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Office of the Auditor General of Norway

The Office of the Auditor General's investigation into the efforts of the authorities to limit flood and landslide hazards

Document 3:4 (2009–2010)

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The Office of the Auditor General's investigation into the efforts of the authorities to limit flood and landslide hazards

Document 3:4 (2009–2010)

To the Storting

The Office of the Auditor General hereby submits Document 3:4 (2009–2010) *The Office of the Auditor General's investigation into the efforts of the authorities to limit flood and landslide hazards* .

The Office of the Auditor General, 15 April 2010

For the Board of Auditors General

Jørgen Kosmo
Auditor General

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The Ministry of Petroleum and Energy

The Office of the Auditor General's investigation into the efforts of the authorities to limit flood and landslide hazards

1 Introduction

Large parts of Norway are at risk of floods and landslides because of topographical and meteorological conditions. The hazards may increase as a result of more extreme weather caused by climate change. This will present challenges for the authorities in relation to limiting the risk of loss of human lives and other assets in the areas at risk.

In Recommendation no 244 to the Storting (1996–97) on Report no 42 to the Storting (1996–97) *Tiltak mot flom ("Measures against floods")*, the Standing Committee on Energy and the Environment emphasised the necessity of measures to protect assets and interests at risk from flooding. The Directorate of Water Resources and Energy (NVE) has national responsibility for limiting the risk of floods and landslides in watercourses, by, among other means, regulation, warning and mapping.

Since 1 January 2009, NVE, an agency under the Ministry of Petroleum and Energy, has had responsibility for landslides and has thereby also assumed overall responsibility for flood and landslide work. The Ministry of the Environment administers the planning part of the Planning and Building Act that regulates how the municipalities organise their work on land use.

The municipalities have been given responsibility for the utilisation of their own land in accordance with national guidelines and are responsible for protecting inhabitants against natural hazards pursuant to the Natural Damage Act and the Planning and Building Act. The municipalities require the help of the central government in the form of landslide expertise and resources for, among other things, mapping. County governors are responsible for checking that flood and landslide hazards are assessed in the municipalities' land use planning.

The goal of this investigation has been to assess the extent to which the Ministry of Petroleum and Energy and the Ministry of the Environment and their subordinate agencies adhere to the decisions and intentions of the Storting and national objectives for the prevention of flood and landslide hazards.

The investigation has been carried out on the basis of the following lines of inquiry:

- What mapping of flood and landslide hazards has been carried out, and how is it disseminated and used by the municipalities?
- How do the authorities at different levels ensure that national objectives in the field of floods and landslides are adequately followed up?

A draft report was presented to the Ministry of Petroleum and Energy and the Ministry of the Environment in a letter of 6 November 2009. The audit criteria had previously been submitted to the ministries. In a letter of response of 30 November 2009, the ministries commented on the report. The Ministry of the Environment generally agrees with the Office of the Auditor General's report and finds that it provides a comprehensive picture of the actual situation for the municipalities and the county governors with respect to the work on the prevention of floods and landslides. The ministries' other concrete comments have been incorporated in the report and in this document. The Office of the Auditor General's investigation report is enclosed as a printed appendix.

2 Methods used in the investigation

Data have been obtained from various sources in order to pursue the lines of inquiry. The investigation is based on map analyses, questionnaire surveys and interviews. A document analysis has also been conducted of key documents from the Norwegian parliament, the Storting. The investigation was carried out in the period from October 2008 to August 2009.

The document analysis of relevant Storting documents was carried out to identify the national goals set for the prevention of flood and landslide hazards. The allocation letters from the Ministry of Petroleum and Energy to NVE and NVE's annual reports from 2004 to 2008 have also been analysed. Relevant regulations, guidelines and instructions relating to the applicable acts have also been reviewed.

A map analysis, in which geographical information systems (GIS) were used, has been carried out to get an indication of the scope of the flood and landslide hazard in Norway. The Norwegian Geotechnical Institute (NGI) conducted the analysis on assignment for the Office of the Auditor General. The analysis covered flood inundation maps and quick clay maps from NVE and susceptibility maps for rockslides and snow avalanches from the Geological Survey of Norway (NGU).

The analysis consisted of three parts:
- A map survey to obtain an indication of how many buildings and inhabitants there are in the mapped hazard and susceptibility area. The hazard levels vary between the different maps. NVE's guidelines define the 200-year flood level as the recommended level for securing buildings.
- A time series data analyses was carried out to identify the development trend in the hazard and susceptibility areas before and after the municipalities were given access to the government mapping.
- In-depth surveys were carried out in eight municipalities in order to establish how they had used the maps.

Questionnaire surveys were sent to all the municipalities and county governors in Norway in order to establish how the municipalities handled their responsibility for the prevention of flood and landslide hazards. Sixty-two percent of the municipalities responded to the questionnaire survey. The response rate among municipalities that have received flood, quick clay or rockslide and avalanche maps was between 63 and 65 percent. All the county governors completed the questionnaire.

The Ministry of Petroleum and Energy and the Ministry of the Environment have been interviewed, as have NVE, NGU, the Directorate for Civil Protection and Emergency Planning (DSB) and one county governor. Eight municipalities have also been interviewed. They were selected on the basis of their flood or landslide risk and geographical distribution and size.

3 Summary of the investigation

3.1 Varying degree of national mapping and dissemination

Limiting flood and landslide hazards is contingent on the government authorities making the flood and landslide maps available to municipalities. Maps are important tools for the municipalities in planning land use, and will serve as the basis for further mapping of specific areas.

National mapping has been carried out of flood and quick clay hazards and susceptibility mapping of rockslide and snow avalanche hazards. The investigation revealed that almost 160,000 people live in areas that, at the end of 2008, were registered as being potentially at risk of floods and landslides.

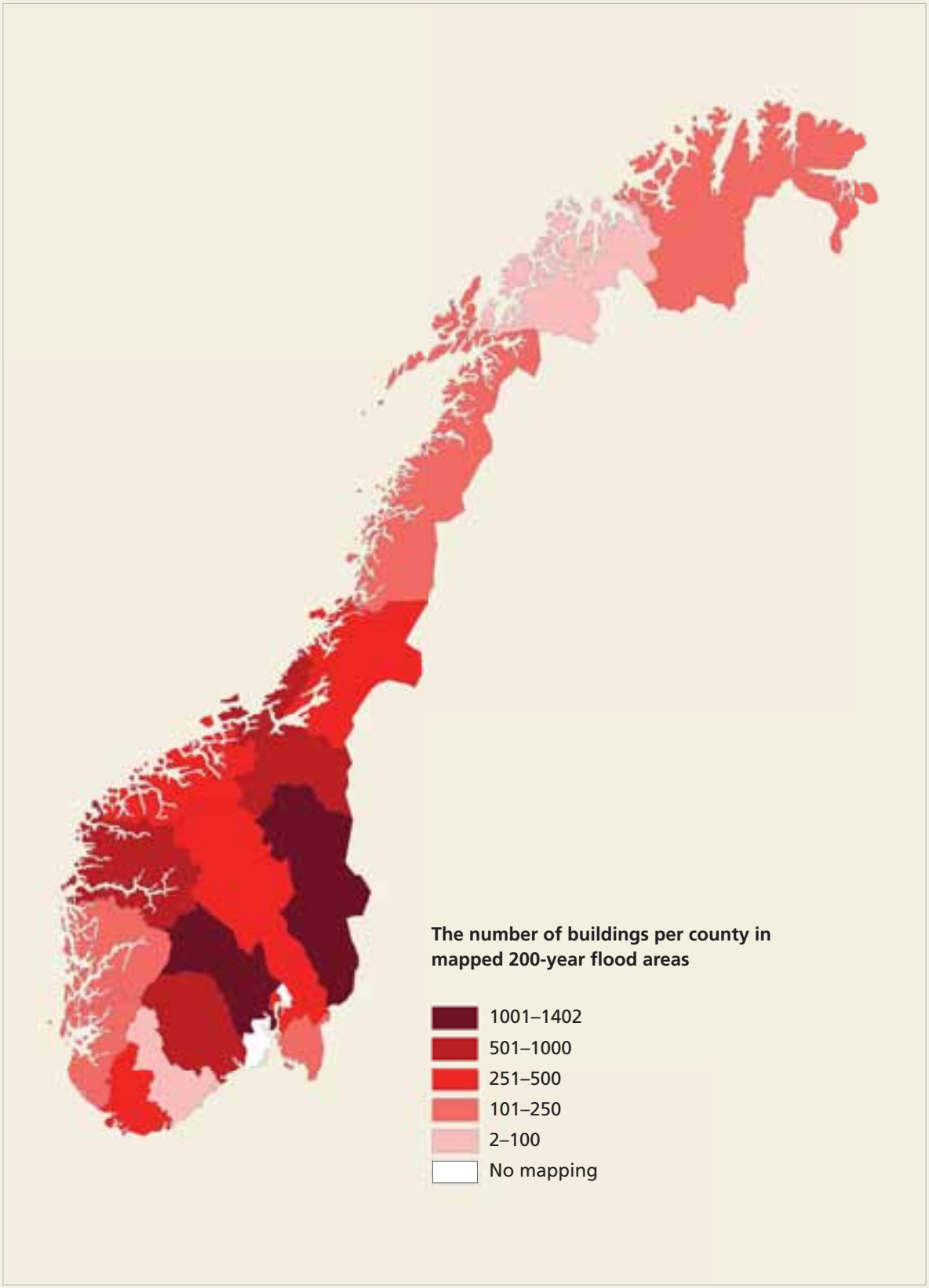
After the big flood in Eastern Norway in 1995, the government appointed a commission on flood protection measures. The commission proposed that a hazard map be drawn up of the watercourse areas in Norway with the greatest flood damage potential. The purpose of the map is, among other things, to give municipalities a better basis on which to limit the risk of flooding through land use planning. As of November 2008, 105 municipalities in 17 counties had received flood inundation maps. Flood inundation maps cover sections of river at risk of flooding with different return periods showing how often a flood of a certain scope will occur on average over a number of years. The mapping has been carried out in accordance with NVE's plans and is now part of the ordinary work of the new floods and landslides agency.

Map 1 provides an overview by county of the number of buildings in 200-year flood zones as of November 2008. The map shows that the highest number of buildings and inhabitants living in flood zones are found in the counties of Hedmark and Buskerud.

The map indicates that there are few buildings in mapped flood areas in the counties of Troms and Aust-Agder. Few sections of river have been mapped in these two counties. The map also shows that there has been no mapping in Oslo and Vestfold.

In its guidelines, NVE has stipulated specific safety levels that are to form the basis for various types of development in areas at risk. Most buildings (homes, holiday homes, agricultural buildings, industrial/commercial buildings/ offices, schools, hospitals, infrastructure etc.) shall be secured against a 200-year flood. The investigation shows that over 22,000 people live in areas that are registered as being at risk of a 200-year flood. There are 6,298 homes, 115

Map 1 The number of buildings per county within the area mapped for 200-year floods



Source: Norwegian Geotechnical Institute

schools, 34 hospitals, 380 holiday homes and 733 hotels in these areas.

Maps are also being drawn up of areas at risk of 500-year floods. The investigation shows that if you include all the buildings within areas mapped for 500-year floods, there are 10,255 buildings and more than 31,000 people living in these areas.

NVE has produced the flood inundation maps and has stated that the maps are handed over at meetings with the relevant municipalities. However, the investigation revealed that some municipalities were not aware of the maps' existence.

The investigation also shows that the municipalities and county governors – the users of the maps – have a positive attitude to the flood inundation maps. Several have said that more stretches of river and smaller watercourses need to be mapped.

Susceptibility maps have been produced for rock-slides and snow avalanches. The maps are not very detailed and are intended to serve as a basis for the municipalities to carry out further surveys. As of November 2008, 171 municipalities in 13 counties had received susceptibility maps covering all or parts of the municipality. Several government agencies have been responsible for drawing up the maps. From 2004 until the end of 2009, NGU was responsible for the mapping. On 1 January 2009, with NGU's assistance, NVE assumed overall government responsibility for landslide mapping.

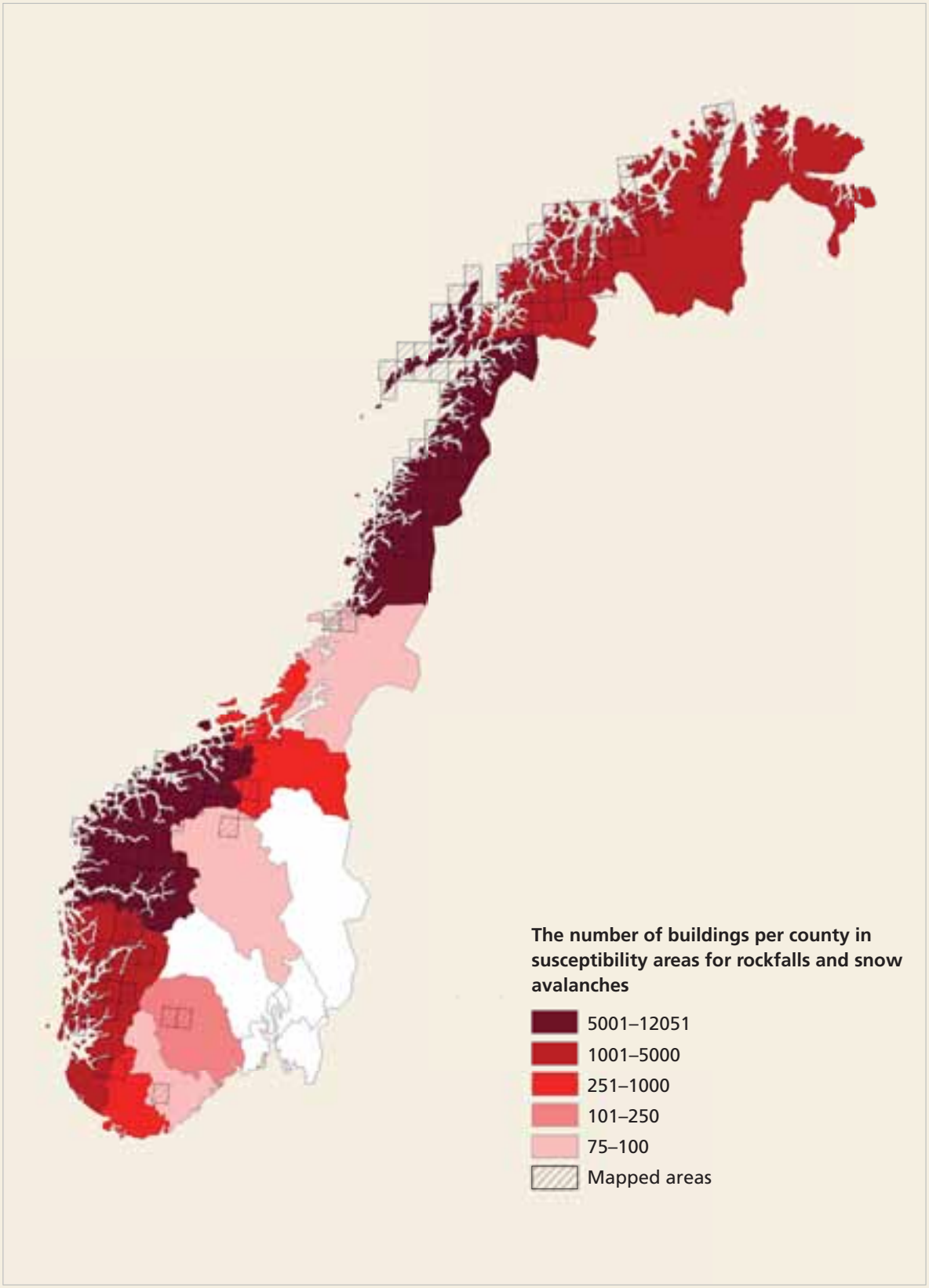
In map 2, the areas that have been mapped are shown as shaded squares. The map shows that there are most buildings in the susceptibility area in the counties of Møre og Romsdal, Sogn og Fjordane and Nordland. The investigation also shows that the highest numbers of people living in susceptibility areas are found in Møre og Romsdal and Sogn og Fjordane. Approximately 60 percent of people living in areas of Norway that are at risk of landslides live in these two counties.

The map also shows that few areas have been mapped in Aust-Agder, Vest-Agder, Telemark, Oppland and Nord-Trøndelag. This explains why so few buildings in these counties are in susceptibility areas. Nor have susceptibility maps been drawn up for Østfold, Akershus, Oslo, Hedmark, Buskerud and Vestfold.

The investigation shows that 24,058 homes are located in susceptibility areas, and that more than 72,000 people live there. In addition, there are 40 hospitals, 167 schools, 15,135 holiday homes and 1,358 hotels in these areas.

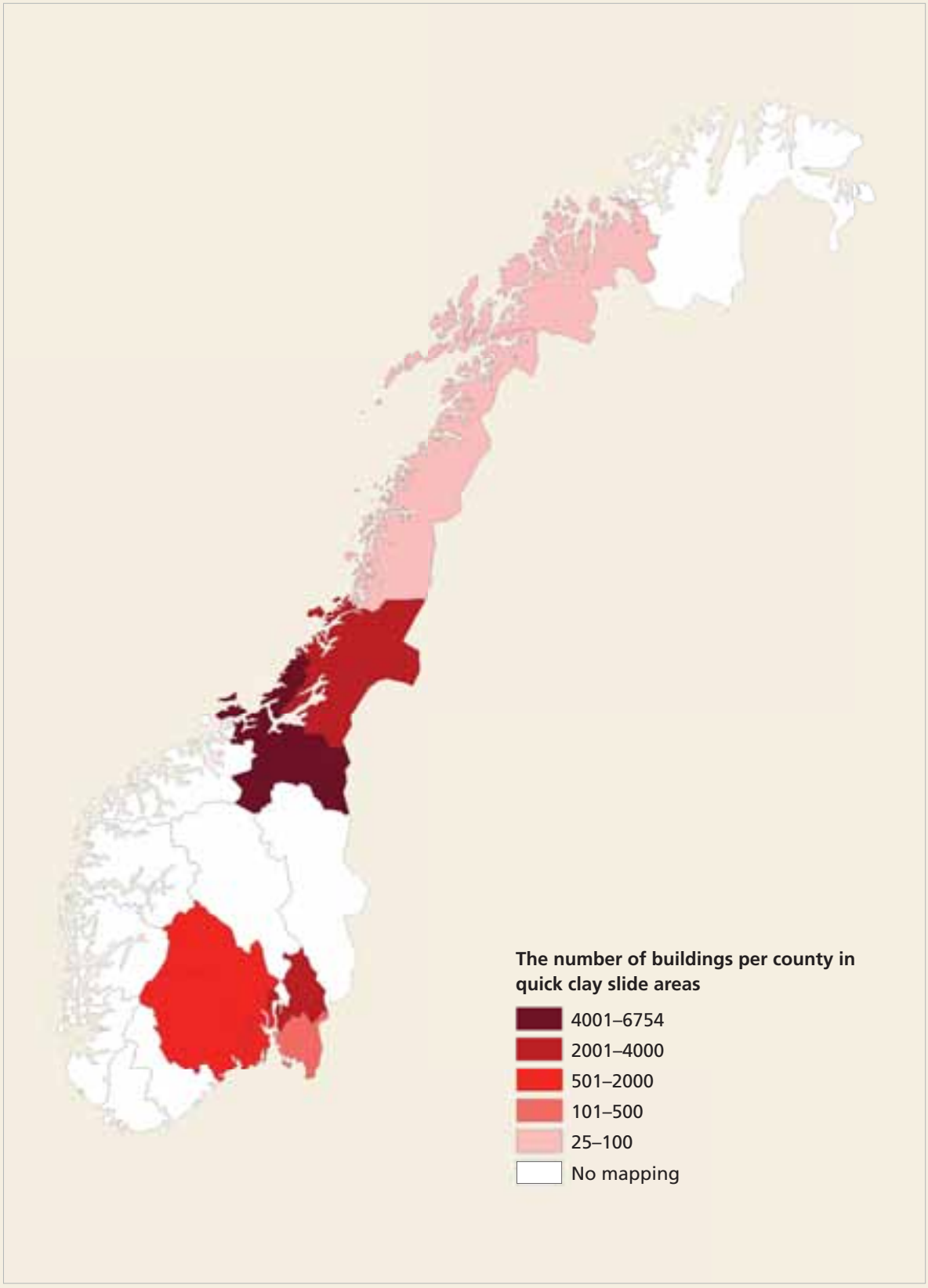
Snow avalanche in the western part of Norway, January 1993. Photo: Jon Eeg / NTB / SCANPIX

Map 2 The number of buildings per county in the susceptibility maps for rockslides and snow avalanches



Source: Norwegian Geotechnical Institute

Map 3 The number of buildings per county in hazard areas that have been mapped for quick clay slides



Source: Norwegian Geotechnical Institute

The maps were produced by several government agencies and have been available at www.skrednett.no since 2007. The municipalities were notified of this by e-mail. The investigation shows that 65 of the 109 municipalities with susceptibility maps for landslides and snow avalanches were unaware that such maps had been produced for them. The lack of awareness of the maps has meant that they have not been used in the municipalities' land use planning. Nor were a majority of county governors aware that the municipalities in their counties had received susceptibility maps. This makes it more difficult for county governors to follow up municipalities' landslide prevention work in an expedient manner.

