RISK ESTIMATION FOR THE HYPOTHETICAL BREACH OF DAMS

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Natural and artificial barrages impounding lakes or reservoirs possess a residual risk of potential failure however this might be very low. To be prepared in the case of any incident the owners and operators of hazardous plants (including dams) are in charge of forwarding information about the possible consequences of any thinkable failure to the authorities. Experiences referring to the elaboration of the required information for the improbable but possible case of dam failure are be presented in the following.

RISK AND PUBLIC

The public and especially people living downstream a reservoir have a more critical view on dams and their hazard potential. Even if it is statistical proven, that the risk getting hurt by a dam failure is much lower than the risk getting involved in a traffic accident it is a legitimate request to get any information about it. This has been enabled by the legislation of the German federal states for about a decade. The analysis of a potential dam break including the flood routing is prescribed by law in many other countries of the world
To provide the relevant information special investigations and technical calculations are necessary.

POTENTIAL DAM BREAK AND RESULTING OUTFLOW

If we consider a real dam, we have to ask how the potential breach formation would be occur. The failure mode depends firstly on the kind of dam. A realistic scenario could be found in the wide range between a sudden and total dam break of an arch dam and a several our long lasting erosion process considering earth dams. The knowledge of historical dam break cases could help to find realistic scenarios.
The final breach depth and width and the breach formation time are the most important parameters to calculate the outflow hydrograph. In order to take their uncertainty into consideration one could use not one definite value for each parameter but a certain number of different values. A occurrence probability can assign to each of this values. Using theses parameters in a large number of combinations the calculation of the outflow will let to numerous hydrographs. At the end the peak discharge, the outflow volume and the time to peak are now also values with a certain occurrence probability.
In a former investigation the considered barrage was a combination between an earth dam section and a concrete dam which includes the spillway. It was assumed that an earthquake, a sudden lowering of the reservoir water level or piping led to different breach formation mechanisms. In

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some cases the breaching of one of the two different dam sections was combined with an flood wave due to a rainfall event. Than the total outflow volume is much larger and the peak discharge due to the dam failure was add up to the maximum discharge due to the rainfall event. The resulting dam break scenarios and the calculated outflow hydrographs were summarised and analysed. This procedure leads also to outflow parameters characterised by a certain occurrence probability.

SURGE WAVE PROPAGATION

In order to estimate the hazard potential of dams and to declare almost realistic flooding areas due to a dam break wave a wide range of calculation software is available. If we have the breach outflow hydrograph as the upstream boundary condition we need a large number of other input data in addition. Each calculation of a dam break wave routing is a very individual task considering specific characteristics and details.

In general the calculation of the flood wave propagation is possible using onedimensional or twodimensional numerical models. Investigations by the authors have showed that onedimensional schemes are sufficient in the majority of calculation tasks especially flood wave propagation along river valleys. Since dams are located in mountain regions the flow path of the surge wave is obviously the downstream river valley. The uncertainty due to the simplification of the threedimensional flow as onedimensional has no more influence on the final result as the uncertainty of the input data. Two dimensional calculation schemes are necessary in the case of unknown flow paths in more even areas. That's why they are indispensable in dike break investigations or in the case of dams impounding settling ponds.

The outflow through a dam breach is a two phase flow. Its numerical simulation is a very complex and time-consuming task and a lot of research is still necessary to get satisfactory results.

HAZARD MAPS

If you have to warn, evacuate and help people in the case of a dam break flood the knowledge about the arrival time as far as the possible maximum water level is necessary.

Hazard maps could provide these information in an comprehensive way. They can show the flooding area along a river reach in addition with further details like flow velocity and discharge and water level hydrographs at certain locations (Fig.1). Each hazard map can only show the consequences of one dam break scenario which should be explained in the map.

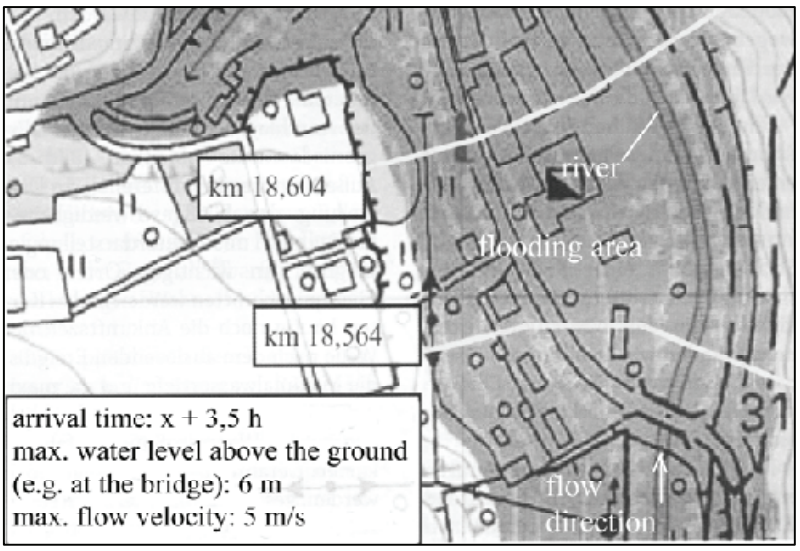

Fig.1: Detail of a hazard map.

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