

INTEGRATION OF FLOOD RISK INFORMATION INTO LAND USE PLANNING IN NORWAY

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SUMMARY

A major flood affecting large parts of the south of Norway in 1995 represented a watershed in Norwegian flood risk management. Previous to 1995 flood risk and hazard management consisted basically of planning and building physical flood protection works. After 1995 emphasis was placed on a more integrated approach to reducing damage by floods, including flood hazard mapping and spatial planning. A guideline for land use planning in areas at risk from a hazard related to rivers were issued in 1999 and revised in 2007. A flood hazard mapping programme was initiated in 1998 and is finalised in 2007. After more than 10 years using this approach we have experience that flood hazard mapping paired with good spatial planning procedures has significant impact on reducing new development in areas with a risk of flooding. This paper describes the guideline and flood hazard mapping programme and gives some examples of how they have been used in practice.

Keywords: flood management, land use planning, flood hazard mapping

INTRODUCTION

Norway has a long tradition in managing floods due to its wet climate, many rivers and mountainous terrain. The hydrological regime in Norway is influenced by the northern position of the country with long winters having low runoff and snowfall accumulation and high spring flows due to snowmelt. High autumn and winter flows are also experienced in the milder coastal climate in the west of the country. Runoff times are generally short due to small catchments and shallow soils. Many rivers in Norway have steep and short courses and the topography is in many parts, similar to that of the Alpine region in Central Europe. Problems associated with erosion, sediment transport and deposition are therefore also of major concern in damage mitigation along rivers. There is also risk of severe accidents caused by quick clay slides in Norway. The country is sparsely populated, in average 14 people per km². The population in the inland is usually concentrated along the valley floors. Good farmland was found on the flood plains and formed the basis for early settlement. Further development and infrastructure such as roads and railways consequently follow the valley floor, and are subject to flooding. Until 1995 flood risk management was very much dominated by traditional physical flood protection works such as flood levees and erosion protection consisting of stone rip rap. In fact much of the know-how on construction and engineering in Norway was actually obtained from the river engineering communities in Austria and Southern Germany. The major actor at the national level dealing with flood risk management, The Norwegian Water Resources and Energy Directorate (NVE), dates back to 1804.

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Norway experienced a major flood in the south-eastern part of the country in 1995. The total economic damage caused by the flood was approx. 230 mill Euros and 7000 people were evacuated. A Commission on Flood Protection Measures was established by Royal Decree after the flood. The Commission produced an Official Norwegian Report (NOU 1996:16) and the report was followed up by a government White Paper (nr 42 1996-1997 – Measures against floods). The White Paper is regarded as a national action plan for Norway on measures against floods.

A central message in the Commissions work was that an integrated approach is necessary in planning and carrying out flood protection measures and that the *'most important measure to reduce flood damage in the future is to improve land use planning in flood prone areas'*. The report and White Paper led to several improvements in flood risk management. The flood forecasting system was continued and strengthened and extra funding for physical protection works was provided. Most importantly however was that a flood hazard mapping programme was initiated and a guideline for land use planning in flood risk areas was issued. Six new positions as land use planners were provided to strengthen NVEs role as the national authority responsible for ensuring acceptable land use in areas with a risk of flood damage.

NVE also runs a national flood warning service, is responsible for the licensing of watercourse regulation schemes and is the national authority for dam safety.

GUIDELINE FOR LAND USE PLANNING IN HAZARD AREAS RELATED TO RIVERS

According to the national Planning and Building Act (PBA) the local municipalities are responsible for taking natural hazards into account in land use planning, and could be liable if damage occurs. NVE is a directorate under the Ministry of Petroleum and Energy with responsibility for the management of the nation's water and energy resources, and play many roles in relation to flood risk management. NVE provides advice to the municipalities, but according to the Planning and Building Act, NVE may also object to land use plans if national interests or regulations are not followed. The Ministry of Environment has the final say if agreement is not reached between the municipality and NVE.

The Planning and Building Act states that development is not allowed, unless safety is at an ***"acceptable level"***. NVE has developed a national guideline defining acceptable safety levels with respect to floods and other hazards related to rivers. The safety levels are differentiated related to hazard type and type of asset.