As mentioned, the susceptibility maps are intended to increase municipalities' knowledge about the areas that require more thorough mapping. The investigation shows that more than half of the municipalities that have received susceptibility maps have not carried out further surveys. Insufficient surveys may lead to the development of areas that are at risk of rockslides and snow avalanches.

The mapping of quick clay was initiated following the mudslide in Rissa municipality in the county of Sør-Trøndelag in 1978 that claimed one life and destroyed 15 farms. Quick clay is clay that was deposited on the seabed (marine clay), but which now exists on land because the land has risen since the last ice age. The sea salt binds the clay, but may be washed out over time, leaving the clay unstable.

The mapping focused on the areas with the most known quick clay deposits. That means areas in Eastern Norway and in Trøndelag, and a few small areas in Northern Norway. As of November 2008, 70 municipalities in nine counties had received quick clay maps from NVE covering parts of the municipalities in question.

Map 3 provides an overview by county of the number of buildings in quick clay areas as of November 2008. The map shows that Sør-Trøndelag has by far the highest number of buildings in mapped quick clay slide hazard areas. In this county, more than 32,000 people live in areas that have been registered as being at risk of quick clay slides. The map also shows that Akershus and Nord-Trøndelag have many building in areas registered as being at risk of quick clay slides. Few areas have been mapped for quick clay in Nordland and Troms, and there are few buildings in these hazard areas.

The survey shows that more than 64,000 people live in 16,879 homes in quick clay hazard areas. The following buildings are also found in these areas: 72 schools, 205 hospitals, 7 prisons, 222 holiday homes and 76 hotels.

The current quick clay maps do not show all quick clay areas, as the mapping does not include areas that are smaller than 2.5 acres or beach deposits. NVE states that the agency is considering surveying beach deposits, but it has no plans to include areas covering less than 2.5 acres. Many municipalities and county governors have stated that the maps should include areas of less than 2.5 acres. They would also like the maps to show the run-out areas of potential quick clay slides, not just the areas in which there is quick clay.

Some municipalities were not aware that they had received quick clay maps. The survey also shows that some of the maps' limitations must be given further consideration. It may be necessary to carry out further surveys of areas outside the demarcated quick clay areas on the map. This issue was highlighted by the landslide in Kattmarka in Namsos municipality in March 2009. A quick clay map had been produced for Namsos municipality, but quick clay was not marked in the Kattmarka area. The area in which the landslide took place was marked as being a beach deposit and had therefore not been checked for the presence of quick clay.

Climate change can introduce more elements of uncertainty in that it brings extreme weather that increases flood and landslide hazards. None of the different mapping projects took climate change into consideration.

County governors need information about how they are to follow up climate adaptation in the municipalities. Half of the county governors said that they needed the authorities' assistance to help them in their work of providing guidance about climate change to the municipalities, which are unsure about how to deal with the issue of climate change in relation to land use planning.

3.2 The ministries' responsibilities and tasks with respect to limiting flood and landslide hazards

Pursuant to the Water Resources Act, the Ministry of Petroleum and Energy is the overriding national watercourse authority and, through NVE, it has responsibility for floods and watercourse-related landslides. Since 1 January 2009, NVE has had responsibility for landslides and has

thereby assumed overall responsibility for work on floods and landslides. Mapping the landslide hazard and assisting in the planning of land use are the tasks that have been given top priority.

Pursuant to the Planning and Building Act, NVE as the expert agency has been given an opportunity to raise objections to the municipalities' land use plans if they do not take adopted national or regional goals, frameworks and guidelines on floods into account. The investigation shows that there are few cases in which objections on the grounds of floods are forwarded to the country governors for mediation. This is explained by the fact that the municipalities take NVE's input into account.

On assignment from the Ministry of Petroleum and Energy, NVE has started implementation of the EU's Floods Directive. NVE states that implementation of the directive means that, in addition to the existing flood inundation maps, measures must be defined for consequences and a method developed to identify risk.

The Ministry of the Environment has administrative responsibility for the part of the Planning and Building Act that concerns planning regulations. This legislation sets a framework for municipalities' planning work with respect to land use. The plan part of the new Act came into force on 1 July 2009, and, among other things, it requires municipalities to carry out risk and vulnerability (RAV) analyses when planning land use.

Pursuant to the Planning and Building Act, the Ministry of the Environment processes objections in connection with land use. The county governors are rarely called upon to mediate in cases where objections have been raised regarding these issues, as matters are generally resolved at an earlier stage through dialogue. There has been only one instance in recent years of a case being sent to the Ministry of the Environment. In that case, the flood hazard was only part of the objection.

The Ministry of the Environment has overriding responsibility for coordinating work on climate adaptation in Norway. The Ministry shall ensure a coherent approach and provide assistance to enable relevant players to fulfil their responsibility for and tasks in the area of climate adaptation. The Ministry is also responsible for providing guidance to the municipalities in their work on climate issues.

3.3 Varying degree of familiarity with and knowledge of floods and landslides in municipalities

The municipalities have a key role in protecting their inhabitants against different natural hazards through the Planning and Building Act and the Natural Damage Act. The national mapping is intended to help the municipalities in this work.

The extent to which municipalities are aware that flood, landslide or quick clay maps have been produced for their areas varies. The susceptibility maps for rockslides and snow avalanches are least known among the municipalities. Lack of awareness of the maps' existence means that they are not used in the work of limiting flood and landslide hazards.

Nor do all the municipalities have the expertise they require to utilise the information provided in the various flood and landslide maps. In relation to the susceptibility maps, municipalities must carry out further surveys of areas with potential landslide hazards. Flood and quick clay maps only cover limited areas, and the municipalities must investigate areas that are not covered by the government mapping.

The investigation also shows that no major changes have taken place with respect to building activity in the municipalities in question before and after areas have been mapped for rockslides and snow avalanches and for quick clay. No corresponding analysis has been carried out with respect to the flood inundation maps as theses maps were too new for it to be possible to uncover any changes in building activity.

Many municipalities have said that current legislation is unclear. They are unsure of their responsibility for protecting inhabitants against flood and landslide hazards. Several municipalities are also unsure about how to handle the new mapping that shows that existing buildings are located in hazard areas for floods, landslides or quick clay slides. Several municipalities were unaware of the fact that they had the legal authority to assign responsibility to landowners.

The municipalities were more aware that they could stipulate requirements for developers in connection with the regulation of new areas. Nonetheless, some municipalities state that they are unsure of their responsibility if a flood or landslide should occur in an area in which they have approved development in accordance with the mapping.

The Ministry of the Environment points out that some municipalities have approved building in areas in which there is a risk of floods or landslides. These municipalities may be financially responsible in the event of an accident if the damage could have been avoided had the planning process been better. In the view of the Ministry, the responsibility for limiting flood and landslide hazards should have been clear to the municipalities as the Ministry has emphasised communicating this to them.

According to the Planning and Building Act, municipalities must ensure through their land use planning that development takes place in secure areas, and in that connection they must assess the prevention of flood and landslide damage. RAV analyses are an important tool that municipalities can use when drawing up land use plans in order to identify areas at risk of floods and landslides. Ten percent of the municipalities that answered the questionnaire survey had not drawn up RAV analyses, and close to 40 percent had RAV analyses from 2005 or older. Since 1 July 2009, municipalities have been required to draw up RAV analyses. Several municipalities have stated that they need the help of government agencies in connection with the work on land use plans and RAV analyses. The great variation between the municipalities' use of RAV analyses and their quality was confirmed by the county governors.

The investigation shows that the municipalities' expertise is crucial in drawing up good RAV analyses and land use plans to limit flood and landslide hazards. Several municipalities do not have procedures in place to secure the transfer of experience and expertise in handling flood and landslide hazards. Furthermore, case processing in small municipalities is often dependent on individuals. The investigation also reveals that municipalities receive a varying degree of help from government agencies in connection with this work.

A large majority of county governors are of the opinion that increased government assistance to raise municipalities' competence in the area of floods and landslides should be given priority. The Ministry of the Environment has also pointed out that the competence and capacity of municipalities vary, and that following up all the municipalities is challenging. The Ministry has also emphasised the importance of county governors' guidance to the municipalities.

4 The Office of the Auditor General's comments

Throughout its history, Norway has always been at risk of floods and landslides, which have led to a great deal of damage and the loss of lives. Floods and landslides must be prevented at as early a stage as possible, and land use planning is the most important way of achieving this.

Pursuant to the Planning and Building Act and the Natural Damage Act, it is the responsibility of the municipalities to prevent and protect their inhabitants against flood and landslide hazards. The municipalities require the assistance and guidance of government agencies in this work. The national authorities have prepared flood and landslide maps for many municipalities. In the Office of the Auditor General's view, however, it can be questioned whether this functions satisfactorily. A number of municipalities and county governors were not aware of the mapping, particularly the susceptibility maps for rockslides and snow avalanches, and over half of the municipalities and county governors were unaware of the existence of the maps. At the same time, the investigation cannot conclude that municipalities are changing the scope of building activity in areas that government mapping has deemed to be at risk of landslides or quick clay slides. In the Office of the Auditor General's view, more government follow-up is required, as is assistance in raising competence to the required level, particularly for small municipalities. The Office of the Auditor General also questions whether the dissemination of information has been good enough.

In the Office of the Auditor General's view, another problem is that the limitations of the different maps have not been communicated clearly enough. Lack of information about the limitations of the maps applies in particular to the susceptibility maps, which require municipalities to carry out more detailed mapping themselves. The investigation shows that this is often not done.

The investigation shows that many municipalities lack adequate expertise to handle floods and landslides and to be able to benefit from the mapping. In addition, the municipalities' lack of understanding about the responsibility they have been assigned leads to development in areas that are at risk of floods and landslides. In the Office of the Auditor General's view, it is necessary to clarify responsibility for preventing floods and landslides in relation to the municipalities.

5 Response from the Ministry of Petroleum and Energy

The matter was presented to the Ministry of Petroleum and Energy and the Ministry of the Environment on 3 February 2010, and the Minister of Petroleum and Energy responded as follows in a letter of 19 February 2010:

"I refer to your letter of 3 February 2010 in which Document no 3: X (2009-2010) "The Office of the Auditor General's investigation into the efforts of the authorities to limit flood and landslide hazards" was submitted to the Ministry for a statement. The Ministry of Petroleum and Energy has obtained comments from the Ministry of the Environment that are incorporated into this letter.

The goal of the Office of the Auditor General's investigation was to assess the extent to which the Ministry of Petroleum and Energy and the Ministry of the Environment and their subordinate agencies adhere to the decisions and intentions of the Storting and national objectives for the prevention of flood and landslide hazards. The investigation was carried out in the period from October 2008 to August 2009.

Both the Minister of the Environment and I largely find the Office of the Auditor General's investigation to be useful. The investigation provides a clear picture of the actual situation facing the municipalities and county governors in their work to prevent flood and landslide risks. In the performance audit, the Office of the Auditor General makes an independent assessment of the work of the authorities and points to the potential for improvement, which can be used in the ongoing work of the authorities. I do, however, have some comments on what has been investigated and on some of the Office of the Auditor General's findings.

The Directorate of Water Resources and Energy (NVE) has for decades attended to government administrative tasks relating to the prevention of the risk of floods and watercourse-related landslides. In this context, NVE has developed an overall administration model for prevention consisting of five types of measures:

- Mapping and disseminating information about hazard areas
- Providing guidance and follow-up in connection with land use planning and land use
- Planning and implementing safeguard measures
- Monitoring and issuing warnings about hazards
- Assisting in emergency response and emergency situations.

From 1 January 2009, NVE also took over central government responsibility for the prevention of other types of landslides, and it will apply the same overall model in this field as well. Responsibility was transferred from a number of government authorities and brought together under one roof at NVE in order to improve government administration. I therefore find it surprising that the Office of the Auditor General has chosen to audit the work of the authorities to prevent flood and landslide risks in the period from October 2008 to August 2009, as this is the period in which measures to improve government responsibility have been implemented. I also note that only two of the five measures in the overall model, namely mapping and land use planning, have been investigated. The result is that the investigation does not provide a complete picture of the authorities' work to prevent flood and landslide risks.

However, I do find the audit useful, as it looks at an important administrative area which is under development. The investigation points out weaknesses that endeavours have already been made to remedy, as well as the potential for improvement within the Ministry's new area of responsibility. It also provides an overview of the division of roles and responsibilities between the government, county governors and municipalities. It is important to distinguish between the various players and the parts they play, since it is only at the government level that material changes have been made; the municipalities' responsibility for protecting inhabitants against natural hazards remains unchanged.

The ministries agree that further mapping of high-risk areas is required in the years ahead. NVE is currently preparing a national mapping plan for landslides, and the agency will carry out national mapping to produce an overview of hazard areas. In addition, it will continue to conduct detailed mapping of flood zones, prepare susceptibility maps for flood hazards, and carry out mapping in accordance with the requirements of the Floods Directive.

The Office of the Auditor General points out that many municipalities are not aware of the existence of the susceptibility maps for rockslides and snow avalanches. In recent years, different agencies have been responsible for drawing up and disseminating such maps. When NVE took

over responsibility for landslides, it also assumed responsibility for drawing up and disseminating these maps. The maps provide an overview of potential hazard areas, and it is recommended that municipalities carry out more detailed surveys of the areas in question to determine the probability of hazard. The Office of the Auditor General points out that a number of municipalities have not carried out such surveys although susceptibility maps exist. It is also pointed out that the level of building activity has not changed greatly in the areas in question. I see a clear connection between inadequate dissemination and insufficient use of the susceptibility maps. It is hard for municipalities to use maps that they do not know that they have.

I agree that the dissemination and use of susceptibility maps for rockslides and snow avalanches have been inadequate. This was one of the reasons why the work of preventing landslide risk was transferred to NVE, as it has long experience of drawing up and disseminating hazard maps for floods and watercourse-related landslides. A number of measures have now been implemented to improve the government's work on the prevention of landslide risks. Efforts have been intensified and made more efficient by concentrating government funding on NVE, and allocating more funds. A special landslide research and dissemination unit has been established in Førde to work on professional development in collaboration with other players, to disseminate information externally and to provide expert assistance to the whole of NVE. In addition, the professional resources at both NVE's head office in Oslo and its regional offices have been increased. I am confident that the increased government effort to prevent landslide risks will result in, among other things, improved dissemination of maps, which in turn will result in more active use of these maps in land use planning.

The Office of the Auditor General also points out that there is a lack of expertise in municipalities and uncertainty about municipal responsibilities in the event of floods and landslides. Pursuant to the Planning and Building Act and the Natural Damage Act, it is the municipalities' responsibility to protect new and existing buildings. It is my understanding that the municipalities are aware of their responsibility to prevent the risk of landslides and other natural accidents to new buildings through land use planning and land use, and by requiring risk and vulnerability analyses to be carried out in accordance with the Planning and Building Act. The ministries will also take steps to ensure that the municipalities are made aware of their responsibility through the ministries' general guidance to municipalities and counties on matters relating to the Planning and Building Act.

In my assessment, the municipalities are not aware to the same extent of their responsibility to protect existing buildings, which is regulated by the Natural Damage Act, and the Office of the Auditor General's investigation confirms this. Municipalities are uncertain about the extent of their responsibility to prevent the risk of landslides in already developed areas, and the extent to which municipalities have a duty or right to construct and maintain physical safeguard measures to protect against landslides and other natural damage. The Ministry of Agriculture and Food is currently revising the compensation provisions in the Natural Damage Act. When this work started, the framework for a government landslide agency had not been decided, and the revision of the protection provisions was therefore postponed. However, it is necessary to make clear the municipalities' responsibility for preventing the risk of natural accidents in already developed areas. It is also necessary to harmonise the protection provisions in the Natural Damage Act with the new Planning and Building Act. Now that NVE has been assigned overall responsibility for landslide prevention, I find that the time has come to consider a revision of the protection provisions. NVE has contributed constructive input on the improvement of the protection provisions in the consultation on the Natural Damage Act, and has asked to participate further in drafting of the regulations.

In conclusion, I would like to emphasise that, in the Ministry's experience, the dialogue with the Office of the Auditor General during the process was good. This means that the areas that the Office of the Auditor General describes in its report to the Storting are deemed to be relevant, and that the Ministry is aware of most of the challenges highlighted. I feel confident that bringing the government's work on the prevention of landslide accidents together under one roof at NVE will result in more coherent, efficient and improved efforts, as well as making it easier for municipalities to seek help in landslide prevention. This strengthening of the government's work has just started, and it will require expertise and considerable resources. The work will therefore have to be built up over time, but it is my opinion that we have a good model to work from."

6 The Office of the Auditor General's statement

Large parts of Norway have been and will continue to be at risk of floods and landslides. Climate change may contribute to increasing the risk of loss of human lives and material assets. The investigation shows that more than 72,000 persons live in over 24,000 homes located in the susceptibility areas for rockslides and snow avalanches. More than 22,000 people live in areas that are mapped as being at risk of a 200-year flood. The Office of the Auditor General is satisfied that the Ministry of Petroleum and Energy and the Ministry of the Environment find the investigation to be relevant and useful to their future work.

The Ministry of Petroleum and Energy raised questions relating to the fact that the Office of the Auditor General carried out its investigation at the same time as the Norwegian Water Resources and Energy Directorate was made national landslide agency. The Office of the Auditor General agrees with the Ministry that concentrating responsibility in a single agency is an important improvement of the landslide and flood work. In the Office of the Auditor General's view, it must also be emphasised that the municipalities are responsible for protecting their inhabitants from floods and landslides. At present, the municipalities' knowledge of the available maps varies greatly. The investigation also shows that municipalities do not possess the expertise required to utilise the information found in the various flood and landslide maps.

The investigation shows that further mapping of areas with a high risk of floods and landslides will be required in the years ahead. The Office of the Auditor General sees it as positive that the ministries plan to increase mapping, but would like to stress that it is a prerequisite that municipalities and county governors are capable of making use of the maps. The ministries state that they will make municipalities aware of their responsibility to prevent flood and landslide hazards through the ministries' general guidance on matters relating to the Planning and Building Act. In the Office of the Auditor General's assessment, it will also require more active guidance and improvement measures from the government considering that many municipalities do not have the basic expertise required to make use of the maps.

In the Office of the Auditor General's opinion, inadequate knowledge of maps, insufficient expertise in their use and unclear understanding of municipal responsibility are serious matters that demand targeted and active government efforts in parallel with the development of the new agency's tasks.

The matter will be submitted to the Storting.

Adopted at a meeting of the Office of the Auditor General on 16 March 2010

Jørgen Kosmo **Arve Lønnum**

Annelise Høegh **Per Jordal** **Synnøve Brenden**

Bjørg Selås

Report: The Office of the Auditor General's investigation into the efforts of the authorities to limit flood and landslide hazards

Appendix to Document 3:4 (2009–2010)

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1 Introduction

1.1 Background

Because of the topographical and meteorological conditions in Norway, large parts of the country are at risk of floods and landslides. This presents challenges for the involved authorities in terms of how best to manage these areas to reduce the risk of loss of human lives and other assets. Climate change also causes more extreme weather and heavy precipitation that can influence flood and landslide hazards.

