and flora
- Activation of retention areas in the floodplains

The land consolidation procedure makes it possible to solve land use conflicts, to make required land available and to secure the result permanently. With the help of these procedures, which closely involve the landowners and the planning authorities, large-scale projects, for example to provide areas for water retention, can be implemented. Since agricultural policy holds a key role in this task, it is important to include farmers in the solution of the problems at an early stage.

Furthermore, the goal of the project “Hellinghauser Mersch” is to coordinate all relevant areas, including flood prevention, water protection, environmental and landscape protection, forestry and agriculture.

4 CONCLUSIONS

Rivers do not stop at property or municipal boundaries. Concerning the field of disaster risk management, the article describes the implementation of different (precautionary) flood prevention strategies and measures by land consolidation projects in the catchment area of the Rhine River. Land consolidation can be used as a highly effective instrument in rural development to contribute to achieving the following goals:

- Improving the competitiveness of agriculture and forestry by means of support for restructuring;
- improving the environment and the countryside by means of support for land management and
- improving the quality of life in rural areas.

The measures explained in chapter 3 provide some principles used in current approaches to flood protection by land consolidation. While in the land consolidation procedure “Bislicher Insel” the focal point lies in technical flood protection measures, the project “Hellinghauser Mersch” explains a more ecologically orientated flood prevention strategy. Because of his special interdisciplinary characteristics, especially the surveyor can contribute extremely to the success of a land consolidation procedure.

As visualized in the examples, the land consolidation procedure always must recognize the *need for diverse local solutions*. Land consolidation must take into account local agricultural, economic, social and environmental characteristics, and must be based upon expectations and needs of the local rural population. Consolidation projects in forested areas will be quite different from those on agricultural plains. The influences of environment and culture, along with financial constraints and other limitations, will make a range of different consolidation approaches necessary.

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