# MENTAL MODELS OF FLASH FLOODS AND LANDSLIDES

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## INTRODUCTION

In natural hazard management emphasis is increasingly put on the information and participation of the local public. A precondition for effective information of the public is the knowledge of the mental models people have about the hazards (ATMAN et al. 1994). Communicators need to know the mental models if they want to design messages that will not be dismissed, misinterpreted, or allowed to coexist with misconceptions. "… a mental model is a mapping from a domain into a mental representation which contains the main characteristics of the domain;" (JUNGERMANN et al. 1991: 228). Due to the lack of knowledge the project “Risk Perception and Risk Communication of Natural Hazards in the Bavarian Alps”, funded by the watershed authority in Bavaria, analysed the mental models of flash floods and landslides. In Figure 1, a simplified scientific model for flash floods is presented below. The relationship between the influencing factors (boxes) is represented by bolts. The key issue of torrent control is to inhibit debris flow and blocks in the stream channel caused by debris or driftwood.

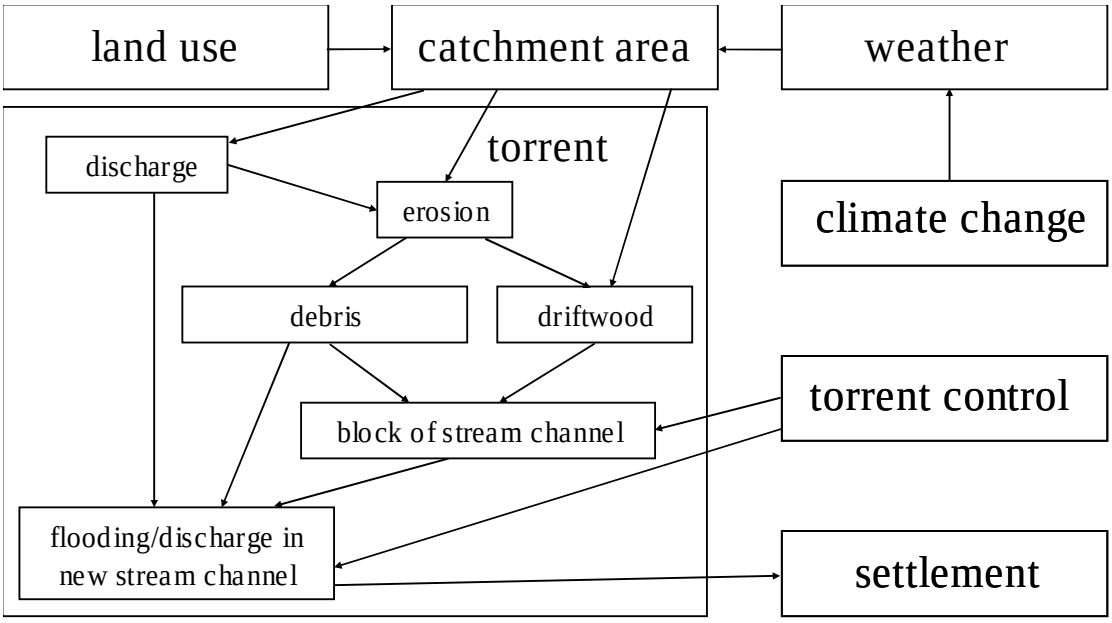


Figure 1: Simplified mental model of flash floods

## METHOD

The study was conducted in four communities in the Bavarian Alps[1], which are endangered by flash floods and land slides.

Employing the method of MORGAN et al. (1992) a qualitative approach was taken first to measure the mental models. Twenty three persons living in risk areas and 14 people responsible for natural hazard management were interviewed. Twenty nine of the 37 interview partners dealt intensively with natural hazards. Respondents were asked to explain the influencing factors for a flood or a landslide in their area. Using additional questions the interviewer tried to obtain explanations for each field mentioned in figure 1. The interviews were documented with tape, transcribed and analysed[2].

With the background of the qualitative interviews ten statements were formed and used in a telephone survey (quantitative interviews). The telephone survey was conducted in February 2001. The sample size was 601. 200 (+1) persons were selected randomly in Benediktbeuern/Ried, Hindelang and Tegernsee[3]. The last birthday method was used to determine the respondent within the household. The respondent had to be older than 16 years. Two years later, the survey was repeated with six statements. Four former statements were not used due to the one sided answer distribution. A new sample was drawn because of a fault of the company, which was hired for the telephone survey.