The biggest flood to hit Eastern Norway for a very long time occurred in May and June 1995. Areas along the Glåma and Lågen rivers and the Trysil watercourse were worst affected. After the flood, the Ministry of Justice and the Police concluded that it was necessary to review the system for flood measures, warnings and forecasts with a view to evaluating measures to prevent such extensive damage in future. This led to the appointment of the Commission on Flood Protection Measures. The commission's report stresses that the planning and implementation of flood protection measures require a coherent approach. Floods are natural events that are difficult to predict, and the risk of flood damage is influenced by a number of decisions made in different contexts by players at the local, regional and central government levels.

Report No 42 to the Storting (1996–97) *Tiltak mot flom ("Measures to prevent flooding")* proposed the implementation of several measures to facilitate the use of watercourse regulation to reduce flooding. In Recommendation No 224 to the Storting (1996–97), the commission specified that measures will be required to protect assets and interests at risk of flooding. The commission also agreed that county governors shall verify that flood hazards and the requirement for expertise, for example from the Directorate of Water Resources and Energy (NVE), have been considered during the municipalities' land use planning.

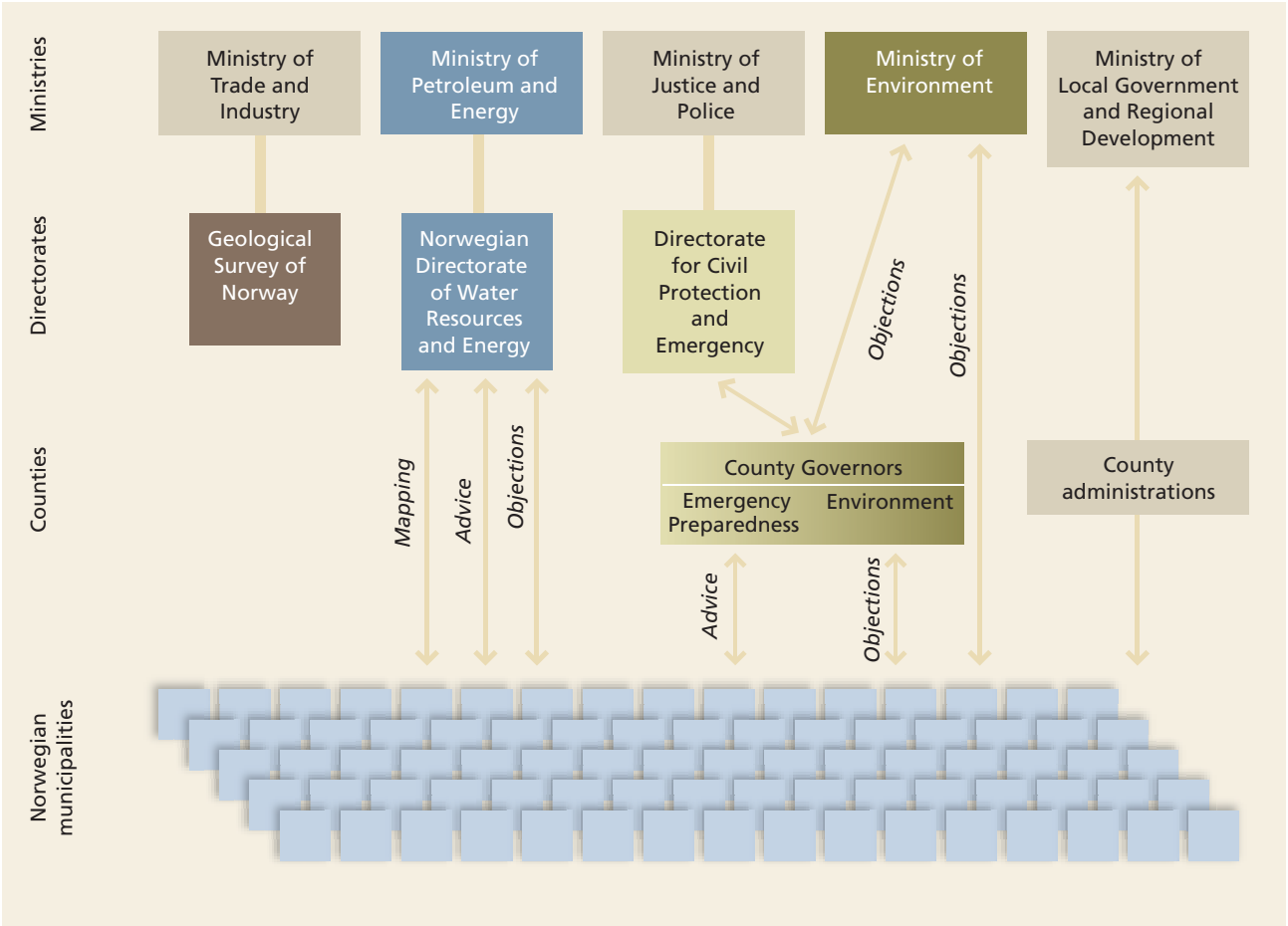
NVE is an agency under the Ministry of Petroleum and Energy with responsibility for limiting floods and landslides in watercourses. From 1 January 2009, the agency was also given overall responsibility for central government administrative tasks relating to landslide prevention.

Previosuly, responsibility for landslides was divided between different ministries, and no single entity has had overall national responsibility for this field. Each ministry has different subtasks in relation to landslide prevention, and in some cases they are limited to matters within the sector covered by the ministry in question. An investigation carried out by the Directorate for Civil Protection and Emergency Planning (DSB) and the county governors showed that the municipalities need government help in the form of landslide expertise and resources for mapping, monitoring and protection. In some cases, the challenges posed by landslide hazards are too great for the municipalities to handle on their own. The government therefore proposed in Report No 22 to the Storting (2007–2008) *Samfunnssikkerhet – samvirke og samordning*[1] *("Civil protection – cooperation and coordination")* to establish a landslide agency from 1 January 2009 under NVE with the Ministry of Petroleum and Energy as the responsible ministry.

The Ministry of the Environment administers the planning part of the Planning and Building Act and regulates how the municipalities organise their work on land use. The Ministry of Local Government and Regional Development is responsible for the building part of the Planning and Building Act, with the National Office of Building Technology and Administration as its primary expert agency in relation to building technology regulations. The Ministry of Justice and the Police has coordinating responsibility for civil protection and agency responsibility for the Directorate for Civil Protection and Emergency Planning, which, among other things, is intended to act as a driving force in efforts to prevent accidents. The Geological Survey of Norway (NGU), which falls under the Ministry of Trade and Industry, is the expert agency in matters relating to geology. The Ministry of Agriculture administers the Natural Damage Act and has overall responsibility for the Norwegian National Fund for Natural Damage Assistance. The Ministry of Transport and Communications has

1) Recommendation No 85 to the Storting (2008–2009).

Figure 1 Overview of government players involved in the work on floods and landslides as of 1 January 2009 after the establishment of NVE as landslide agency



Source: Office of the Auditor General

delegated responsibility for mapping of the landslide hazard for roads to the Norwegian Public Roads Administration and for railways to the Norwegian National Rail Administration.

The municipalities have been given responsibility for their own land areas in accordance with the national guidelines. Pursuant to the Natural Damage Act and the Planning and Building Act, the municipalities are also responsible for protecting residents against natural hazards. Land use in areas at risk of flooding is the most important measure to keep the risk of flood damage at an acceptable level. In this context, reference is made to the importance of municipal land use planning and of taking flood hazards into consideration in land use planning and the processing of building applications. The landslides in Bergen in 2005, in Ålesund in 2008 and in Namsos in 2009 demonstrated how exposed residential areas may be to landslides.

1.2 Objectives and lines of inquiry

The goal of the investigation

The goal of the investigation is to assess the extent to which the Ministry of Petroleum and Energy and the Ministry of the Environment and their subordinate agencies follow up the decisions and intentions of the Storting and national objectives for the prevention of flood and landslide hazards.

Lines of inquiry

The investigation was carried out based on two main lines of inquiry with pertaining sub-lines:

1 What mapping of flood and landslide hazards has been carried out, and how are the results disseminated?

   1.1 How many buildings are located in areas mapped by the government, and how many people live in these areas?

1.2 How extensive is the government mapping?

1.3 Is the knowledge gained from the government mapping disseminated to relevant users?

2 How do the authorities ensure that national flood and landslide objectives are adequately followed up?

2.1 How does the Ministry of Petroleum and Energy fulfil its responsibility and tasks relating to the prevention of flood and landslide hazards?

2.2 How does the Ministry of the Environment fulfil its responsibility and tasks relating to the prevention of flood and landslide hazards?

2.3 How do the municipalities fulfil their responsibility and tasks relating to the prevention of flood and landslide hazards?

Definitions

Flood: overflow of water from watercourses and extreme precipitation that can affect buildings, infrastructure and people.

Surface runoff: surface water outside watercourses. This is primarily a problem in cities and towns where water from precipitation runs off the surface of impermeable surfaces.

Landslide: rapid movements of snow, rocks, quick clay, earth and other loose sediments that could cause extensive damage and cost lives. In this investigation, the term 'landslide' only covers rockslides and snow avalanches.

Quick clay slide: a specific type of landslide. Quick clay is clay that was deposited on the seabed (so-called marine clay), but which is now found on land because the land has risen since the last ice age. The salt from the sea binds the clay, but may be washed out over time, leaving the clay unstable.

Hazard: Exposure to events that could result in damage.

Hazard level: Probability that an event will occur.

Consequence: Extent of damage should the event occur.

Risk: The product of the hazard level and the consequence.

Vulnerability: Inability to withstand loads that could cause great damage or major loss of assets.

Susceptibility map: Overview map showing potential hazards.

Hazard zone map: Detailed maps showing hazard zones for various probabilities of floods or landslides.

Risk map: Detailed map ranking hazard zones on the basis of damage potential (consequences).

Return periods: a relative figure expressing how often a flood of a certain scope occurs on average over a number of years. Return periods are calculated on the basis of measurements of the flow of water in the watercourse in question over a number of years. In its flood inundation maps, the Directorate of Water Resources and Energy (NVE) distinguishes between flood return periods of 20, 50, 100, 200 and 500 years.

2 Method

The investigation is based on quantitative data, statistical analyses, interviews, questionnaire surveys and document reviews. The data was collected in the period from October 2008 to August 2009.

2.1 Analysis of areas mapped for floods and landslides

A study of existing maps was carried out in order to find out how the various government mapping projects for flood and landslide hazards in Norway are used by the public administration. The Norwegian Geotechnical Institute (NGI) carried out the study on assignment for the Office of the Auditor General. The results are available in the report *Bruk av farekart for flom og skred i Norge ("The use of hazard maps for floods and landslides in Norway")*.

The following maps were used in the analysis:
- flood inundation maps from the Directorate of Water Resources and Energy (NVE)
- susceptibility maps for rockfalls and snow avalanches from the Geological Survey of Norway (NGU)
- quick clay maps from NVE

NVE submitted the flood inundation maps and quick clay maps on 13 November 2008. NGU submitted the susceptibility maps for rockfalls and snow avalanches on 17 November 2008. The Norwegian Mapping Authority submitted building data from GAB[2] on 5 December.
The study consisted of three parts:
- a map survey
- a time series data analysis
- an in-depth study

Map survey

Maps from the different government mapping projects were analysed to arrive at an indication of the extent of flood and landslide hazards in Norway. The hazard levels vary between the flood inundation maps, the quick clay slide maps and the susceptibility maps for rockfalls and snow avalanches. NVE guidelines use the 200-year flood as the recommended level for securing buildings, and this is the level used by the map survey. For the quick clay maps, all the areas where quick clay has been found have been studied, regardless of the degree of hazard or risk.

The analysis compared potential hazard areas in the government maps with the GAB register and produced an overview of the number of buildings in these areas. Table 1 shows the buildings included in the survey.

A comparison between Statistics Norway's population data from the most recent census (2001) and the number of buildings in potential flood and landslide areas provides an estimate of how many people live in these areas. The survey showed that the data submitted was of good quality. There was a small margin of error in the data from GAB,[3] and some buildings were located in places with a potential risk of more than one hazard.[4] However, there are so few of these buildings that it will have no bearing on the results of this investigation.

Time series data analysis

A time series data analysis carried out on the basis of findings from the map analysis illustrates the development trend before and after the municipalities had access to flood and landslide maps for their areas. The purpose was to find out whether municipalities took the mapping into consideration in land use administration.

The various map series were initiated at different times and were handed over to the municipalities as they were completed. In order to make the presentation clearer, the year when a municipality was given the relevant flood and landslide maps is set as 0. The development pattern was examined for the ten years prior to year 0 and for the time

2) GAB is a national register and information system containing data about all landed properties in Norway; owners, addresses and buildings larger than 15 square metres. The GAB register has subsequently been replaced by Matrikkelen *("the cadastre")*, but at the time of the study it lacked data from more than 100 municipalities. It was therefore decided to use GAB in the analysis rather than the, at the time, incomplete Matrikkelen.

3) Of a total of 3,852,023 buildings registered in GAB, 175 were registered with invalid coordinates and eight were of unknown type. These buildings were excluded from the data basis and had little practical impact on the results.

4) 72 buildings are located in areas mapped for both flood hazard and quick clay slide hazard, while 249 buildings are located in areas mapped for both flood hazard and potential rockslide or snow avalanche hazard.

Table 1 Groups of buildings used in the analyses and the types of buildings included in these groups

Building groups	Name	Included building types from GAB
1	Residential buildings	Detached houses, semi-detached houses, terraced houses, linked houses, other small houses, large multi-dwelling buildings and buildings for shared housing
2	Holiday homes	Holiday homes, cabins, buildings on mountain summer pasture farms etc.
3	Hotels	Hotel buildings, buildings providing overnight accommodation and other hotel and restaurant buildings
4	Schools	School buildings, playgrounds, day care centres for children, university and university college buildings
5	Hospitals	Hospitals, nursing homes and other health-related buildings
6	Prisons	Prison buildings

since year 0. The survey only covered municipalities that had received maps before 2005, as they had had an opportunity to take the maps into consideration in their planning work.

In-depth study

An in-depth study of eight selected municipalities was carried out. The goal of the study was to assess the extent to which the various maps were used, and to determine whether the eight municipalities had arranged for detailed surveys and/or implemented security measures in cases where planning permission was granted in areas with potential flood and landslide hazards. The in-depth study also elucidated how the selected municipalities handle flood and landslide hazards in general, including at the municipal sub-plan level, zoning plan level and building application level. The study also uncovered the challenges faced by municipalities in relation to expertise in preventing new buildings from being located in areas at risk of landslide or flooding.

The eight municipalities were selected on the basis of findings in the map and time series data analyses, types of hazard, geographical distribution and their size.

- Five of the municipalities had flood inundation maps, five had susceptibility maps for rockfall and snow avalanches, and three had quick clay maps. Five of the municipalities had received more than one type of map.
- The population in potential hazard or susceptibility areas varied from 2.6 to 82 percent of the municipality's total population.
- The municipalities are located in the counties of Akershus, Buskerud, Hedmark, Rogaland, Hordaland, Møre og Romsdal, Sør-Trøndelag and Troms.

The population of the municipalities varies from fewer than 1,000 to more than 60,000 inhabitants.

The in-depth study was carried out by the municipalities being sent findings from the map and time series data analyses in advance and being asked to comment on these findings in interviews. For four of the municipalities, the meeting was held by phone, and for the four others in person. A common interview guide was prepared for the meetings, and the municipalities were given an opportunity to elaborate on their answers afterwards.[5]

2.2 Questionnaire surveys

Two questionnaire surveys were carried out in order to find out what the county governors and municipal administrations think about the mapping of flood and landslide hazards and how they use the maps in their land use planning. One questionnaire was sent to all Norwegian municipalities and one to the county governors. The questionnaires were distributed electronically using a program called Questback. Before it was distributed, the questionnaire was quality assured by means of a pilot survey carried out in two municipalities.

The municipalities were asked to state who was the right person to respond on behalf of the municipality. Information from their websites was used for municipalities that did not respond to this enquiry. The questionnaire was sent to all 430 municipalities in Norway, and 266 responded, a response rate of about 62 percent. Municipalities in all the Norwegian counties have

5) The in-depth study shows that many of the buildings located in areas with potential flood or landslide hazards have been approved by the municipalities following further surveying, safeguard measures or technical measures.

responded. The individual counties' response rates varied between 39 and 75 percent. Of municipalities that have received flood, quick clay or rockslide and snow avalanche maps, 63, 65 and 64 percent, respectively, have completed the questionnaire.

The questionnaires for the county governors were sent to their entities for civil protection, and they all responded.[6]

2.3 Interviews

In order to shed light on central authorities' efforts in the field of floods and landslides, interviews were carried out with the Ministry of Petroleum and Energy, the Ministry of the Environment, the Directorate of Water Resources and Energy, the Geological Survey of Norway and the Directorate for Civil Protection and Emergency Planning.

One county governor's civil protection department and one county geologist were interviewed based on the risk and the degree of exposure of areas in their respective counties. A total of eight municipalities were interviewed. These municipalities were selected on the basis of their risk of floods and/or landslides as well as their geographical distribution and size.

The interviews were carried out in the period from September 2008 to August 2009. An interview guide was prepared for each interview and minutes were taken. The minutes used in the report have been verified by the interviewees.

2.4 Document analysis

In addition to the Planning and Building Act and the Natural Damage Act, relevant documents from the Norwegian parliament, the Storting, have been reviewed to identify the national goals that apply to the limitation of flood and landslide hazards.

Relevant regulations, circulars, guidelines and instructions relating to the applicable acts have also been reviewed.

The allocation letters from the Ministry of Petroleum and Energy to NVE relating to flood and watercourse-related landslides and NVE's annual reports from 2004 to 2008 have also been analysed. In addition, a list has been obtained of objections by NVE to municipalities' zoning plans concerning flood or landslide issues.

Relevant EU directives have been reviewed in connection with future requirements for watercourse-related natural damage.

6) Oslo and Akershus share a county governor. Thus the report's sample included 18 county governors.

3 Audit criteria

In Proposition No 1 to the Storting (2007–2008) for the Ministry of Petroleum and Energy, the field of energy and water resources has been clarified in that four main goals have been defined. Two of them are particularly relevant to the work of preventing flood and landslide hazards:

- Safeguard environmental and user interests in watercourses
- Protect society against watercourse accidents and ensure supply security and emergency preparedness in relation to the power supply

The Storting expects the public administration to be managed in accordance with the principle of goal and performance management. The Appropriations Regulations require a description of the results that are to be achieved. The results achieved must also be commented on, and other information with a bearing on the evaluation of the allocation proposal for the next budget year must be presented. The use of resources and measures must be efficient in relation to the stipulated result requirements.[7] Goal and performance management is a tool to clarify goals, stipulate result requirements and establish procedures for reporting on goal achievement and outcomes. The fundamental governing principles are specified in the Regulations on Financial Management in Central Government, section 4.[8]

According to Recommendation No 219 to the Storting (1996–97) *Regional planning and land use policy*, it is only by means of mapping risk factors that it is possible to take such factors sufficiently into consideration during planning processes.

The Norwegian state must make national map data available to all municipalities. The municipalities must prepare overviews of local conditions relating to risk and vulnerability.[9] In addition, they must ensure that up-to-date public maps are available for the purposes mentioned in the act, including drawing up the land use part of the municipal plan, zoning plans and development plans.[10]

7) The Appropriations Regulations of 26 May 2005, sections 9 and 10.
8) The Regulations on Financial Management in Central Government, adopted on 12 December 2003.
9) Report No 29 to the Storting (1996–97) Regional planning and land use policy, cf. Recommendation No 219 to the Storting (1996–97).
10) The Planning and Building Act (1985) section 5.