The first guideline for land use planning in flood hazard areas was issued in 1999. It was revised in 2006/2007. The main philosophy behind the first guideline was to quantify and define acceptable hazard levels for different types of assets. This was generally well received and did clarify to local authorities what were acceptable levels of risk for different assets. The guideline focused however rather unilaterally on building types. It did not capture planning objectives according to the Planning and Building Act and there was a need for more clarification as to how the guideline could be implemented in land use planning processes. A further reason for revising the guideline was to include the risk of quick clay slides and include advice as how to proceed in areas with a potential risk, i.e. were hazard information is not readily available. Quick clay slides are closely associated with river erosion and areas at risk of such landslides have been mapped since 2000. More information on the programme is available in Endre et al. (2004).

A main aim has been to develop a stepwise procedure for identifying potentially hazardous areas so as to prevent planning development in hazard areas at an early stage in the planning process. This reduces the need for protection that is often costly and will require maintenance. Furthermore protected hazard areas will always have a residual risk despite protection. If development can be avoided in areas with a potential for flooding, this is always a preferred option to physical protection. Besides cost and residual risk a further reason for this is the environmental aspect. Good hazard management in areas close to rivers coincides closely with good environmental management of such areas. Revision of the guideline was part of the Interreg project FLOWS (www.flows.nu) and a description of these in English is given in Berg et al. (2006).

The revised guideline defines safety levels in areas at risk of different hazards connected to rivers such as flooding, ice flows, debris flows and quick clay slides. These are, similar, to the first guideline, differentiated according to the function of the building. Table 1 and table 2 show the safety classes related to floods and debris flows respectively.

Tab. 1: Acceptable safety levels related to floods.

Safety class	Type of asset	Return period
		<i>Flooding, erosion, ice flow</i>
F 1	Small garages, boathouses, sheds	1/20
F 2	Houses, cabins, industry, offices, important infrastructure	1/200
F 3	Hospital, emergency institutions, critical infrastructure	< 1/1000

Tab. 2: Acceptable safety levels related to debris flows and land slides

Safety class	Type of asset	Return period
		Debris flow/ land slides
S 1	Garages, boathouses	1/100
S 2	Small domestic buildings, cabins,	1/1000
S 3	Other buildings	< 1/1000

NVE expects the municipalities to assess the flood risk as part of the land use planning process. Based on a Provision from 2006 on Environment Impact Assessment (EIA), the revised NVE guideline of 2007 aims at clarifying what this includes related to the different planning levels.

The planning process in a municipality is typically split into three levels:

1. Municipal plan - giving principal strategies for land use within the municipality,
2. Zoning plans - where specific areas are zoned for different land use with detailed regulations
3. Building case - where the processing of building application is done.

A stepwise procedure for assessing the hazards has been designed to fit with these levels. The following procedure is now recommended:

- Municipal plan: potential hazard should be identified
- Zoning plan: the actual hazard should be described and risk quantified
- Building case: a satisfactory level of safety must be documented

This procedure ensures that areas with a potential hazard are identified at an early stage. This will give municipalities more reliable and predictable land use plans. Previous experience has been that the flood hazard has been identified at a very late stage in the planning process, when other principal strategies for structural development have been decided upon. The only practical way of tackling the hazard is then often to go ahead with development and include structural protection of some sort.

The revised guideline also offers detailed technical instructions for assessing the risk of flooding and the same for assessing the risk of quick clay landslides.

Tab. 3: Implications for development under design flood level, as function of flow velocity and flood depth

Hazard categories	Implications for development
High hazard: Depth > 1.5m or velocity * depth >1.5 (m ³ /s)	No development accepted
Low hazard: Depth < 1.5m or velocity * depth <1.5 (m ³ /s)	Development could be accepted provided protection measures will prevent damage to property and people. Damage to small garages etc., can be accepted provided the annual probability of damage is less than < 1/20

If development is allowed below the design flood level, protective measures must be put in place. This could be levees or special design of the building to prevent damage. A new feature in the revised guideline is a proposal on limiting the possibility of development below design flood level, based on the hazards connected to flow velocity and flood depth. This is inspired by similar restrictions from other countries, and still undergoing evaluation. Similar restrictions would apply behind levees. Table 3 shows the proposal as of February 2007.