## RESULTS OF THE QUALITATIVE INTERVIEWS

For **floods** the key factors weather conditions, problems with debris and driftwood, and constructions of the watershed authority were often mentioned. The respondents well understood the first two factors. The necessity of sediment retention structures was seen only by the best informed persons. The torrent control constructions were often criticised. Especially the high water speed in the Maclith-channels (Hindelang) was made responsible for damages. The conditions in the catchment area (topography, size and form of the catchment area) and the impact of the land use system were seldom mentioned. The exception was the connection between storms/bark beetle infestation – deadwood – forestry.

In contrast to floods, the influencing factors for **landslides** were poorly understood. The respondents sometimes supposed that a high water content of the soil causes landslides. They

[1] Benediktbeuern/Ried (Kochel) (3700 inhabitants); Hindelang (4800); Tegernsee (4000); Tiefenbach (800)
[2] See LAMNEK (1993). In contrast to the standard approach the interview was not fully transcribed. Only the important statements were noted word by word.
[3] Tiefenbach was excluded from the survey, because too few inhabitants lived in the risk area.

used pictures of changing underground springs and wounds of the soil surface for water infiltration. The inhabitants of Tegernsee often spoke about the weight of big trees and the vibrations during storms as release for landslides. Simultaneously landslides after clear cuts were mentioned. The impact of the trees was seen on the roots arming the soil and the higher water content after the clear cut. The given explanations are only partly correct. Especially for the impact of the vegetation the thickness of the landslide has to be considered. Only two of 29 respondents knew that.

The biggest differences in the complexity of the mental models were between respondents living only for a short time in the area and inhabitants with long experience. The other important influencing factor was the readiness to deal actively with the natural hazards theme. The respondents with the most accurate mental models talked about science books, they read about the hazards, discussions with experts, and their personal perceptions being out during bad weather conditions.

## RESULTS OF THE QUANTITATIVE INTERVIEWS

Only 60% of the respondents knew that thunderstorms as well as long lasting rainfalls can cause flooding of torrents. Similar to the qualitative interviews most respondents (strongly) agreed with the statement about the possibility of blocks in the stream channel (see figure 2). 8% of the respondents, which knew something about the blocks, disagreed that this should be a big problem. In Tegernsee even 23% had this opinion. It is understandable that people think blocks with branches and garden waste is not such a big problem than blocks with trees. The answers to the statements about climate change show the bigger uncertainty of the public: More respondents did not know an answer. 85% of the respondents thought, that climate change will lead to more flooding. The statements about the precise results of climate change (more snow in late winter, longer rain periods) show the misconceptions or gaps in understanding. The uncertainty of the public is also obvious at the last two statements. Like the statement about the long lasting rainfalls it can be proposed an influence of the mass media reporting about renaturation as the best adjustment against flooding at big rivers.

The differences between the two surveys are very small. In 2003 the respondents used the answer “don’t know” less. For statistical analysis the correct answers were coded as 1 the wrong answers as 0. For example people who agreed or fully agreed with the first statement in figure 2 got one point. Then a scale was build by addition of the six statements used in both surveys. Univariate and multivariate analysis were undertaken using correlation and analysis

of variance. Univariate following groups had a better knowledge consistent for both surveys: 1) people using many different channels to inform themselves about natural hazards, 2) people expressing fear about natural hazard, 3) people with hazard experience.

In the multivariate analysis, only the community of the respondents had a significant influence of a small to middle strength in both surveys.