3.1 The Ministry of Petroleum and Energy

Pursuant to the Water Resources Act, the Ministry of Petroleum and Energy is the superior watercourse authority for all far-reaching decisions relating to floods and landslides in connection with Norwegian water resources.[11] Within the energy and water resources sector, the Ministry of Petroleum and Energy has overall responsibility for power supply emergency response and the emergency planning tasks relating to floods, clay slides, dam breaches and other accidents in the country's watercourses.[12]

Report No 42 to the Storting (1996–97) *Tiltak mot flom ("Measures to prevent flooding")* states that flood inundation maps will constitute an important improvement of the basis for risk analyses in watercourses.[13] In its consideration of the report, the Standing Committee on Energy and the Environment stated in Recommendation No 244 to the Storting (1996–97) that the preparation of a series of national flood inundation maps is a positive development. The grounds given are that, not only will this show what watercourses are most at risk of flooding, it will also form a good basis for a more conscious use of areas at risk of floods.

Preposition No 1 to the Storting (2005–2006) for the Ministry of Petroleum and Energy states that the Norwegian Directorate of Water Resources and Energy (NVE) must give priority to the task of protecting lives and assets along the watercourses, and that NVE must be prepared for more frequent and larger floods and more landslides in connection with the watercourses. The need to reduce the negative consequences of climate change must form the basis for government and municipal planning.[14]

11) The Water Resources Act section 64, cf. Royal Decree of 15 December 2000.
12) Proposition No 1 to the Storting (2005–2006), Ministry of Petroleum and Energy, cf. Budget Recommendation No 9 to the Storting (2005–2006).
13) Report No 42 to the Storting (1996–97) *Tiltak mot flom ("Measures to prevent flooding")*, cf. Recommendation No 244 to the Storting (1996–97).
14) Proposition No 1 to the Storting (2007–2008), Ministry of Petroleum and Energy, cf. Budget Recommendation No 9 to the Storting (2007–2008).

The main goal of the mapping of hazard areas along watercourses is to provide the municipalities with a better basis for land use planning.[15] NVE must help municipalities take areas at risk of floods and landslides into account in their land use planning. In Recommendation No 244 to the Storting (1996–97), the Standing Committee on Energy and the Environment refers to NVE, with its expertise on watercourses, as a key element in the assessment of flood hazard areas. The committee agrees that the agency's capacity for providing guidance to municipalities and considering municipal plans for land use must be improved.

Pursuant to the Planning and Building Act, NVE has a right to raise objections in planning matters relating to watercourses.[16]

In Recommendation No 85 to the Storting (2008–2009), the Storting supported the proposal in Report No 22 to the Storting (2007–2008) *Samfunnssikkerhet – samvirke og samordning*[17] *("Civil Protection – cooperation and coordination")* that government administrative tasks relating to landslide prevention be delegated to NVE. This was based on the need for a more uniform, efficient and stronger contribution in connection with landslide prevention. Municipalities and developers' responsibility to safeguard against landslides in land use planning and during development remains unchanged.[18] The responsibility each ministry has for flood and landslide problems within its areas of responsibility has not been changed.[19]

3.2 The Ministry of the Environment

The Ministry of the Environment has primary administrative responsibility for the government's planning tasks and shall endeavour to ensure that national decisions are followed up in regional and municipal planning.[20] In Recommendation No 244 to the Storting (1996–97), the Standing Committee on Energy and the Environment states that improved management of the utilisation of areas at risk of floods is the most important measure to keep the risk of flood damage at an acceptable level.

The Ministry of the Environment has adminstrative responsibility for the part of the Planning and Building Act that concerns planning regulations.[21] These regulations stipulate how the municipalities should manage areas that could be at risk, including from floods and landslides. The Act applies to all land in the country, including watercourses, unless otherwise stipulated in or pursuant to statutes.[22]

The preamble to the Planning and Building Act states that planning shall facilitate the coordination of central government, county and municipal activities and provide a basis for the use and protection of resources and for development. Through planning, the Act shall help ensure that land use and the building of homes benefits individuals and society as a whole.[23]

Report No 23 to the Storting (1992–93) *Om den regionale planleggingen og arealpolitikken ("On regional planning and land use policy")* takes as its starting point that the use of goal and performance management in relation to municipal administration will primarily be a suitable form of management where the government has defined clear goals for municipal activities. This also applies where the government has a clear need to monitor the municipalities to ensure that they are following up priority goals that they have been ordered to implement. Continuous feedback on the results achieved is a precondition if central government authorities are to be able to follow up their overall national responsibility.

Agencies with tasks related to resource utilisation, conservation measures, development and cultural or social issues at the municipal level shall provide the municipality and county administrations with the help they require in their planning work.[24] The county governors must also monitor other public agencies to ensure that they fulfil their duty to provide help.[25] The county governors must ensure that land use planning takes into consideration measures to reduce the probability of negative consequences of extreme events such as

15) Proposition No 1 to the Storting (2007–2008), Ministry of Petroleum and Energy, cf. Budget Recommendation No 9 to the Storting (2008–2009).
16) The Planning and Building Act (1985) sections 20-5 and 27-2.
17) Recommendation No 85 to the Storting (2008–2009), cf. Budget Recommendation No 9 to the Storting (2008–2009).
18) Report No 22 to the Storting (2007–2008) *Samfunnssikkerhet – samvirke og samordning ("Civil Protection – cooperation and coordination")*. Recommendation No 58 to the Storting (2008–2009).
19) Recommendation No 9 to the Storting (2002–2003), cf. Report No 17 to the Storting (2001–2002) *Samfunnssikkerhet – veien til et mindre sårbart samfunn ("Civil Protection – the road to a less vulnerable society")*.
20) The Planning and Building Act (1985) section 13 second paragraph.
21) The Planning and Building Act (1985) section 13.
22) The Planning and Building Act (1985) section 1.
23) The Planning and Building Act (1985) section 2.
24) The Planning and Building Act (1985) sections 9-3 and 12-3.
25) The Planning and Building Act (1985) section 12-3 first paragraph last sentence.

landslides and floods.[26] In Recommendation No 244 to the Storting (1996–97), the Standing Committee on Energy and the Environment stated that the county governors must make sure that the flood hazard and need to draw on expertise, for example from NVE, has been taken into consideration in the municipalities' land use planning.

The county governors have both a right and a duty to raise objections to municipalities relating to their handling of planning and building matters. The provision on objections provides for the possibility of changing a municipal decision if it is in violation of national goals and interests as they are expressed in circulars, national political guidelines, Reports to the Storting and other documents.[27] If the municipalities so wish, the county governors may mediate between municipalities and opposing parties before a case is forwarded to the Ministry. If mediation at county level is unsuccessful, the case is forwarded to the Ministry of the Environment to be decided. The Ministry will then decide whether the objections are to be allowed. In this context, the ministry can make such changes to the plan as it deems necessary.[28] In its processing of Report No 31 to the Storting (1992–93) *Om forholdet mellom staten og kommunane ("On the relationship between central government and municipalities")*, the committee refers to the fact that the government authorities are responsible for ensuring that national considerations are taken into account through their right to object to zoning plans and the land use part of municipal plans.[29]

The county governors are the government's link with the municipalities. They shall communicate the government's environmental goals and interests, elaborate on guidelines and follow up developments in relation to the municipalities. In a management system based on goal and performance follow-up, this role will be strengthened through greater focus on guidance and dialogue.[30]

The municipal plan forms the basis for planning, administration and development in the municipalities.[31] The Planning and Building Act is based on land as a rule being allocated on the basis of the land use part of the municipal plan. The municipal council must carry out an overall evaluation of the municipal plan, including an assessment of whether changes are required, at least once each election period.[32] Clearer requirements should be stipulated for municipalities to revise their municipal plans in relation to national goals and new regional guidelines in county sub-plans and national requirements.[33]

The Planning and Building Act states that risk areas, including areas with landslide and flood hazards, must be described in zoning plans.[34] The area shall be mapped in so far as it forms part of the economic cartography.[35] Zoning plans and plans for the construction of housing must as a rule be in accordance with the land use part of the municipal plan.

Municipalities must ensure continuous municipal planning aimed at coordinating physical, financial, social, aesthetic and cultural development within their areas.[36] Planning must be in line with national and important regional goals, frameworks and guidelines. Pursuant to the Planning and Building Act, municipalities must cooperate with other public agencies with interests in a case, and request statements in matters that fall under the relevant agencies' areas of expertise.[37] It is the municipalities' responsibility to ensure that flood hazards have been assessed and taken into consideration in land use planning and the processing of building applications.[38] The municipalities have a similar responsibility for surface runoff.[39] Municipalities can demand that real property, or rights to real property, be surrendered. Among other things, they are entitled to ban the felling of trees or other particular forms of utilisation when this is necessary in order to implement safeguard measures to prevent natural damage. Municipalities may decide to impose a ban on building on and dividing properties or parts of properties located in areas where a natural damage hazard may exist.[40]

26) Proposition No 1 to the Storting (2005–2006), cf. Proposition No 1 to the Storting (2006–2007) and Proposition No 1 to the Storting (2007–2008), Ministry of Ministry of Government Administration and Consumer Affairs.
27) The Planning and Building Act (1985) section 27-2.
28) The Planning and Building Act (1985) sections 20-5 and 27-2.
29) Recommendation No 237 to the Storting (1992–93).
30) Report No 58 to the Storting (1996–97) *Environmental Protection Policy for a Sustainable Development* and Recommendation No 150 to the Storting (1998–98).
31) The Planning and Building Act (1985) section 20-6.
32) The Planning and Building Act (1985) section 20-1.
33) Recommendation No 219 to the Storting (1996–97).
34) The Planning and Building Act (1985) section 25, No 5 Danger areas, cf. the Natural Damage Act section 20.
35) Natural Damage Act section 22.
36) The Planning and Building Act (1985) section 20-1.
37) The Planning and Building Act (1985) sections 10-1 and 5.
38) Recommendation No 244 to the Storting (1996–97), cf. Report No 42 to the Storting (1996–97).
39) Water Resources Act section 7.
40) The Planning and Building Act (1985) sections 33 and 68, cf. the Natural Damage Act section 20-22.

4 Facts

4.1 What mapping of flood and landslide hazards has taken place, and how is it communicated?

4.1.1 Mapping and communication of flood hazards

The Commission on Flood Protection Measures that was appointed after the big flood in Eastern Norway in 1995 proposed that a national map database of flood inundation maps be established for those sections of Norwegian watercourses where the damage potential is greatest. The Commission recommended detailed mapping of terrain and river profiles and the calculation of water levels and flood dimensions.[41]

The main purpose of the flood inundation maps is to provide municipalities with a better basis for land use and emergency planning. The maps are intended to help to reduce damage by preventing new development in areas at risk of flood. In its guidelines, NVE has stipulated the safety levels that should form the basis for various types of development in areas at risk.[42] Most buildings (homes, holiday homes, agricultural buildings, industrial buildings, office buildings, schools, hospitals, infrastructure etc.) must be protected against a 200-year flood.[43]

As recommended by the Commission on Flood Protection Measures, the areas along major watercourses that have historically been most at risk of flooding have now been mapped. The flood inundation maps have been produced in various scales, usually between 1:5000 and 1:15000. The reason for this variation is the design of the various map sheets and whether the area in question is covered by one or more sheets. It was also important that the sheets overlap. Map 1 shows which stretches of watercourse had been mapped for flood hazard as of November 2008. The mapping work was carried out by NVE.

Map 1 shows the mapped flood hazard areas. Most of the mapping has been done in Eastern Norway and in the counties of Møre og Romsdal and Sør-Trøndelag. Short stretches have been mapped in most counties.

Flood in Glomma, June 1995.

41) NOU 1996:16 *Tiltak mot flom ("Measures to prevent flooding").*

42) NVE guidelines no 1/2008 *Planlegging og utbygging i fareområder langs vassdrag ("Planning and development in hazard areas along watercourses").*

43) See more about return periods in the list of definitions in the Introduction section.

Map 1 Watercourses with flood inundation maps

Source: Norwegian Geotechnical Institute

Map 2 The number of buildings per county in mapped 200-year flood areas

Source: Norwegian Geotechnical Institute

Table 2 Buildings and inhabitants within mapped 200-year flood areas

County	Number of buildings	Number of persons
Hedmark	1 402	3 323
Buskerud	1 313	4 222
Sogn og Fjordane	848	2 177
Sør-Trøndelag	601	2 061
Telemark	516	1 696
Oppland	479	1 029
Akershus	477	1 567
Vest-Agder	466	1 722
Møre og Romsdal	372	768
Nord-Trøndelag	320	1 023
Finnmark	215	449
Hordaland	137	317
Rogaland	131	458
Nordland	125	314
Østfold	107	799
Troms	49	109
Aust-Agder	2	0
Total	**7 560**	**22 034**

Source: Norwegian Geotechnical Institute

Table 3 Buildings and inhabitants within mapped 500-year flood areas

County	Number of buildings	Number of persons
Hedmark	1 791	4 202
Buskerud	1 589	5 427
Akershus	1 475	5 565
Sogn og Fjordane	903	2 303
Sør-Trøndelag	801	2 633
Telemark	766	2 593
Vest-Agder	590	2 100
Oppland	550	1 212
Møre og Romsdal	469	1 087
Nord-Trøndelag	397	1 254
Finnmark	258	551
Nordland	168	382
Rogaland	164	563
Hordaland	144	331
Østfold	107	799
Troms	80	193
Aust-Agder	3	3
Total	**10 255**	**31 198**

Source: Norwegian Geotechnical Institute

How many buildings and inhabitants are there in the flood areas covered by the government mapping work?

The Norwegian Geotechnical Institute (NGI) has, on assignment from the Office of the Auditor General, prepared a report that provides an overview of the number of buildings and inhabitants in areas which the mapping identified as being at risk of floods and landslides. NVE guidelines recommend that no houses be built within the 200 year flood zone, which is the level shown in map 2.

Map 2 provides an overview by county of the number of buildings in 200-year flood zones as of November 2008. The map shows that the highest number of buildings in flood zones is found in Eastern Norway, where most mapped stretches of watercourse are found, and the lowest numbers are in the counties of Aust-Agder and Troms. As the map shows, there has been no mapping in Oslo and Vestfold.

Table 2 shows the estimated number of buildings and inhabitants per county within the 200-year flood zone. The table shows that there are more than 7,500 buildings and about 22,000 persons living in mapped flood zones for 200-year floods. The buildings in the table include 6,298 homes, 115 schools, 34 hospitals, 380 holiday homes and 733 hotels.

Hedmark is the county with the highest number of buildings in areas mapped for 200-year floods, but there are more inhabitants in such areas in Buskerud. There are more persons per house there than in Hedmark, where there are also more buildings without permanent residents.

NVE also produces maps for 500-year floods. For a total overview of the mapped flood hazard in Norway, table 3 shows how many buildings and inhabitants there are in the 500-year flood areas.

Table 3 shows that there are more than 10,000 buildings and about 31,000 persons living in mapped flood zones for 500-year floods. These figures include the 200-year flood figures, and there are more than 2,500 more homes in areas mapped for 500-year floods. The increase is smaller for other types of buildings.

As for a 200-year flood, Hedmark is the county with the highest number of buildings in mapped 500-year flood zones. Akershus will be particularly affected by a 500-year flood, but Buskerud also has more people living in flood zones than Hedmark. The explanation is the same as for a 200-year flood.

Map 3 Inundation map for 10-year flood, Lillestrøm

LEGEND

- European roads, classified roads and county roads with road number
- Municipal and private roads
- Flooded classified and county roads
- Flooded municipal and private roads
- Railroad
- Flooded railroad
- Dike
- Municipal borders
- Power lines
- Contour lines with 5-metre intervals
- Buildings not at risk from flooding
- Buildings at risk from flooding
- Buildings at risk of water in the basement
- Rivers and lakes
- Area flooded
- Basement-free zone – areas less than 2.5 meters above flood zone level. At risk of water in basement.
- Low points – areas with no direct connection to the river (behind dikes, canals etc. Probably of flooding.

Source: Norwegian Directorate of Water Resources and Energy

How extensive is the government mapping?
NVE has stated that the flood inundation project has been completed, and that about 120 stretches of river have been mapped, which is in line with the goal. A total of 105 municipalities have received flood inundation maps. Mapping priorities were decided based on the probability of flood damage, NVE's experience and input from municipalities and county governors.

Flood inundation maps are produced by NVE and show the areas that will be flooded in a flood situation, as well as the return period, normally 10, 20, 50, 100, 200 and 500-year floods. The flood inundation mapping covers the sections of major watercourses that have the highest risk of flood damage. Minor rivers and watercourses are not covered by the national mapping project.

To illustrate this, the flood inundation maps for the town of Lillestrøm (maps 3, 4 and 5) are printed below for a 10, 200 and 500-year flood. The maps show that only the rivers Nitelva and Leira have been mapped for flood hazard. The smaller Sagelva river on the left-hand side of the map has not been mapped for floods.

Map 4 Inundation map for 200-year flood, Lillestrøm

Source: Norwegian Directorate of Water Resources and Energy

Map 5 Inundation map for 500-year flood, Lillestrøm

Source: Norwegian Directorate of Water Resources and Energy

Map 3 shows how a 10-year flood will primarily flood undeveloped river banks. This area is marked in light blue.

Map 4 shows that a 200-year flood indicated in light blue will also affect some commercial and residential areas. The shaded areas are less than 2.5 metres above the flood zone. The basements of buildings within these areas are at risk of being flooded. These buildings are marked in yellow. The areas and buildings mentioned are only shown in the maps for the 200-year flood, which is the standard map in relation to NVE's guidelines for land use. Dikes have been built along the Nitelva river to prevent 200-year floods. NVE requires a safety margin of 0.5 metres for 200-year floods, and the dikes in Lillestrøm do not meet this requirement.[44]

Map 5 shows that a 500-year flood will affect large commercial and residential areas, including Kjeller Airport. The light blue areas are the flooded areas. Orange marks buildings at risk of flooding, yellow marks buildings where there is a risk of water in the basement, while gray marks buildings not at risk of flooding. None of the dikes in Lillestrøm are dimensioned to withstand a 500-year flood.[45]

NVE has stated that the agency is carrying out a review to uncover needs for further mapping and prioritisation. The flood inundation maps are continually evaluated on the basis of new data. It is also necessary to map the effect of erosion that affects various river courses. Keeping the maps up-to-date is part of the flood inundation map work, where minor watercourses will be a priority area in future. NVE's priority list contains a total of 37 stretches of river, assigned priority from one to three. Oslo and Vestfold, which are currently not included in the national flood inundation project, have two priority two watercourses each.[46]

NVE has also stated that, for the preliminary flood risk mapping, the agency will develop a method to generate susceptibility maps for all watercourses. It has also specified that the mapping of smaller watercourses will require other methods than those used in the present flood inundation maps.

As urbanisation increases and impermeable surface materials such as asphalt and concrete become more widely used, the surface's ability to absorb large quantities of precipitation will be reduced. Climate change may result in more rain floods, which will particularly affect urban areas where the capacity of the pipe network could determine whether flood damage will occur.[47] Urban surface runoff could also cause sewage to run into river and lakes, entailing a risk of drinking water and swimming areas being polluted.

NVE has emphasised that, according to current regulations, responsibility for surface runoff in developed areas rests with the municipalities and is closely linked with municipal sewerage systems. NVE is aware that there are major shortcomings in the data for urban surface runoff, and there is currently discussion about whose responsibility this should be. NVE has also pointed to the fact that the EU Floods Directive covers mapping of surface runoff,[48] and that the directive also requires hazard and risk mapping for urban areas.

The Directorate for Civil Protection and Emergency Planning (DSB) has questioned whether the water transport system and treatment plants are sufficiently dimensioned to be able to withstand future climate change, and it describes the management of urban surface runoff in cities and towns as a 'forgotten' Norwegian vulnerability area.[49]

NVE has stated that debris flows are a type of soil slide that primarily occurs suddenly in steep watercourses and streams carrying large amounts of water, and which leads to erosion. NVE stated that it is developing a new method of mapping this landslide hazard. The goal is to produce susceptibility maps of areas with potential debris flow hazards.

What do the county governors think of the flood inundation maps?