FLOOD HAZARD MAPPING

As part of the effort to improve land use planning and as an aid to local authorities a flood hazard mapping programme was started in 1998.

A total of 134 areas covering approximately 1100 km of river length will be mapped by the end of the programme in 2007. The maps are provided digitally to enable users to make their own presentations in combination with other land use and hazard information. The method includes flood frequency analysis, hydraulic simulation based on surveyed cross sections of the river bed, GIS analysis identifying inundated areas based on a digital elevation model with high resolution (5x5m) and vertical accuracy (+/- 30 cm). The maps are presented in a standard format (fig 1) and the modelling is performed for six different flood levels, the 10-, 20-, 50-, 100, 200- and 500- year floods.

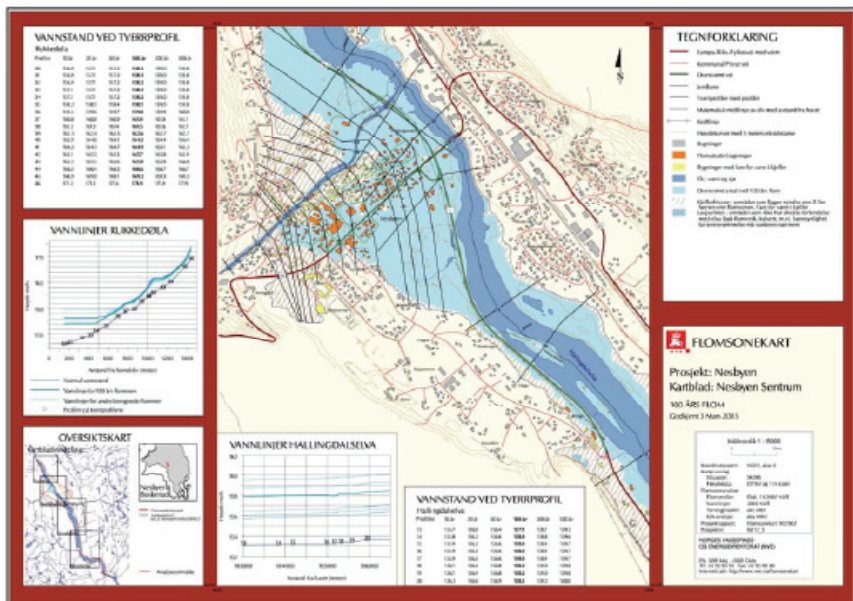


Fig. 1: Flood hazard map for the municipal centre of Nesbyen in the county of Buskerud in South Norway. The map shows the flooded area for a flood with a 100 year return period in the main river and tributary. The tables and graphs give the water levels for floods with different return periods.

The main target groups are municipalities and county officials, who are responsible for land use planning and emergency planning at local and county levels respectively. All maps are presented in meetings with the local authorities and often at meetings with the general public present as well. The press are usually present at such meetings and they are important in increasing the awareness of flood risk among the public. The maps are presented by a representative of the group that has produced the map and a land use planner from NVE. This is to ensure that the maps are to be understood and used as tools in land use planning.

The maps are a useful tool in contingency planning and are used actively in flood situations. During a major flood situation (50 year flood) in 2007 the maps were actively used to manage the situation and give advice to affected municipalities.

The flood hazard mapping programme is to be finalised by the end of 2007. Further reaches with a high flood risk have been identified and the mapping continues as part of a general effort mapping different hazards related to rivers. Included in this is mapping of potential hazard related to floods and debris flows.

EXPERIENCES

There are a number of municipalities that take into account the danger of flooding or other hazards connected to rivers using local knowledge of the situation. We also know that a number of land use plans that take into account results of flood hazard mapping or other hazard mapping produced by government agencies without contacting NVE beforehand. Obviously some of the information from NVE in the form of flood hazard maps has been unwelcome to municipalities and developers with economic interests in areas at danger of flooding. Not least when the maps are accompanied by the information that development within the area covered by a flood with a 200 year return period will not be allowed. In a number of cases NVE has had to use its right to contest land use plans that conflict with safety levels.