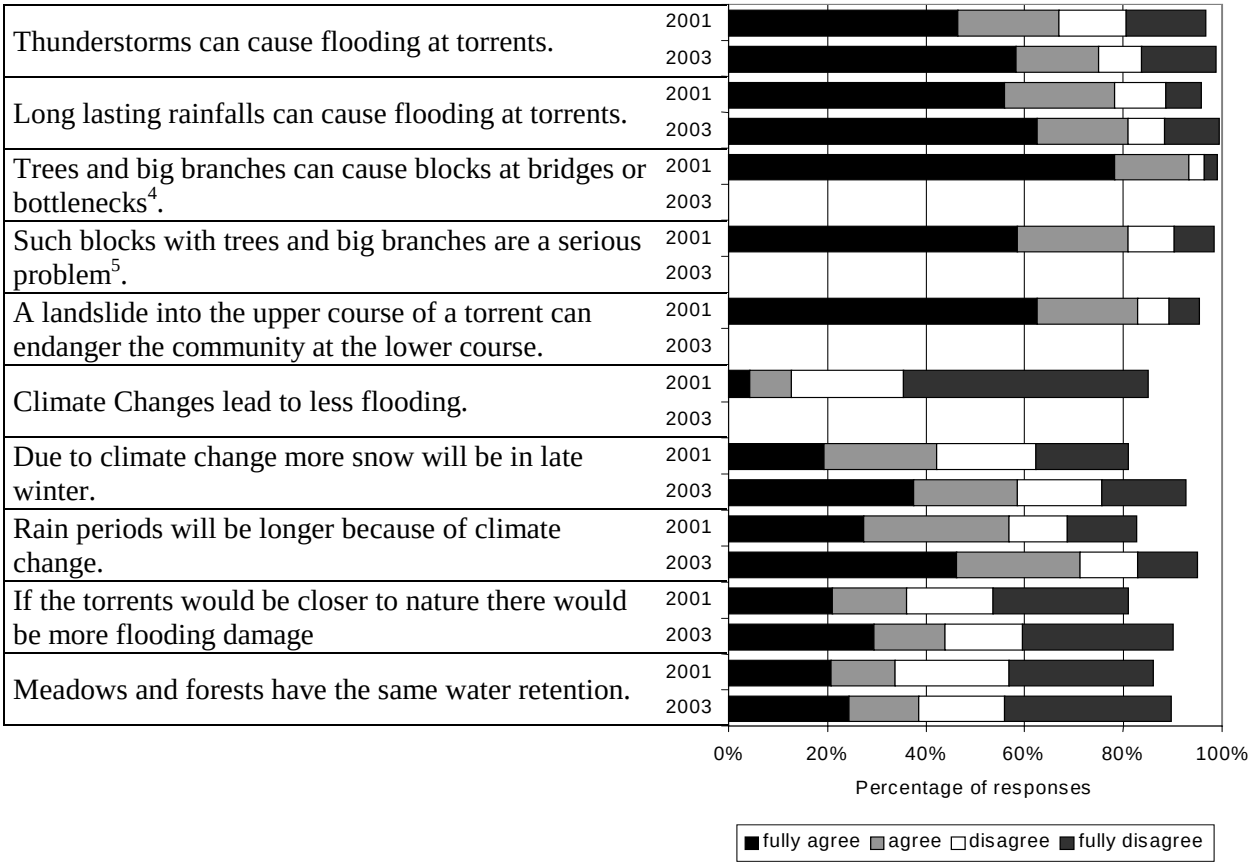


Figure 2: Answers to the statements of the quantitative questionnaire. The answer “don’t know” is not shown.

## DISCUSSION

The main limitation of the open question about the influencing factors in the qualitative interviews was the tendency of the "well informed" respondents to focus on special themes without explaining central connections. Although the interviewer often asked additional questions which concentrated on the central issues, people tended to leave the theme back to the special problems. Nine of 29 mental models about flooding seem to be incompletely measured. This number is smaller for the mental models about landslides (5 of 30) because

[4] For the interviews in Tegernsee the statement was: Branches and garden waste can cause blocks at tubes.
[5] For the interviews in Tegernsee the statement was: Such blocks with branches and garden waste are a serious problem.

the respondents often explained their gaps in understanding. This problem can be solved by confronting the respondents with the analysed mental model in a follow-up interview. Thus, the respondent can fill gaps in the presented mental model or find out the misunderstandings in the researchers analysis. Another possibility is that the researcher draws a mind map of the explanations of the respondent to confront the respondent with the mind map within the same interview.

Only one approach to measure the mental models within standardised interviews is presented in this paper. In the second approach the respondents should decide if the influence of factors like thunderstorms, blocks in the stream channel, side erosion, torrent control structures or private adjustments was small, middle or big for flooding damage. The interviewers mentioned problems of the respondents to understand this kind of question. They wanted to tell the interviewers if the factor is responsible for increasing or decreasing damage. There was also a huge influence of the age in answering correctly. People above 70 had a worse knowledge. Expecting this as an effect of the question form, the approach was rejected.

The shortcoming of the used approach in the telephone surveys is that people can guess the right answer. Thus, the differences between informed and uninformed people were not as big as in the qualitative interviews.

The consistent results of the qualitative and the quantitative interviews are:

- The more visible a influencing factor the better it is understood. The trigger events for landslides are poorly understood. Also the knowledge of the effects of forests and meadows on the water runoff is small.
- Mental models are (highly) influenced by the local conditions. Thus, one has to consider the local situation to inform the public correctly and appealing about natural hazards.

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