The county governors are tasked with following up the municipalities' land use and zoning plans in relation to natural hazards such as floods. The county governors use NVE's flood maps as support in their follow-up of the municipalities' land use planning, and they were therefore asked

44) Naserzadeh, Ahmed and Pereira, Julio: *Flomsonekart, Delprosjekt Lillestrøm ("Flood inundation maps, sub-project Lillestrøm").* NVE report no 13/2005.
45) Naserzadeh, Ahmed and Pereira, Julio: *Flomsonekart, Delprosjekt Lillestrøm ("Flood inundation maps, sub-project Lillestrøm"),* NVE report no 13/2005.
46) www.nve.no.
47) CIENS Adaptation to climate change in the Oslo Region, report 1 – 2007.
48) Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks.
49) Directorate for Civil Protection and Emergency Planning; National Vulnerability and Emergency Preparedness Report for 2005 and National Vulnerability and Emergency Preparedness Report for 2007.

to comment on their use of the flood inundation maps and what they think of them.

Municipalities in 17 counties have received flood inundation maps. The county governors in these counties were asked in the questionnaire survey how the flood inundation maps functioned as a tool in planning and building matters. Eleven of them responded that they were largely satisfied with the flood inundation maps as a tool in planning and building matters, while six county governors answered that they were partly satisfied. They were also asked how confident they were that the flood inundation maps show all hazardous areas. The majority of county governors responded that they are very confident that the flood inundation maps show all hazardous areas.

One county governor stated that he was not confident that the flood inundation maps show all hazardous areas, and elaborated on this as follows: "... the flood inundation mapping does not cover all watercourses that may need mapping. For areas that have been mapped, the estimates are based on past observations, and this is a potential weakness, particularly in relation to future climate change."

In the questionnaire survey, the county governors were asked to comment on proposals for improving the maps. The majority stressed that the maps must cover more watercourses. Three county governors commented that the maps did not take climate change into consideration. Ten county governors wanted maps that were easier to coordinate with their own mapping tools, as there are different types of digital mapping tools for use in land use and zoning work.

Is the knowledge passed on to relevant users?
Dissemination of national mapping, map data and information to municipalities and other relevant users is very important in order to achieve the national objectives for the prevention of flood hazards.

In the interviews with NVE, it was said that the flood inundation maps are handed over to the municipalities at meetings with the administration and political leadership to which the press is also invited. NVE emphasised that the information from the maps can help to raise some municipalities' awareness of flood hazards.

In order to find out whether the municipalities were aware that they had received flood inundation maps, they were asked about this in the questionnaire survey. Of the 226 municipalities that responded, 65 (25%) of them had received flood inundation maps from NVE. Six of them were not aware that they had received such maps. The other 59 municipalities stated that they had received flood inundation maps.

4.1.2 Mapping and communication of landslide hazards

Susceptibility maps have been prepared for rockfall and snow avalanches. The scale of the susceptibility maps is 1:50000, and they cover about 50 percent of Norway.[50] The Geological Survey of Norway (NGU) used to be responsible for the mapping. From 1 January 2009, NGU carries out the mapping on assignment from NVE. The maps are available on the website *skrednett.no*. Large mountainous areas were not mapped in the past because there was no settlement or infrastructure, and therefore a low risk of damage. Some of these areas may have been developed since then. The scale of these maps is larger than for the hazard maps, and they are therefore called susceptibility maps.

Among other things, the susceptibility maps have been produced in order to help municipalities in their land use planning, and they form the basis for map analyses.

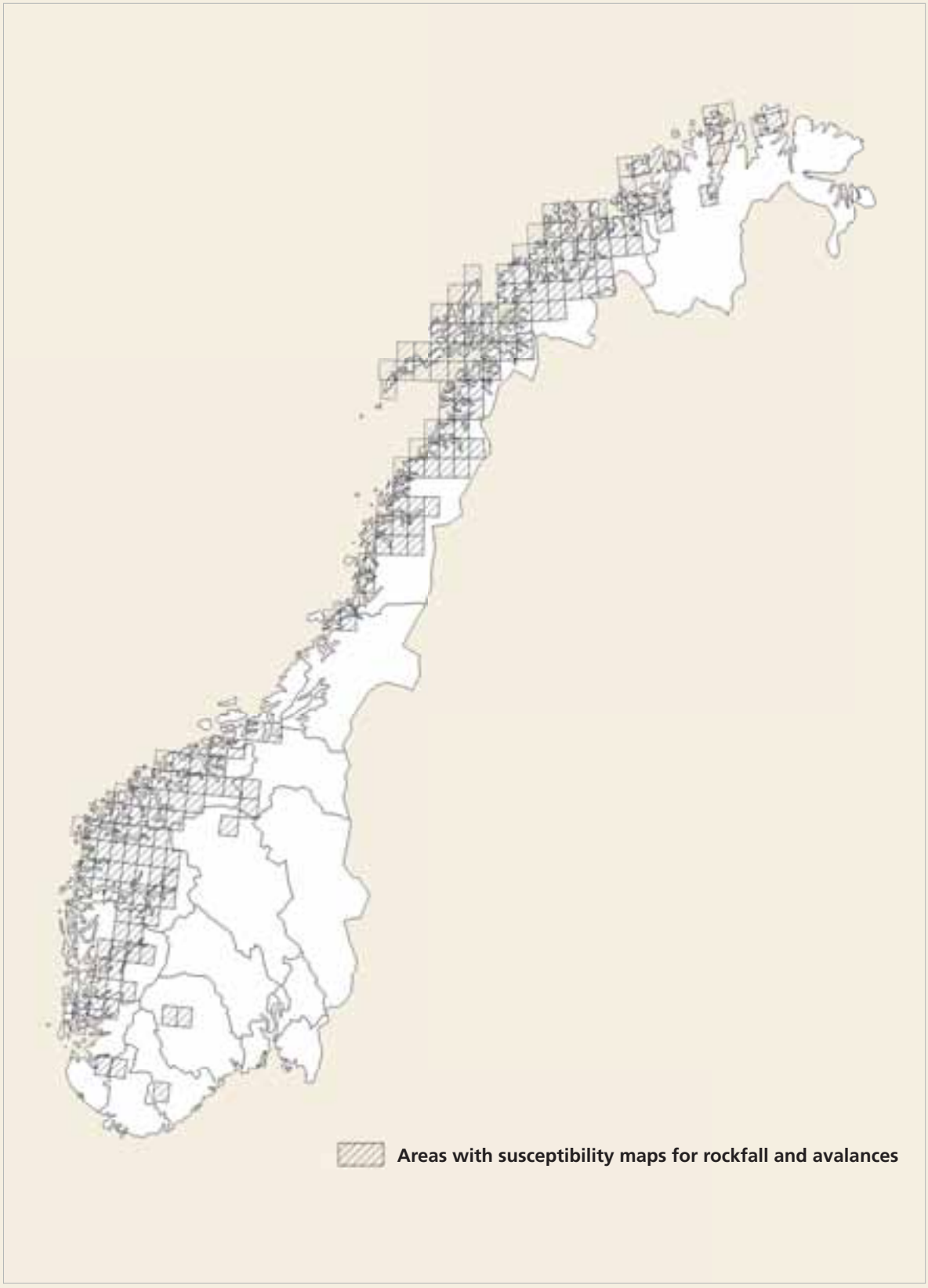
Map 6 shows the areas that have susceptibility maps for rockfall and snow avalanches. These areas are spread across 171 municipalities, and the maps cover all or part of the municipalities. The map data were supplied by NGU and show the areas mapped as of November 2008.

The map shows that most mountainous and coastal municipalities in Western and Northern Norway have been mapped for rockfall and snow avalanches.

How many buildings and persons are there in the landslide areas covered by the government mapping work?
In the same way as for the flood inundation maps, the number of buildings in the susceptibility areas has been mapped. Map 7 shows buildings within the mapped susceptibility areas for rockfall and snow avalanches as of November 2008 by county.

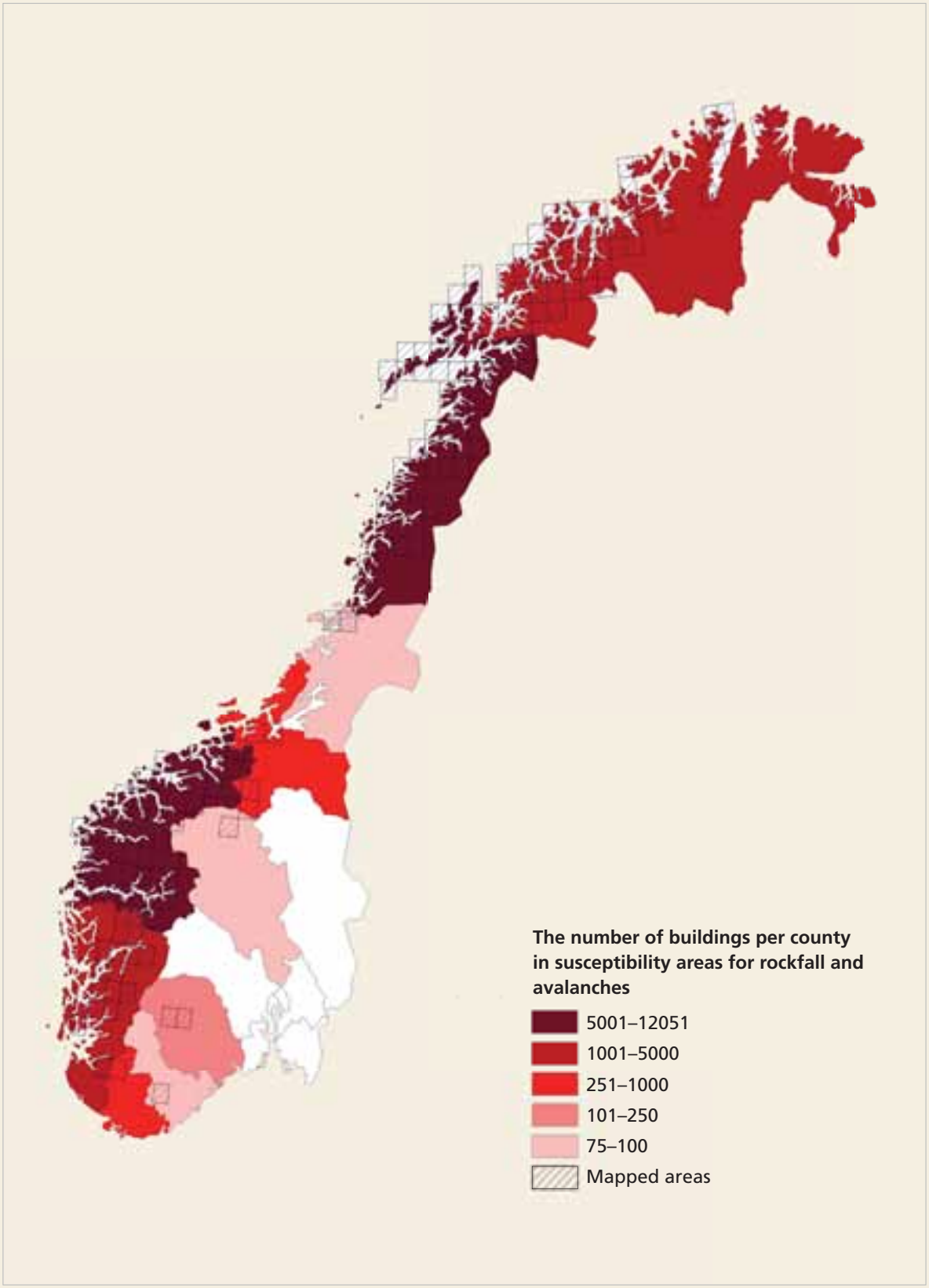
50) The susceptibility maps follow the N50 series, which is the Norwegian Mapping Authority's main series of topographical maps, and which is also called M711.

Map 6 Areas with susceptibility maps for rockfall and snow avalanches



Source: Norwegian Geotechnical Institute

Map 7 The number of buildings per county in susceptibility areas for rockfall and snow avalanches



Source: Norwegian Geotechnical Institute

The map shows that there are most buildings in the susceptibility areas in Møre og Romsdal, Sogn og Fjordane and Nordland. Few areas have been mapped in Aust-Agder, Vest-Agder, Telemark, Oppland and Nord-Trøndelag. The map also shows that six of 19 counties (Østfold, Akershus, Oslo, Hedmark, Buskerud and Vestfold) do not have susceptibility maps.

Table 4 provides an overview of the number of buildings located in areas mapped for rockfall and snow avalanches by county, and how many inhabitants these mapped susceptibility areas are estimated to have. The table covers the 13 counties with susceptibility maps.

Table 4 shows that more than 40,000 buildings are located in mapped susceptibility areas for rockfall and snow avalanches. Over 24,000 of them are homes, in which a total of about 72,000 persons live. Møre og Romsdal and Sogn og Fjordane are the two counties with the highest number of buildings and inhabitants in susceptibility areas for rockfall and snow avalanches. Approximately 60 percent of people living in areas that are potentially at risk of landslides live in these two counties. The survey also includes buildings that are not homes. Nordland has more buildings in susceptibility areas than Troms, although more people live in these areas in Troms. Troms also has more homes with a greater average number of residents than in Nordland. In addition to homes, the buildings in the table include 40 hospitals, 167 schools, 15,135 holiday homes and 1,358 hotels.

Map 6 shows that few or only small areas have been mapped in Nord-Trøndelag, Aust-Agder and Oppland. This explains why so few buildings in these counties appear in the table. The map also shows that only one map sheet has been mapped from Vest-Agder. This area contains 252 buildings with 73 residents.

How extensive is the government mapping?

NGU has referred to the fact that the susceptibility maps are overview maps on a scale of 1:50000. The term susceptibility maps was introduced by NGU in 2007 because some municipalities imposed bans on building within mapped areas without carrying out further surveys. The susceptibility maps only provide an indication of the landslide hazard and indicate where further surveys are required. The maps do not differentiate between where landslides may start and how far a landslide may extend.

NGU has stressed that it is a disadvantage that the map series covers two different processes, rockslides and snow avalanches, with different return periods. This has consequences for the maps' usefulness. The maps do not indicate how often landslides may occur. NGU states that the maps were produced relatively cheaply and quickly, but with varying quality. The assessments in the field depend on personal judgment, and the data basis is often not very well documented. The number of persons who carry out a survey of an area has therefore subsequently been increased from one to two.

A map sheet for Rauma municipality is shown below as an illustration of susceptibility maps for rockfall and snow avalanches. The map is meant to give an initial indication of any landslide hazard and is divided into three zones:

- potential hazard areas
- areas with little or no landslide hazard
- unmapped areas

Map 8 shows potential hazard areas along most of the mountainsides. The mountaintops are marked in yellow, which indicates that the areas have not been mapped due to lack of infrastructure. The areas at the bottom of the valley are white, indicating that there is little or no hazard of rockslides or snow avalanches. The maps do not differentiate between where landslides may start and the direction in which they will move.

What do the county governors think of the susceptibility maps for rockfall and snow avalanches?

As for the flood inundation maps, county governors who stated that municipalities in their county had susceptibility maps for rockfall and snow avalanches were asked if these maps met their requirements.[51] Susceptibility maps exist for 13 counties, but only five county governors knew of the maps.

Two of the county governors stated that the susceptibility maps for rockfall and snow avalanches were not very satisfactory. The grounds given were that the maps are too rough and inaccurate. The third county governor replied that the susceptibility maps were to a certain extent satisfactory as a tool in planning and building matters. The last two county governors felt that the susceptibility maps were largely satisfactory. One of them said:

51) Municipalities that have stated that they have received susceptibility maps but which, according to NGU's data, have not been sent maps, have not been included in the responses.

Table 4 Buildings and inhabitants in mapped susceptibility areas for rockfall and snow avalanches

County	Number of buildings	Number of persons
Møre og Romsdal	12 051	23 224
Sogn og Fjordane	10 547	19 423
Nordland	5 391	8 108
Troms	4 959	9 645
Hordaland	3 975	6 456
Finnmark	1 191	2 937
Rogaland	1 180	1 306
Sør-Trøndelag	786	630
Vest-Agder	252	73
Telemark	193	142
Nord-Trøndelag	81	114
Aust-Agder	77	68
Oppland	75	29
Total	**40 758**	**72 155**

Source: Norwegian Geotechnical Institute

Map 8 Rockslide and snow avalanche susceptibility map for Åndalsnes in Rauma municipality in Møre og Romsdal

Source: www.skrednett.no

> "The real problem has nothing to do with the quality of the susceptibility maps. The susceptibility maps must be "coarse-meshed". What is missing is a methodology and guidelines for the preparation of risk and hazard zone maps. That is something else altogether. Susceptibility maps cannot be improved to become hazard zone maps. We need both."

The other county governor expressed the following opinion:

> "Susceptibility maps provide a good overview, but cannot be used as risk or hazard zone maps. There are "educational" challenges relating to explaining what the maps actually show and the limitations in the use of such maps."[52]

All five county governors want more accurate maps than the rockfall and snow avalanche susceptibility maps. Other proposed improvements to the maps included indicating the areas that can be affected by landslides more clearly, indicating safety measures and coordinating them with the county governor's maps. Maps should also incorporate local knowledge in a better way, for example by indicating previous landslides.

Is the knowledge passed on to relevant users?
NGU has stated that the susceptibility mapping was initiated in 1980 by the Norwegian National Fund for Natural Damage Assistance, and NGI was given the task of preparing the maps. In the second half of the 1990s, the Ministry of the Environment decided that the Norwegian Mapping Authority should continue the mapping programme. NGU took over responsibility from 2004, and with the start-up of www.skrednett.no in 2005 all susceptibility maps were digitalised. The maps have been passed on to the municipalities by the agencies that have been in charge of preparing them at different times.

Susceptibility maps for rockfall and snow avalanches have been prepared for 109 of the 266 municipalities that responded to the questionnaire survey. The majority (65) of the 109 municipalities stated in the questionnaire survey that they had no knowledge of the maps. The remaining 44 municipalities answered that they were aware that they have received susceptibility maps. As mentioned above, the susceptibility maps may cover all of or only parts of a municipality.

52) Questionnaire survey of county governors.

The county governors were asked whether municipalities in their county had received susceptibility maps for rockfall and snow avalanche. Of the 13 county governors in question, eight answered that they were not aware of any municipalities in their county having received such susceptibility maps. In these eight counties, there are 11,514 buildings in areas mapped for potential rockfall and snow avalanches, and 20,065 persons live in these areas.

The Ministry of Petroleum and Energy has stated that it has no specific plans for NVE to pass on old maps, among other things because work is under way on new susceptibility mapping for rockfalls. Dissemination is one of NVE's priority tasks, along with mapping and land use planning. NVE has stated that e-mails were sent to all municipalities and that information about the new susceptibility maps for rockfalls has been made available on NVE's website.