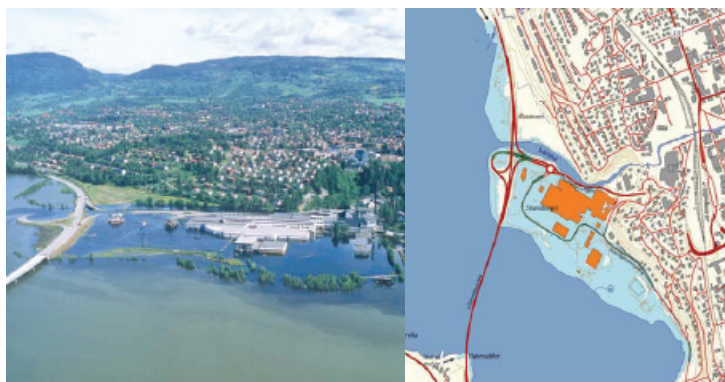


Fig. 2: The photo to the left shows the flooded area in Lillehammer in 1995 and the flood hazard map for the same area for a flood with a 100 year return period.

Contesting a plan however provides the legal basis for NVE to mediate with the municipality and try to find constructive solutions to development in affected areas. Our experience in contesting plans is that this gives us the opportunity to enter a good dialogue with the municipalities. We experience that this can lead to a shift in the attitude in the municipality dealing with the risks.

A good example of this is the municipality of Lillehammer lying at the outlet of the Laagen into Norway's largest lake, the Mjøsa in South East Norway. A small area of this municipality has a risk flood damage. Despite a large amount of flood damage during the 1995 flood (figure 3) the municipality still wanted to push through development in the hazard area. Only after the plans for development were contested by NVE was the municipality willing to revise the plans. We now have a good cooperation with this municipality on land use issues in the flood hazard area.

Other municipalities are fully aware of, and willing to deal with flood problems in their areas. The municipality of Åsnes also situated in South East Norway has a long history of flooding. The municipality has, in collaboration with NVE and other authorities, carried out a comprehensive project to show how the guidelines and flood hazard maps can be used in practical land use planning. They have carried out a comprehensive range of registrations for the planning process such as a depth map and registration of buildings of historical interest and potential pollutants in the flood hazard areas. They have pointed out the need to identify and put restrictions on land use in areas protected by flood levees in case of overtopping. There was previously not much awareness on the residual risk in areas that are protected by levees. The municipality has contributed to raising awareness on this issue. The planning project was part of the Interreg project FLOWS (Udnæseth et. al, 2006).

CONCLUSIONS

The response of local authorities has been positive to the guidelines and hazard maps although it is difficult to exactly measure the effect of measures on land use planning. In many cases these have prevented new development in flood hazard areas and led to restrictions on land use. In other cases it has led to flood protection of existing development where this has not been sufficiently safe.

There is a relatively strong focus on development on hazards in land use planning in today Norway. There has been a high concentration of hazardous events with a large amount of damage and in two cases loss of life over the past 3-4 years. Local municipalities became especially aware of their responsibilities as a planning authority after two landslides in the city of Bergen that both had a tragic outcome. In addition the media focus on climate change and effects of these have made the public more aware of natural hazards.

It is our impression that local authorities are becoming more aware and willing to take natural hazards into account both due to societal pressure and more information on such hazards. The revised guideline clarifies how to take natural hazards such as flooding and quick clay landslides into account in the planning process and several municipalities have already implemented these in their planning process. The stepwise approach will hopefully make it easier for local authorities to take this into account at an early stage.

We do however see a large challenge in dealing with further development in already built up

and protected hazard areas. Increasing the amount of vulnerable infrastructure increases the risk of damage and there is always a residual risk in hazard areas that have been protected physically. It is not always feasible to hinder further development in already developed. Rethinking traditional protection policies and finding alternatives to raising levees will be necessary in the future.

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