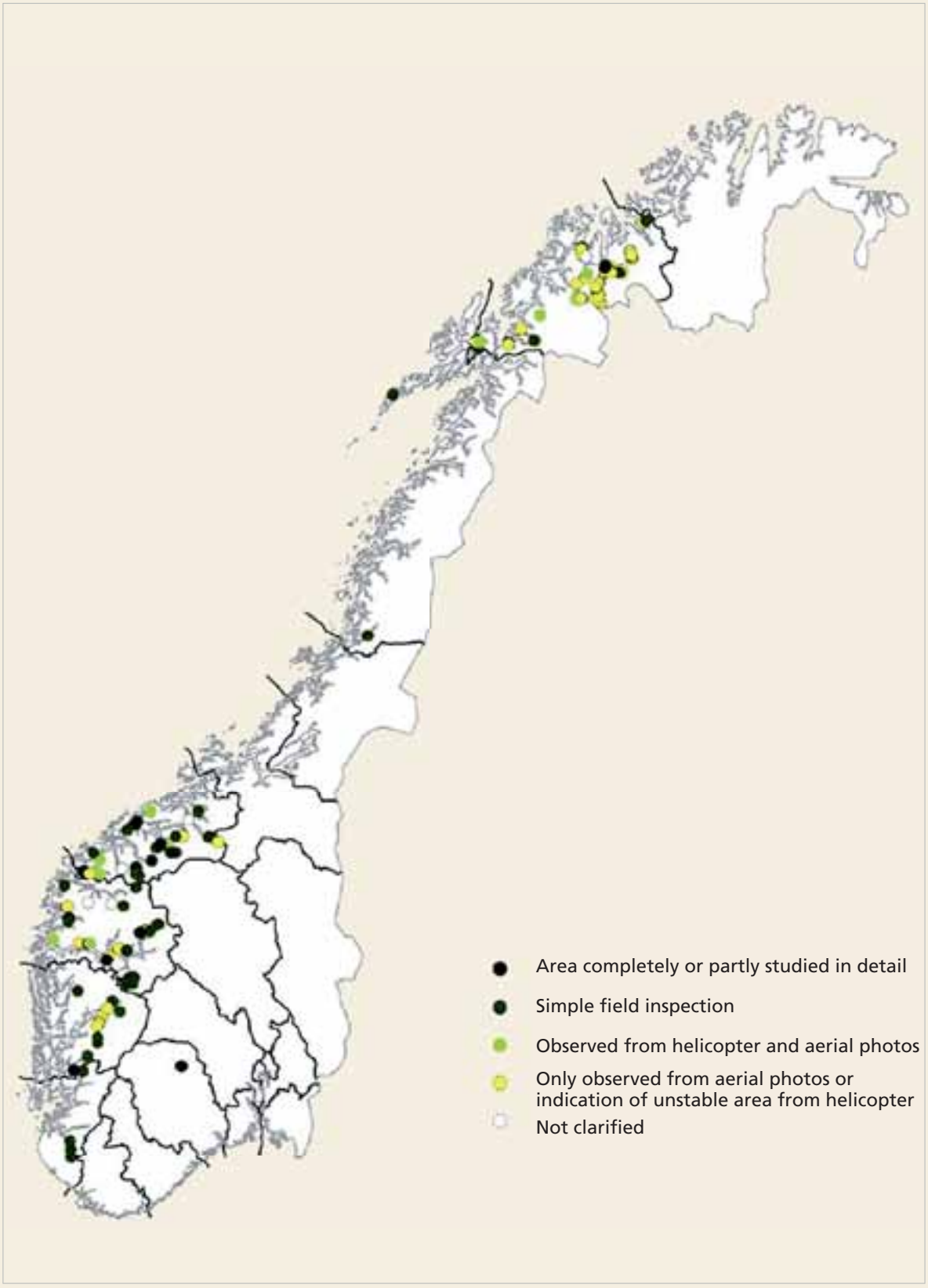
Other and new landslide mapping by national authorities
Large rock avalanches have a volume of more than 100,000 cubic metres. In some cases, rock avalanches as small as 10,000 cubic metres can carry large amounts of lower-lying scree with them. In such cases, the definition of large rock avalanches must also cover smaller rock avalanches that could carry with them loose debris and result in a total volume of more than 100,000 cubic metres.[53]

The Directorate for Civil Protection and Emergency Planning states in its national vulnerability analysis for 2007 that large rock avalanches constitute a serious risk in parts of Norway.[54] There were three such avalanches in the 20th century: in 1905 and 1934 in Loen and in 1936 in Tafjord. A total of 175 people were killed by these avalanches. The largest avalanche in Norwegian history was the Tjelle avalanche in the Langfjord in the Romsdal region in 1756, where about 15,000,000 cubic metres of rock fell into the fjord and caused tidal waves of more than 50 metres.[55]

In the 1990s, NGU initiated systematic mapping of potential rock avalanches in collaboration with the county geologist for Møre og Romsdal. The Åknes/Tafjord project drew particular attention to

53) Geological Survey of Norway, *Store fjellskred i Norge ("Major rock avalanches in Norway"),* 2006.
54) Directorate for Civil Protection and Emergency Planning. *National Vulnerability and Emergency Preparedness Report (NSBR)* 2007.
55) www.skrednett.no

Map 9 Known unstable mountain areas in Norway



Source: The report *Store fjellskred i Norge ("Major rock avalanches in Norway")*

the matter. In 2006, the government appointed an interdepartmental working group under the Ministry of Agriculture and Food which later that year had the report *Store fjellskred i Norge ("Major rock avalanches in Norway")* prepared.[56]

This report identifies a total of 186 potentially unstable mountain areas in seven counties. Thirty of the mountain areas have been examined in detail, while the rest of the mountains have been mapped to varying degrees. In addition, it emerged that 400–500 locations with potential rock avalanche hazards should be roughly mapped. NGU states that it is necessary to systematically map the whole country using modern methods in order to make it easier to find other major potential rock avalanches.

Map 9 shows the location of these mountain areas and their mapping status as of 2006. The majority of the 186 known unstable mountain areas were in Western Norway and in Troms county. Most of the 30 mountains examined in detail are in Møre og Romsdal. 52 of the mountain areas where simple field investigations have been carried out are in Western Norway. Most of them have been observed from helicopters, or they have simply been studied from aerial photos (in Troms, a total of 53 mountains). NGU has stated that they are currently involved in county projects in Troms, Sogn og Fjordane and Møre og Romsdal. NVE has stated that it will be difficult for individual municipalities to handle the problems associated with major rock avalanches, and that the state must provide extra assistance to such municipalities.

After the snow avalanche in Vassdalen in 1986, where 16 soldiers were killed during a NATO training exercise, the Norwegian armed forces have prepared snow avalanche maps for their training areas. The maps have been produced on the basis of theoretical and mathematical criteria based on the inclination of the terrain, angle of the sun, vegetation etc.[57]

The armed forces' snow avalanche maps are designed for use by military units, preferably during training exercises where an avalanche group will provide daily avalanche forecasts. The maps show two zones: the trigger area and runout area. The basis for the dimensions of the hazard areas is avalanches with an estimated return period of about 100 years, which means that the extent of large and rare avalanches will not always be included. This map series is not suitable as an aid in land use planning and processing of building applications.[58] The maps are also available to others at www.skrednett.no.

The Norwegian Public Roads Administration also registers landslides affecting roads, and the Norwegian National Rail Administration registers those that affect the railway system. The report from NGI shows that such maps are unsuitable as an aid in municipal land use planning since they do not show the potential extent of rare landslides, which the Planning and Building Act requires for new buildings.[59]

The in-depth study of eight municipalities showed that there are municipalities that use the Norwegian Public Roads Administration's landslide registration maps in their assessment of building matters. Such maps show where landslides have hit roads, but do not indicate the areas where they started, their extent or their return period. They are not intended for use in building matters or zoning plan processing.[60]

The Ministry of the Environment stated in an interview that it does not consider it problematic that some municipalities use the Norwegian Public Roads Administration's maps in their land use planning. The Ministry pointed out that these are often the only detailed maps that exist, and it is therefore natural for the municipalities to use them in their land use planning. The Ministry of the Environment has stressed that the municipalities must assess how reliable this mapping is, and use it sensibly.

In time, the current susceptibility maps for rockfall and snow avalanches will be replaced by new susceptibility maps that will cover the whole country. New susceptibility maps for rockfalls for all of Norway were presented in May 2009.

Map 10 is an example of a susceptibility map used in this investigation. The map shows that only part of the municipality has been mapped.

56) Geological Survey of Norway, *Store fjellskred i Norge ("Major rock avalanches in Norway"),* 2006.
57) Report to the Office of the Auditor General from the Norwegian Geotechnical Institute *Bruk av farekart for flom og skred i Norge ("The use of hazard maps for floods and landslides in Norway").*
58) Report to the Office of the Auditor General from the Norwegian Geotechnical Institute *Bruk av farekart for flom og skred i Norge ("The use of hazard maps for floods and landslides in Norway").*
59) Report to the Office of the Auditor General from the Norwegian Geotechnical Institute *Bruk av farekart for flom og skred i Norge ("The use of hazard maps for floods and landslides in Norway").*
60) Report to the Office of the Auditor General from the Norwegian Geotechnical Institute *Bruk av farekart for flom og skred i Norge ("The use of hazard maps for floods and landslides in Norway").*

Map 10 Old susceptibility map for rockfalls and snow avalanches, section from Melhus municipality

KEY

Mapped for landslide hazard

Potential hazard area

Not mapped

Safe areas

Source: www.skrednett.no

Map 11 New susceptibility map for rockfalls, section from Melhus municipality

KEY

Rockfalls – susceptibility map

Trigger area

- Terrain where rockfalls can be triggered
- Rockfalls can start from smaller hillsides not indicated by the contour lines

Runout area

- Terrain below the trigger area that the
- The range of very rarely occurring landslides can exceed the indicated run-out area. This map can therefore not be used to plan buildings.

Source: www.skrednett.no

Map 12 Mapped hazard areas for quick clay slides

Source: Norwegian Geotechnical Institute

Table 5 The number of buildings and residents in mapped quick clay areas

County	Number of buildings	Number of persons
Sør-Trøndelag	6 754	32 025
Akershus	3 897	11 586
Nord-Trøndelag	2 028	5 340
Buskerud	1 833	6 519
Telemark	1 238	3 942
Vestfold	1 123	3 356
Østfold	488	1 479
Nordland	65	155
Troms	25	55
Total	**17 541**	**64 457**

Source: Norwegian Geotechnical Institute

Mapped areas with no landslide hazards are white. Pink areas are potentially at risk of landslides. The rest of the area, marked in yellow, has not been mapped.

Map 11 is produced using a new method based on digital GIS analyses. Geographical information systems (GIS) are computer-based systems for the recording, modelling, adaptation, analysis and presentation of geographical data.

Here, the whole map sheet has been mapped, and it shows that a large part of the municipality may be at risk of rockfall. Terrain where rockfalls can be triggered is marked in red, and pink marks the runout areas that the rockfalls can reach. NGU specifies that this is still a susceptibility map and that further surveys will be required in the event of development.

4.1.3 Mapping and communication of quick clay slides

The background for the mapping of quick clay was the 1978 Rissa landslide in which one person was killed and 15 farms destroyed. The landslide destroyed a large area and had a volume of between five and six million cubic metres. It attracted a lot of public attention, and the authorities saw a need for mapping of the quick clay areas. The work took as its starting point NGU's Quaternary geology mapping, which shows what processes created various soil types. Marine deposits are of particular interest in relation to quick clay.

NGU has stated that, in order to improve existing knowledge of areas with quick clay, a hazard zone mapping programme was initiated in 2000 in a collaboration between NVE, NGI, NGU and relevant municipalities. To begin with, marine clay areas in Eastern Norway and the Trøndelag region were given priority, but the mapping has now been expanded to also cover smaller locations in Northern Norway.

NVE has stated that the mapping project for quick clay has been completed for South-Eastern Norway and the Trøndelag region. The areas mapped as of November 2008 are shown in map 12.

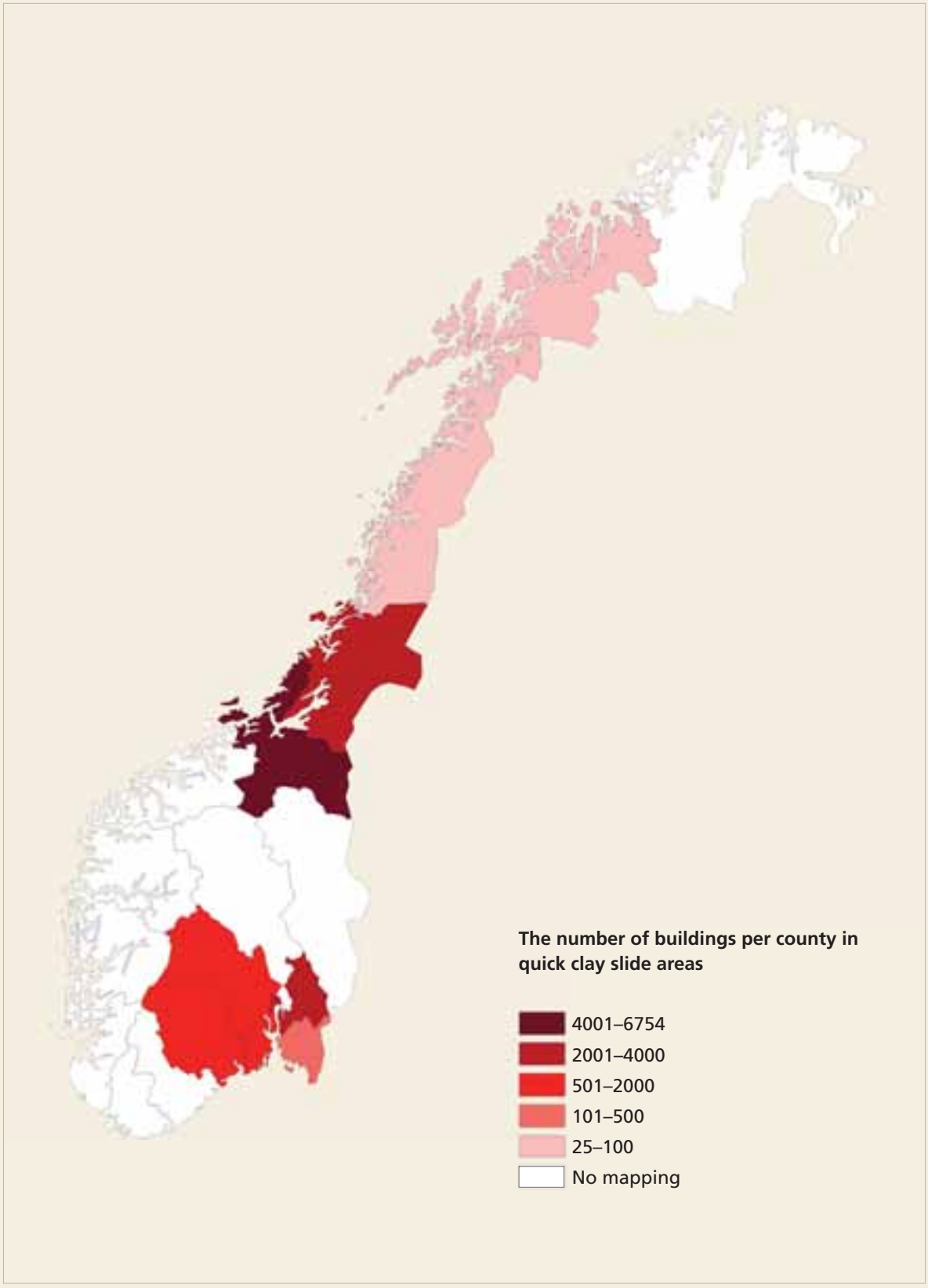
Map 12 shows the areas identified as hazard areas for quick clay slides. A total of 70 municipalities in nine counties have received quick clay maps. The maps focus on areas with marine deposits where the occurrence of quick clay is most well-known. This includes areas in Eastern Norway and the Trøndelag region, but smaller areas in the counties of Nordland and Troms have also been mapped. In an enclosure with a letter of 30 November 2009, the Ministry of Petroleum and Energy stated that more than 1,600 Norwegian quick clay zones with landslide hazards have been mapped. The zones have been classified by hazard level, consequence and risk.

How many buildings and persons are there in the quick clay areas covered by the government mapping work?

Map 13 and table 5 provides an overview by county of the number of buildings and areas at risk of quick clay slides.

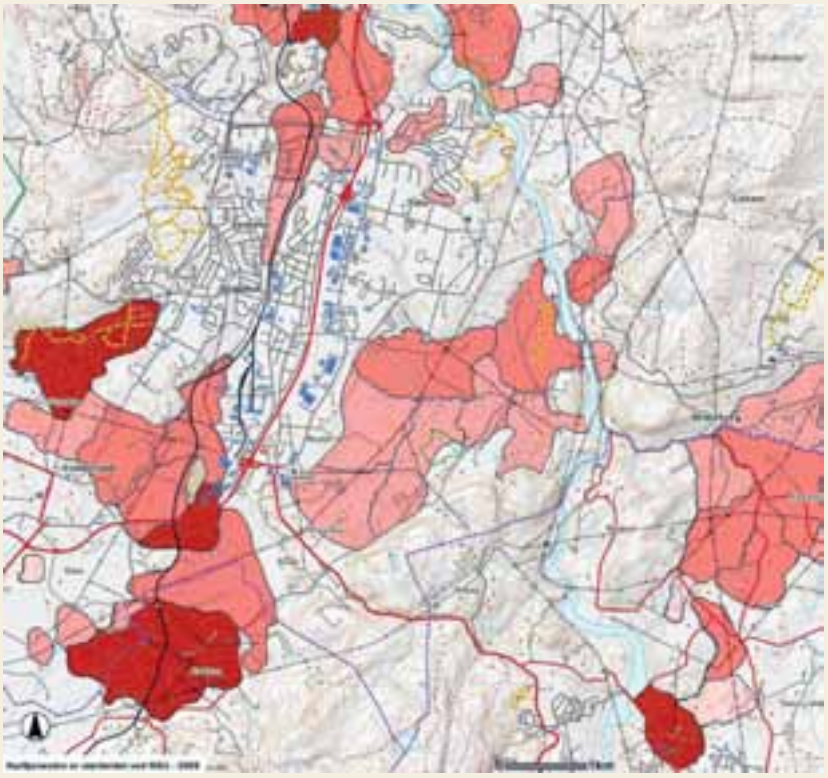
Map 13 shows that Sør-Trøndelag has the highest number of buildings in the mapped hazard area for quick clay slides. The map also shows that Akershus and Nord-Trøndelag have many buildings in mapped quick clay areas. Few areas have been mapped for quick clay in Nordland and

Map 13 The number of buildings in mapped hazard areas for quick clay slides by county



Source: Norwegian Geotechnical Institute

Map 14 Quick clay map for Trondheim municipality



Source: www.skrednett.no

Troms. It is also evident that no mapping has taken place in ten counties.

Table 5 provides an overview by county of the estimated number of buildings and residents in mapped quick clay areas.

The table shows that there are 17,541 buildings (16,879 homes, 72 schools, 205 hospitals, 7 prisons, 222 holiday homes and 76 hotels) and more than 64,457 inhabitants in the areas mapped for quick clay slides. Sør-Trøndelag has by far the highest number of buildings and inhabitants in quick clay areas, but Akershus, Nord-Trøndelag and Buskerud also have many buildings in quick clay areas.

How extensive is the government mapping of quick clay areas?

The incidence of quick clay is limited because special soil mechanics are required for quick clay to arise. This means that mapping need not be as extensive as for floods and rockslides.

The quick clay slide maps show zones with areas exceeding 2.5 acres and altitude differences of more than 10 metres. The quick clay programme is intended to provide an improved basis for reducing the risk of loss of life and assets as a result of landslides along watercourses.

Map 14 shows the mapping for parts of Trondheim municipality. It has been included to illustrate a quick clay map. The coloured areas show mapped areas where quick clay is assumed to be present or has been found. The different colours denote different categories of quick clay slide hazard. Before construction activity that could affect the stability of the soil is started in these areas, more detailed surveys are required, as well as safeguard measures if relevant.[61] Unmarked areas could also contain quick clay, since the mapping only shows zones of more than 2.5 acres. Nor does it indicate runout areas.

NVE has stated that its goal is to draw up a landslide mapping plan during 2009 that will include quick clay based on a risk assessment. This is particularly relevant to Northern Norway and beach zones in areas that have already been mapped.

NVE has also specified that the agency has no plans to map zones smaller than 2.5 acres in its

61) NVE *Planlegging og utbygging i fareområder langs vassdrag ('Planning and development in hazard areas along watercourses')* no 1 2008, revised 5 March 2009.

Quick clay slide in Namsos, March 2009. Photo: Gorm Kallestad / Scanpix

national mapping. The questionnaire survey found that some municipalities wanted more detailed mapping of quick clay. 25 municipalities with quick clay maps and two county governors with quick clay maps in their counties thought that the maps should include quick clay areas of less than 2.5 acres.

What do the county governors think of the quick clay maps?

As for the flood inundation maps and susceptibility maps for rockfall and snow avalanche, the county governors were asked for their opinion of the quick clay maps. Nine county governors stated in the questionnaire survey that municipalities in their counties had received quick clay maps. The county governors were asked how satisfactory they found the quick clay maps to be in connection with the processing of planning and building matters. Seven county governors responded that the quick clay maps are to a great extent satisfactory, while the other two responded that they are to a certain extent satisfactory in planning and building matters.

When asked to propose improvements in the quick clay maps, four county governors thought that the quick clay maps should be coordinated with the county governors' mapping tool. The same four county governors gave the same response when asked to propose improvements in the flood inundation maps.

However, the county governors consider it a problem that there are areas at risk of quick clay slides that have not been mapped. They are particularly concerned about areas smaller than 2.5 acres, which are not part of the national hazard mapping for quick clay slides. Four county governors also wanted the maps to indicate areas that could be affected by quick clay slides, as well as any safeguard measures implemented.

Is the knowledge obtained passed on to relevant users?

NVE has stated that the agency hands over quick clay maps at similar meetings with the municipalities as for flood inundation maps. Of the 70 municipalities that have received quick clay maps, 43 responded to the questionnaire survey. Four of the municipalities were not aware that they had received such maps.

The example of Namsos

On 13 March 2009, there was a quick clay slide at Kattmarka in Namsos municipality. Several houses and cabins were swept away, and roads as well as the water and sewage networks were damaged. The landslide affected nearly 100 persons, but no one was injured. The Kattmarka

landslide covered about 7.5 acres. The quick clay mapping of Namsos did not indicate that this area was at risk of quick clay sides.

The landslide in Namsos occurred in an area marked as beach deposits in the Quaternary geology map from the NGU.

The Ministry of Transport and Communication initiated an investigation of the landslide. The report was presented on 26 June 2009 and concluded that the slide had been triggered by ongoing road work. The report shows that it is a well-known fact in the geotechnical community that not all quick clay zones have been mapped. It is not uncommon for soil examinations of marine clay deposits to uncover unknown quick clay zones.[62]

NVE has stated that the agency had provided input to the work on the municipal plan for Namsos stating that they should be aware of the quick clay risk in Kattmarka.

4.1.4 How does climate change affect flood and landslide mapping?

The Ministry of Petroleum and Energy has stated that the work on climate adaptation has resulted in increased attention being devoted to flood and landslide hazards. The Ministry has referred to the increase in knowledge about potential climate change, including more rain and snow, rising temperature and new precipitation patterns. The Ministry emphasised the methodological problems relating to planning when there are so many elements of uncertainty in relation to future climate change.

NVE has stated that the agency has established an internal climate group to carry out an evaluation of the impact of climate change. The group will coordinate its work with the interdepartmental climate group under the Ministry of the Environment and the public study of vulnerability and the consequences of climate change in Norway.

The Ministry of the Environment has stated that the management signals regarding flood and landslide hazards as a result of climate change primarily consist of stipulating requirements for risk and vulnerability analyses in all municipalities through legislation[63] and in guidance.[64]

Climate change in the form of increased precipitation will cause large floods to occur more often. NVE has stated that the flood discharge for the different return periods may change, and that they will focus more on small watercourses, debris flows and landslides caused by extreme precipitation. The agency has stated that a margin should be added to the 200-year flood levels in the flood inundation maps for land use planning purposes, which in NVE's opinion should provide a certain amount of leeway and ensure a preventive approach to future climate change.

NGU has pointed out that climate change is not a parameter used in their susceptibility maps, but that it must be considered in any future mapping of hazard zones.

At the national level, climate change will result in an increase in the number of 100-year landslides. Moreover, the borderline for 100-year landslides must be moved further down the hillsides as the landslide frequency increases.

The expected rise in temperature will cause permafrost to thaw. This could cause melting in mountain areas that are currently frozen, thereby making mountain areas that are already at risk more unstable.[65]

NVE has stated that quick clay slides are first and foremost triggered by erosion and man-made events. The Directorate cannot see a direct connection between extreme precipitation and quick clay slides and believes that an increase in extreme precipitation will not entail any changes in the current quick clay maps. NGI has stated that increased precipitation and flooding increases erosion along watercourses, which could in turn increase the quick clay slide hazard.

62) NTNU *Skredet i Kattmarkvegen i Namsos 13. mars 2009 ("The landslide in Kattmarkvegen in Namsos on 13 March 2009"). Report from the investigation team appointed by* the Ministry of Transport and Communication.

63) The Planning and Building Act section 4-3.

64) *Samfunnssikkerhet i arealplanlegging – Kartlegging av risiko og sårbarhet ("Civil protection in land use planning. Mapping of risk and vulnerability").* Theme booklet from the Directorate of Civil Protection and Emergency Planning.

65) Ketil Isaksen *Endring i permafrost ("Permafrost changes")* in *Utviklingen av naturulykker som følge av klimaendringer ("The development of natural accidents as a result of climate change"),* CICERO Report 2007:33.

4.2 How do the authorities ensure that national objectives relating to floods and landslides are adequately followed up?

Pursuant to the Water Resources Act, the Ministry of Petroleum and Energy is the overriding national watercourse authority and, through NVE, it has responsibility for floods and watercourse-related landslides. The Ministry of the Environment is responsible for the part of the Planning and Building Act that concerns planning of land use for land that could be exposed to hazards, including floods or landslides. Each municipality approves development in accordance with their land use and zoning plans.

4.2.1 The Ministry of Petroleum and Energy's responsibilities and tasks with respect to limiting flood and landslide hazards

The Ministry of Petroleum and Energy has overriding responsibility for mapping hazard areas and preventing watercourse-related damage. In a letter of 30 November 2009, the Ministry states that it is working to reduce risk. Some of the measures are aimed at reducing hazard, while most of them are aimed at reducing consequences.

NVE is under the authority of the Ministry of Petroleum and Energy. The agency shall help to prevent damage from floods, erosion and landslides by

- mapping and disseminating information about hazard areas
- providing municipalities with expert advice and guidelines in land use planning and development
- providing municipalities with expert help and financial assistance in the planning and implementation of safeguard measures
- issuing warnings of flood and landslide hazards
- providing expert assistance to municipalities, the police and other emergency response organisations in emergency situations

From 1 January 2009, NVE was assigned national responsibility for handling government administrative tasks relating to landslide prevention. This assigning of responsibility for and tasks relating to flood and landslide efforts in Norway to one agency strengthens the government's work on preventing landslides. It is an important priority for NVE in 2009 to develop sufficient capacity and expertise to exercise its responsibility for landslides. Mapping the landslide hazard and assisting in land use planning are also priority tasks.[66]

NVE's responsibility for providing government help to prevent landslides does not alter the responsibility of municipalities and developers for landslide-related safety in land use planning and development.[67]

NVE's organisation consists of a head office in Oslo and five regions with regional offices as shown in map 15. The responsibility for providing input to and issuing statements on municipal land use plans rests with the regional offices. The agency has stated that the head office has drawn up common procedures for how the regional offices are to deal with floods and landslides.

Map 15 NVE's regions and regional offices

Source: Norwegian Directorate of Water Resources and Energy

NVE has specified that the agency provides feedback on overall municipal plans, not on all zoning plans. It has experienced periods during which it has not had the capacity to reply to all planning-related enquiries. The Ministry of Petroleum and Energy states in an enclosure to its letter of

66) Proposition No 1 to the Storting (2008–2009), the budget of the Ministry of Petroleum and Energy, cf. Budget Recommendation No 9 to the Storting (2008–2009).

67) Proposition No 1 to the Storting (2008–2009), the budget of the Ministry of Petroleum and Energy, cf. Budget Recommendation No 9 to the Storting (2008–2009).

Table 6 An overview of the number of objections raised by NVE in connection with flood and landslide hazards in the period 2003–2008

	Northern Region	Central Region	Western Region	Eastern Region	Southern Region	Total figures for NVE
2003	0	2	0	0	3	5
2004	3	2	1	2	3	11
2005	1	7	0	1	5	14
2006	1	7	0	0	13	21
2007	2	15	1	2	14	34
2008	0	17	0	4	14	35
Total	**7**	**50**	**2**	**9**	**52**	**120**

Source: Norwegian Directorate of Water Resources and Energy

30 November 2009 that plans for known quick clay areas are given priority.

Pursuant to the Planning and Building Act, NVE shall, as the expert agency, raise objections to municipal land use plans if they do not take adopted national or regional objectives, framework conditions and guidelines into consideration. During the interview with NVE's head office, it was stated that there is systematic contact with the county governor in question in the event of objections.

Table 6 shows that NVE has raised 120 objections concerning watercourse-related hazards in the period 2003–2008. The Southern Region and Central Region stand out with the greatest numbers of objections by far. The main reason given for the Southern Region is high development activity, but the high number of areas exposed to flooding and quick clay slides is also an important factor. In the Central Region, more than half the objections are raised on grounds of quick clay. This region also has a high level of development activity. The map study shows that there are many buildings in flood zones and a very high number of buildings in quick clay areas in the Central Region.

The Western Region stands out with a low number of objections, and the regional office has stated that the municipalities largely contact the agency at an early stage in their planning work. This gives NVE the opportunity to provide information about hazard maps and which flood hazards must be taken into consideration. In NVE's opinion, this reduces the need for objections.

NVE stated that the agency sees few risks being taken by municipalities in relation to hazard areas, and that few such cases therefore end in mediation. There has only been one instance in recent years of a case being sent to the Ministry of the Environment. In that case, the flood hazard was only part of the objection.

NVE's landslide prevention budget for 2009 was NOK 108 million.[68] As a result of landslide responsibility being transferred to NVE, approximately NOK 36 million has been transferred from other ministries' budgets in addition to NVE's existing landslide allocation of approximately NOK 42 million. In addition, the budget has been increased by NOK 27.6 million.[69]

The EU Floods Directive was adopted by the EU on 23 October 2007, but it has not yet been incorporated into the EEA agreement.[70] NVE has started preparing implementation of the directive in Norway on assignment from the Ministry of Petroleum and Energy. The principle of the Floods Directive is that mapping and planning efforts should be proportionate to the risk. The directive requires that necessary knowledge of the flood risk must be obtained through mapping, and that measures must be planned in a coherent and coordinated manner in accordance with adopted procedures.

NVE has pointed out that the introduction of the Floods Directive requires preliminary flood risk mapping as well as a hazard and flood risk mapping. According to NVE, the hazard and flood risk mapping is covered by the existing

68) Proposition No 1 to the Storting (2008–2009), the budget of the Ministry of Petroleum and Energy, cf. Recommendation No 9 to the Storting (2007–2008).
69) Proposition No 1 to the Storting (2008–2009), the budget of the Ministry of Petroleum and Energy.
70) Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks.

flood inundation maps, but consequence targets must also be stipulated and a method of determining risk must developed.

4.2.2 The Ministry of the Environment's responsibilities and tasks with respect to limiting flood and landslide hazards

The Ministry of the Environment has administrative responsibility for the part of the Planning and Building Act that concerns planning regulations. This legislation sets the framework for municipalities' planning work with respect to land use. The Ministry has seen a need for certain adjustments in the legislation and in the planning section of the new act that came into force on 1 July 2009. General guidelines have been prepared for the new provisions of the act[71] and thematic guidelines for civil protection and planning.[72]

Flood and landslide mapping is an important basis for handling flood and landslide hazards in land use planning. It is the county governor's responsibility to follow up the municipalities' work on land utilisation in land use planning. In the questionnaire survey, all county governors replied that they participate in municipal planning forums and planning processes through dialogue, start-up meetings, input and consultations, and that they stipulate requirements for consideration of, among other things, flood and landslide hazards. The county governors also stated that they to a great extent check whether the municipalities have considered flood and landslide hazards in their plans for land use. In the questionnaire survey, about half the municipalities with land use plans from 2008 answered that they had received input from the county governor relating to flood and landslide hazards.

Mediation in objection cases is the county governor's responsibility. Six of the county governors state in the questionnaire survey that mediation is rarely required. The other county governors responded that problems are solved at an earlier stage through dialogue, and that the municipalities comply with input from county governors without mediation being necessary. The Ministry of the Environment processes plans for land use in cases where municipal councils have rejected objections. The Ministry's decision is final and cannot be appealed. The Ministry of the Environment has stated that it receives few objections relating to floods and landslides, but that in 2008 it received three objections to plans for areas that will be at risk in the event of rock avalanches from Åkneset.

In the questionnaire survey, the county governors were given an opportunity to comment on measures to reduce the risk of floods and landslides that should be given priority in future. Fourteen county governors stated that government assistance for expertise development in the fields of floods and landslides should be given priority or higher priority. When asked about future expert help in connection with floods and landslides in municipal land use planning work, 14 county governors responded that this assistance should be given priority or higher priority. Ten of the 18 county governors felt that there was still a need to prioritise statutory regulation of flood and landslide areas. The Ministry of the Environment states in its letter of 30 November 2009 that, in the Ministry's opinion, the recently adopted Planning and Building Act adequately addresses the statutory considerations.

What responsibility does the Ministry of the Environment have for ensuring that climate change is taken into consideration?

The Ministry of the Environment has overall responsibility for coordinating climate adaptation work in Norway. The Ministry shall ensure a coherent approach and help to enable different players to attend to their responsibilities and tasks in the area of climate adaptation. The practical coordination work is assigned to a secretariat at the Directorate of Civil Protection and Emergency Planning (DSB). DSB has stated that it cooperates well with NVE on climate adaptation work.

Since 2001, Norway has been preparing the introduction of the EU Water Framework Directive of 23 October 2000,[73] which was incorporated into the EEA agreement in 2008. The directive's objective is to promote coherent water management. The directive provides an overriding framework for several underlying EU directives, including the Floods Directive and the Drinking Water Directive. The Ministry of the Environment has overall coordinating responsibility, while the Directorate for Nature Management

71) *Planlegging etter Plan- og bygningsloven ("Planning in accordance with the Planning and Building Act"), Circular T-1476.*

72) Booklet from the Directorate of Civil Protection and Emergency Planning: Samfunnssikkerhet i arealplanlegging – Kartlegging av risiko og sårbarhet *("Civil protection in land use planning. Mapping of risk and vulnerability").*

73) Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.

manages the practical work. NVE contributes along with other relevant directorates.

The Ministry of the Environment has stated that, among other channels, climate information is given to municipalities through the *Livskraftige kommuner* programme under the auspices of the Norwegian Association of Local and Regional Authorities (KS). The Ministry has emphasised that it has a responsibility to provide guidance to the municipalities in climate issues.

In the questionnaire survey, half the county governors called for assistance from central government authorities on the issue of potential climate change. This applied in particluar to guidance to municipalities where they were uncertain about climate-related matters in connection with risk and vulnerability and land use planning work. Most county governors were also dissatisfied with the answers they had received to their enquiries on climate issues. Answers from DSB and NVE, among others, were perceived as imprecise and difficult to transpose to local conditions.

4.2.3 The municipalities' responsibilities and tasks with respect to limiting flood and landslide hazards

Pursuant to the Planning and Building Act, the municipalities are authorised to make the best possible use of land in the municipality based on existing needs. Land must be set aside for various purposes, including housing development, commercial activities, schools and infrastructure. Municipalities must ensure through their land use planning that development takes place in secure areas, and, in that connection, assess the prevention of flood and landslide damage.

The Natural Damage Act section 20 states that the municipality is responsible for taking precautions against natural damage in accordance with the Planning and Building Act and implementing necessary protective measures.

As mentioned in chapter 4.1, the national mapping showed that about 66,000 buildings are located in areas mapped for 200-year floods, quick clay and landslides. These buildings include homes, schools, hospitals, nursing homes, prisons, holiday homes and hotels. Almost 160,000 persons live in the mapped hazard and susceptibility areas.

How do the municipalities see their own responsibility?

The municipalities have a key responsibility to protect their inhabitants against various natural hazards, if relevant with the assistance of the central authorities. In the questionnaire survey, the municipalities were asked to state how they perceived their legal and financial liability with respect to flood and landslide hazards. The responses show that the municipalities see this question as complicated, and that many municipalities are of the opinion that the present legislation is unclear about their responsibility in this field. They are uncertain about what responsibility the municipality actually has. For example, many were not aware of their responsibility pursuant to the Natural Damage Act.

Many municipalities point to the responsibility for older buildings as a problem, particularly for homes built before there was a zoning plan for the area. The question is what municipalities should do with new information. New mapping of an area may show that buildings are located in the hazard area for flooding, landslides or quick clay. The municipalities are uncertain about the extent of their responsibility for securing such areas. This applies, among other things, to which safeguard measures municipalities can order landowners to implement. This problem is particularly difficult when safeguard measures must be implemented on the property of other parties than those who benefit from the measures.

The municipalities find it easier to set requirements in connection with the zoning of new areas. Pursuant to the Planning and Building Act, they can require further mapping and, if relevant, safeguard measures as a precondition for permitting development of the area.

Some municipalities nonetheless point out that there is a problem if the municipality has permitted development following the necessary mapping and the area has been registered as hazard-free. Some municipalities then ask what their responsibility would be should a landslide or flood nonetheless occur in the area. The municipalities also ask how much responsibility they can assign to the developer who was responsible for mapping the area.

The Ministry of the Environment has pointed out that municipalities that have approved building in areas at risk of floods or landslides may be financially liable in the event of an accident if the

Table 7 In which year was the municipality's plan for land use most recently updated?

	How many	%
2008	43	16
2007	47	18
2006	45	17
Older	126	47
Does not know	3	1
Does not have one	2	1
N=	**266**	**100**

Source: Office of the Auditor General

Table 8 In which year was the municipality's RAV analysis most recently updated?

	How many	%
2008	53	20
2007	29	11
2006	29	11
Older	105	39
Does not know	24	9
Does not have one	26	10
N=	**266**	**100**

Source: Office of the Auditor General

damage could have been avoided had the planning process been better. In the Ministry's opinion, the responsibility for limiting flood and landslide hazards should be clear to the municipalities as the Ministry has emphasised this in its communciations with them.[74]

The Ministry of Petroleum and Energy has stated that the Ministry is aware that the municipalities want more information and stronger government involvement. The Ministry referred to the principle of subsidiarity, and administrative practice gives municipalities an independent responsibility within their areas. The Ministry of Petroleum and Energy has stated that, in some cases, the Ministry provides financial support for safeguard measures through NVE, but that it has no obligation to contribute resources in this field. The municipal responsibility also entails financial responsibility for securing existing settlements.

The municipalities' work on land use plans

Municipalities are obliged to prepare land use plans, and they were asked in the questionnaire survey when they had last drawn up land use plans. Table 7 shows when the plans were updated, and shows that nearly half the municipalities have land use plans from before 2006. The Planning and Building Act requires municipalities to evaluate their land use plans once during each election period. 43 of the municipalities have a land use plan that was approved in 2008.

Of the 265 municipalities that answered this question, less than half said that they had land use planning expertise themselves and did not require assistance in this work. 36 municipalities asked government agencies for assistance in preparing land use plans, but either did not receive help or were of the opinion that the help was inadequate.

74) See Circular T 5/97 *Arealplanlegging og utbygging i fareområde ("Land use planning and development in hazard areas").*

Risk and vulnerability analyses (RAV analyses) are an important tool for municipalities when drawing up land use plans in order to identify areas at risk of floods and landslides. With effect from 1 July 2009, municipalities are required to carry out an RAV analysis to provide a better basis for their land use planning.

In the questionnaire survey, the municipalities were asked when they last carried out RAV analyses. Table 8 provides an overview of the years when they were updated, and shows that ten percent of the municipalities have not carried out RAV analyses, and that nine percent do no know whether they have such an analysis. 39 percent of the analyses were carried out before 2006.

The in-depth study shows that it may be a challenge for municipalities exposed to several types of hazards to see the different kinds of hazard in context. One example that was highlighted was flood diversion channels located in such a manner that avalanches could block them.

The questionnaire survey of the county governors contained a question about the county governors' assessment of the quality of RAV analyses carried out by municipalities. Half the county governors were of the opinion that quality varies, and that several of the municipalities could improve their RAV analyses. Four of the county governors stated that it is difficult to assess the quality of RAV analyses. The last five county governors stated that most of the RAV analyses carried out by municipalities are of good quality.

In the questionnaire survey, 265 municipalities were asked whether they had received government assistance in connection with RAV analyses. 87 municipalities replied that they possessed the relevant expertise and therefore did not have to ask for help in carrying out such analyses.

35 municipalities wanted more help, and six received no help. 77 municipalities did not know whether they needed help for RAV analysis work. A number of municipalities stated that they need help in this work. One of the municipalities in the survey stated the following:

> "Municipalities need help, and leaving too much up to each individual municipality is a waste of resources. Central management is appropriate in this field. No one demonstrates on the streets in support of RAV analyses. The pressure on politicians focuses on education, care for the elderly and sports."[75]

The Ministry of the Environment has stated that management signals relating to flood and landslide hazards resulting from climate change are mainly given through legislation in that the new Planning and Building Act stipulates a requirement for RAV analyses. The Ministry stresses that, through RAV analyses, the municipalities will obtain a map basis with pertaining legal measures, but underlines that it is a precondition that the municipalities have the resources and expertise required to utilise the knowledge that they obtain in this manner.

The in-depth study shows how the municipalities' expertise is crucial in relation to producing good RAV analyses and land use plans to limit flood and landslide hazards. In addition to RAV analyses, geographical information systems (GIS) are an important tool in land use planning. One county governor said that some municipalities have inadequate GIS and planning expertise. As regards internal expertise in the use of GIS, 124 municipalities in the questionnaire survey answered that they possessed this expertise and that they therefore did not need government assistance. 25 municipalities wanted more help, and seven municipalities did not receive help even though they had asked for it.

The in-depth study showed that, in municipalities with small populations, case processing is highly dependent on individuals. In larger urban municipalities, more departments and personnel are often involved in work on the land use plan. It also emerged that many municipalities lack procedures for ensuring transfer of experience and expertise when it comes to handling flood and landslide hazard.

75) Questionnaire survey of the municipalities.

14 county governors who commented on future priorities in relation to flooding and landslide hazards answered that increased government help to raise competence in this field should be given priority.

The Ministry of the Environment has also pointed out that the competence and capacity of municipalities varies, and that following up all the municipalities is therefore challenging. The Ministry has also pointed out the importance of county governors' guidance to the municipalities. At the same time, the Ministry has underlined the value of intermunicipal cooperation in order to increase regional expertise and capacity.

The Ministry of the Environment has initiated an extensive training programme for county governors, county administrations and municipalities in connection with the new Planning and Building Act, but it emphasised that the introduction of the new act requires an extensive guidance process which has not been concluded.

How do municipalities use and perceive the flood and landslide maps?

In order for municipalities to be able to exercise their responsibility for preventing flood and landslide hazards, they need information about where the risk is greatest. The national mapping of flood and landslide hazards is intended to assist municipalities in this work.

In the questionnaire survey, the municipalities that had received flood inundation maps, susceptibility maps for rockfall and snow avalanches and quick clay maps were therefore asked their opinion about the maps that had been prepared for areas within the municipality. The answers were given by map type.

Flood inundation maps

59 of the municipalities that responded to the questionnaire survey had received flood inundation maps. About one third of them replied that the maps were to some extent satisfactory for their use. More than two-thirds of municipalities felt that the flood inundation maps were largely satisfactory.

Municipalities were also given the opportunity to comment on what aspects of the flood inundation maps could be improved. The flood inundation maps produced by NVE often only show parts of larger watercourses that will cause damage in the event of flooding, and smaller watercourses are

Table 9 Have municipalities organised their own mapping of flood hazard and received flood inundation maps?

		Have the municipalities received flood inundation maps?		
		Yes	No	Total
Have the municipalities organised their own flood hazard survey?	Yes	19	50	69
	No	46	151	197
		65	**201**	**266**

Source: Office of the Auditor General

often not included in the flood projects, but are shown on the flood map itself. Of the municipalities in the questionnaire survey that had received flood inundation maps, 17 said that the maps must include larger sections of the watercourses, while 21 would like the maps to include smaller watercourses.

More than one third of municipalities with flood inundation maps stated that it must be possible to coordinate the maps with the mapping tools at the municipalities' disposal. It was also emphasised in interviews that it was a problem for some municipalities that there are many types of digital maps from various government expert agencies. NVE, on the other hand, stated that the maps are delivered in the formats that the municipalities themselves request in order to make it as easy as possible to use them together with the municipalities' mapping tools.

The national flood inundation maps only cover parts of larger watercourses, and municipalities must arrange for further mapping of other rivers as required. In the questionnaire survey, the municipalities were asked if they had carried out their own survey of flood hazard. Table 9 shows how many municipalities have received flood inundation maps and have themselves surveyed the flood hazard. About two thirds of the municipalities that have received flood inundation maps from NVE have not carried out their own surveys of the flood hazard. The table also shows that three-quarters of the municipalities that responded to the questionnaire survey had not surveyed the flood hazard. Fifty municipalities have carried out their own surveys even though they have not received flood inundation maps from NVE.

Susceptibility maps for rockfall and snow avalanches

In the same way, the municipalities that have received susceptibility maps for rockfall and snow avalanches have replied to a question about the extent to which the maps meet the municipalities' needs in planning and building matters. Of the 44 that stated that they had received maps, six municipalities found the maps to be not very satisfactory. More than half the municipalities found the maps to be satisfactory to some extent, and ten municipalities replied largely satisfactory.

44 of the municipalities that responded to the questionnaire survey were aware that susceptibility maps for rockfall and snow avalanches had been prepared for their municipality. These municipalities answered questions about how the susceptibility maps could be improved. 27 municipalities wanted more accurate maps. Other proposed improvements included improving the marking of areas that could be affected by landslides (15), indicating safeguard measures (10), including local knowledge to a greater extent (17) and a need for coordination with the municipal map tool (17).

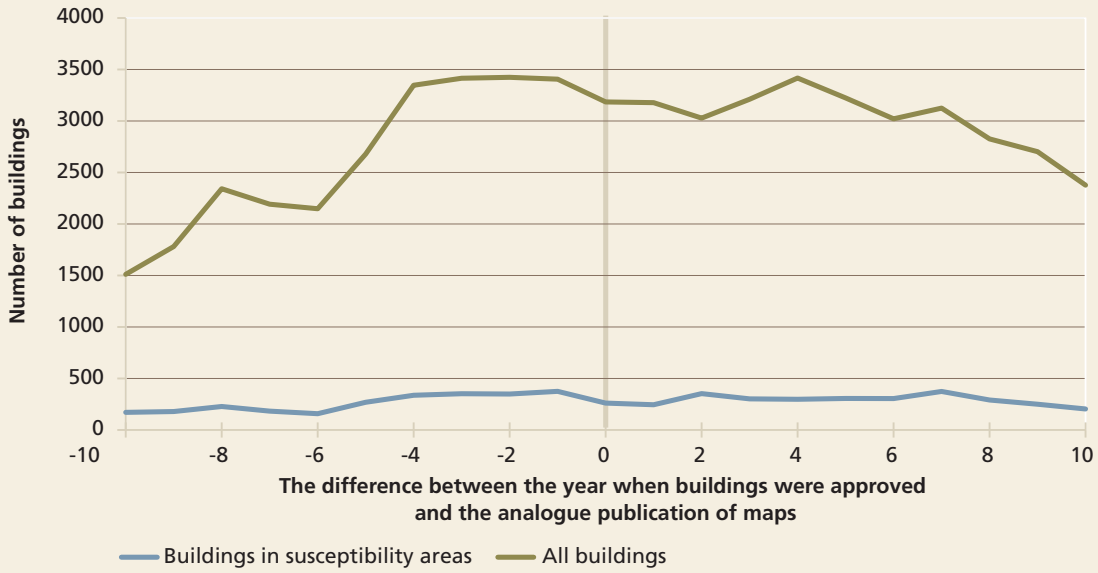
The Directorate of Civil Protection and Emergency Planning stated that the agency is aware that municipalities have previously stated that the maps are not sufficiently detailed. The

Table 10 Have the municipalities carried out their own surveys of landslide hazard and received susceptibility maps?

		Have the municipalities received susceptibility maps?		
		Yes	No	Total
Have the municipalities carried out their own survey of the landslide hazard?	Yes	46	35	81
	No	63	122	185
		109	**157**	**266**

Source: Office of the Auditor General

Figure 2 The number of buildings in mapped susceptibility areas for rockfall and snow avalanches in Norway



Source: Norwegian Geotechnical Institute

Geological Survey of Norway (NGU) emphasised that the susceptibility maps are intended as information to municipalities and other parties working on land use planning about where rockslide or snow avalanche hazards may exist. The scale of the maps means that the level of detail is insufficient, and a more detailed assessment of the area will be required.

The susceptibility maps are intended to help municipalities to decide whether further mapping is required. As for floods, the municipalities in the questionnaire survey were asked whether they had carried out their own survey of the landslide hazard. Table 10 shows how many municipalities have received susceptibility maps and have themselves examined whether there is a landslide hazard. More than half of the municipalities in the questionnaire survey that had received susceptibility maps from NGU had not examined the landslide hazard themselves. As previously mentioned, few municipalities were aware that susceptibility maps for rockfall and snow avalanches had been prepared for the municipality. A total of 185 municipalities had not carried out their own surveys of the landslide hazard. 35 municipalities that have not received susceptibility maps have surveyed the landslide hazard themselves.

A time series data analysis has been carried out to illustrate settlement developments in selected municipalities with susceptibility maps for rockfall and snow avalanches. The purpose is to find out whether municipalities take the maps into consideration when they process building cases. The times series data analysis has primarily been used for municipalities for which the maps were available before 2005.

Figure 2 shows the total number of buildings, and the number of buildings approved in susceptibility areas for rockfall and snow avalanches during the ten years before and after publication of the maps. All data have been normalised to the maps' publishing year, and the 0 line represents a number of different years. The figure shows how the total number of buildings has dropped slightly, while the number of buildings in susceptibility areas for rockfall and snow avalanches has remained stable. The time series data analysis shows that the publication of susceptibility maps for rockfall and snow avalanches has not influenced building activity in susceptibility areas to any significant extent.

No corresponding analysis has been carried out with respect to the flood inundation maps as these maps are too new for it to be possible to detect any changes in building activity.

Quick clay maps

In the questionnaire survey, the municipalities that have received quick clay maps were asked about the extent to which these maps met the municipality's requirements in planning and building matters. Of the 36 municipalities that answered this question, two stated that the quick

Table 11 Have the municipalities carried out their own studies of quick clay hazards and received quick clay maps?

		Have the municipalities received quick clay maps?		
Have the municipalities carried out their own studies of quick clay landslide hazard?		Yes	No	Total
	Yes	19	12	31
	No	24	211	235
		43	**223**	**266**

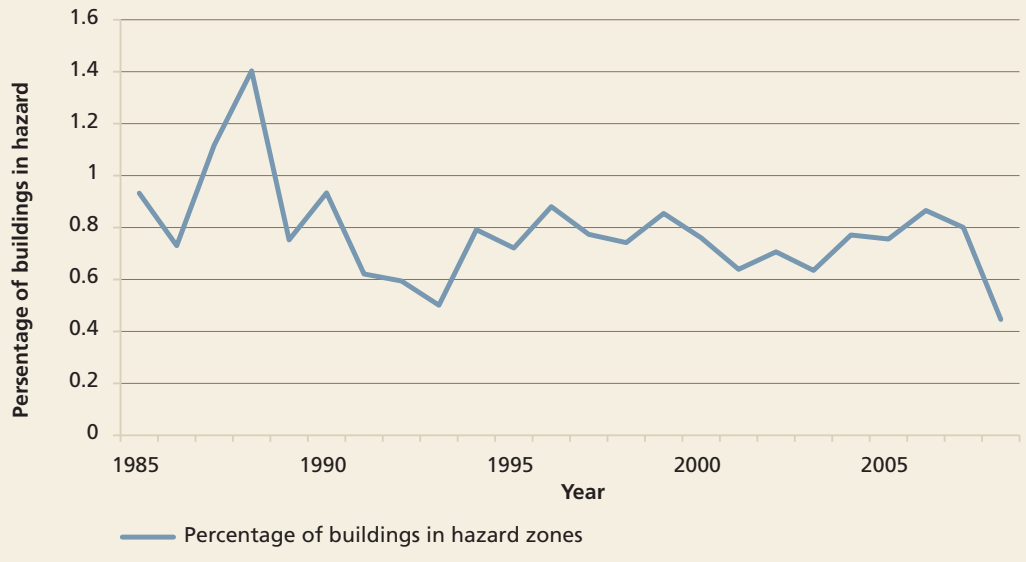
Source: Office of the Auditor General

clay maps are useless, and two said that the maps are not very satisfactory in connection with planning and building matters. 23 municipalities are to a certain extent satisfied with the quick clay maps, and nine municipalities are largely satisfied with the quick clay maps as a tool in planning and building matters.

In the questionnaire survey, the municipalities that had received quick clay maps were asked how these maps could be improved. 38 municipalities replied to this question. The quick clay maps only show quick clay zones of more than 2.5 acres, and 25 of the municipalities said that the maps should also include smaller quick clay areas. 12 municipalities stated that something should be done about the fact that the maps only show quick clay zones, not areas that could be affected by landslides. 11 municipalities stated that the maps should show safeguard measures, and 13 municipalities were of the opinion that the maps should be delivered in a format that can be coordinated with the municipal mapping tool. Like flood inundation maps, quick clay maps are provided by NVE in the format that the municipalities request. In the in-depth study, some municipalities also said that they would like clarification on what their policy should be in relation to the areas adjoining the mapped hazard zones.

Since quick clay is found in a limited geographical area, it is natural that fewer municipalities have carried out their own mapping for this category than for other types of hazard areas. As previously mentioned, national mapping of quick clay has been carried out in 70 municipalities, and 43 of these municipalities participated in the questionnaire survey. Table 11 shows how many of the municipalities in the questionnaire survey that have received quick clay maps have carried out their own surveys. The table also shows the total number of municipalities in the questionnaire survey that have carried out quick clay studies themselves. A total of 31 municipalities state that they have carried out their own quick clay mapping. Of these municipalities, 19 have received quick clay maps from NVE. The table

Figure 3 Percentage of buildings in mapped quick clay areas in Norway (1985–2007)



Source: Norwegian Geotechnical Institute

also shows that 12 municipalities have organised their own survey without receiving quick clay maps from NVE.

NVE has sent quick clay maps to municipalities in which quick clay has been found. It points out that there could be areas within the municipality that are not covered by the national mapping, such as quick clay areas smaller than 2.5 acres or beach deposits. 24 municipalities that have received quick clay maps have not carried out additional studies and are therefore unable to identify any such areas.

A time series data analysis has also been carried out in order to determine whether the municipalities take the quick clay maps into consideration when processing building matters. The times series data analysis has mainly been used for municipalities for which the maps were available before 2005.

Hazard maps for quick clay were made digitally available from 2001, which means that, also in the case of quick clay, there are relatively few years of data available to produce times series.

Figure 3 shows the development of building activity in hazard zones for quick clay slides seen in relation to the total number of buildings approved during the same period. The figure shows no great changes in the development pattern during the 20-year period, and the percentage of buildings in hazard zones varies between 0.5 and 1.4.

The main conclusion for quick clay is that the time series data analyses do not show significant trends in building activity development before and after mapping of these areas.

5 Assessments

Norway's topography presents great challenges in terms of floods and landslides. By mapping areas at risk in order to enable hazard areas to be taken into consideration in land use planning, the authorities reduce the risk of loss of human lives and other assets in floods and various types of landslides. Pursuant to the Natural Damage Act and the Planning and Building Act, it is the responsibility of the municipalities to prevent and protect their inhabitants against flood and landslide hazards. At the same time, the municipalities need government guidance and assistance in their work to limit flood and landslide hazards.

The Norwegian Directorate of Water Resources and Energy (NVE) became the national flood and landslide agency with effect from 1 January 2009. Previously, no single government agency has had overall landslide responsibility. Gathering responsibility in one agency is a good starting point for improving the government's work to prevent flood and landslide hazards.

5.1 Further mapping is still required

It is a condition for the reduction of risk that the national authorities make flood and landslide maps available, and that the municipalities organise further mapping based on their own requirements. National mapping of flood and quick clay slide hazards and susceptibility mapping of rockfall and snow avalanche hazards have been carried out. The studies show that about 160,000 persons live in areas that were mapped as 200-year flood zones or susceptibility areas for rockfalls or snow avalanches or hazard areas for quick clay at the end of 2008. There are almost 66,000 buildings in these areas.

The flood inundation maps were prepared based on knowledge about the risk of floods and previous incidents. The flood inundation project has been concluded in accordance with its objective, and further mapping is part of NVE's future work. The investigation shows that county governors and municipalities have a positive attitude to the mapping and have confidence in the flood inundation maps. At the same time, however, they believe that the scope is insufficient, and that more river stretches and smaller watercourses should be mapped.

Landslides are more difficult to predict and entail a greater risk of loss of lives than floods. Susceptibility maps have been produced for rockfalls and snow avalanches for decades, and several players have been involved in the work. It is assumed by the government that the susceptibility maps will provide municipalities with information about where they should carry out more thorough mapping. This investigation shows that the majority of municipalities do not do this. More than half the municipalities that have received susceptibility maps have not carried out further studies.

There are people living in large areas containing quick clay. Considerable areas of marine deposits, for example in Oslo and parts of Northern Norway, have not yet been mapped under the auspices of NVE's quick clay project. Moreover, the quick clay maps do not cover beach deposits or areas smaller than 2.5 acres. The investigation shows that a number of county governors and many municipalities are of the opinion that the maps must be improved, among other things by including areas under 2.5 acres and potential runout areas.

Climate change introduces many elements of uncertainty to the work of preventing floods and landslides. None of the existing national mapping projects are up-to-date in relation to climate change forecasts. The investigation shows that county governors and municipalities do not know how to take climate change into consideration in their work to limit flood and landslide hazards.

5.2 Many municipalities have insufficient knowledge of the mapping

It is a precondition for the mapping being used that it is communicated to the users. The investigation shows that a majority of the municipalities and county governors in question were not aware that susceptibility maps for rockfalls and snow avalanches existed for their area. The investigation also highlights the fact that the

users do not always have a sufficient understanding of how the maps should be used in preventive work. The lack of awareness of the available maps results in them not being used in land use planning and risk and vulnerability (RAV) analyses in the municipalities. This could result in buildings being built in areas at risk of floods and landslides.

On this basis, it can be questioned whether the dissemination of the susceptibility maps to the municipalities has been sufficiently systematic and thorough. Moreover, it can be questioned whether the limitations of the different types of maps have been communicated clearly enough by the central authorities.

5.3 Many municipalities need government assistance

The ministries are responsible for following up and helping municipalities to take flood and landslide hazards into consideration in their planning work. This responsibility is primarily exercised through guidance and the efficient use of objections by the county governors and NVE. The investigation indicates that, on the whole, the municipalities take account of flood and landslide-related input from the expert agencies. However, the investigation shows that several municipalities at risk of floods and landslides do not have an adequate understanding of relevant legislation. It appears that municipalities are not sufficiently aware of their responsibility pursuant to the Natural Damage Act.

The investigation also shows that many municipalities lack the required expertise to prevent flood and landslide hazards. A number of municipalities also state that they do not get the help they request from government agencies. Nearly all the county governors agree that increased government assistance to raise competence in municipalities should be a priority area. The investigation shows that municipalities do not change their development patterns after receiving hazard or susceptibility maps for landslides.

5.4 Future challenges

With effect from 1 July 2009, the Planning and Building Act requires municipalities to prepare RAV analyses that must include flood and landslide hazards. It is an important condition for goal achievement that municipalities possess the expertise and capacity needed to meet the new requirements. The investigation shows that the RAV work is inadequate in many municipalities, and that the degree of municipal expertise in this area varies. Based on the investigation's findings, there is reason to question whether the intentions of the Planning and Building Act will be adequately addressed without further government follow-up and help in competence-raising and guidance, particularly for the many small municipalities. These needs are also emphasised by the county governors.

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Office of the Auditor General of Norway

Riksrevisjonen
P.O. Box 8130 Dep
N-0032 Oslo

+47 22 24 10 00 (Tel.)
+47 22 24 10 01 (Fax)
riksrevisjonen@riksrevisjonen.no

www.riksrevisjonen.no