

RURAL DAM RISK IN ARMENIA

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Armenia is a region of the Caucasus, which is exposed to many natural catastrophes, but the most dangerous are the impacts of earthquake and floods.

Earthquake and floods may cause dam failure, though the dam can be destroyed due to causes not related to natural catastrophes.

Some dams being under the auspices of the Government are regularly monitored with different success. About 50 rural dams are currently not monitored and could present a real hazard. Rural dams built by local communities are different from the well-engineered ones.

It is evident that the scientists, national, regional and local authorities must come together in order to outline a strategy for the prevention of the impacts of dam failure on the population, vital infrastructures and property. Dam risk reduction should continue to be a major priority for regional, national and international development at least for Caucasus.

Armenia is one of the countries with high density of population and location of dams (fig. 1). Most of the dams are situated in high land areas of 1500 – 2500 m above the sea level.

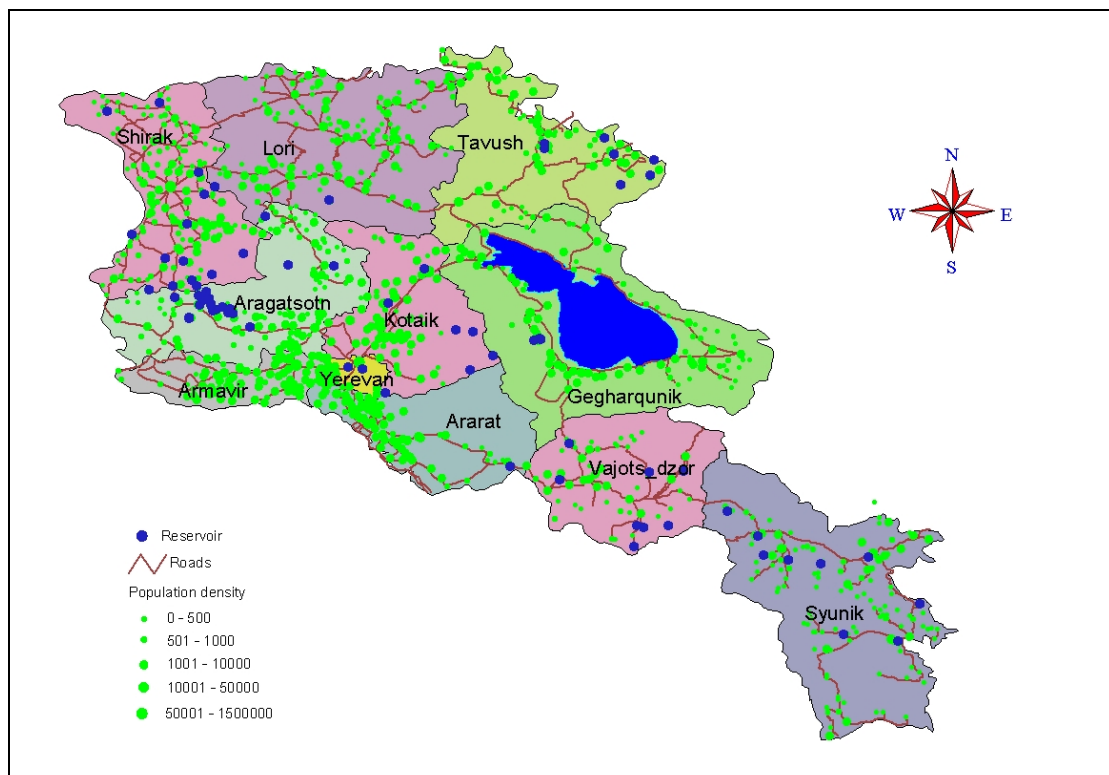


Fig. 1 Density of population and location of dams

The vast majority of dams are embankment ones. The difficulties of topographic, geological and seismic conditions of the country make high the demands to design, construction and operation of dams.

The 82 existing dam in Armenia can be divided into two categories:

- 34 dams higher than 15m
- 48 rural dams below 15m.

The most rural dams were built in 1950-1970 i.e. they have been under exploitation for a rather long time. During long operation period the dams are getting older. At present some of those dams are ignored by regional authorities.

Recent technical inspections have revealed that most of rural dams pose a serious hazard to the population downstream because the rural dams had been built by local communities without technical assistance of any qualified organization.

As the rural dams are mostly filled in two or three months during spring floods, the proper assessment of maximal expected flood is very important.

The seismicity in the territory of Armenia, according to the new map of seismic hazard, is considerably higher than that defined many years ago, when the dams were constructed.

Fore significant dam failure occurred in Armenia in 1974, 1976, 1978 and 1994.

Table 1

Dam failures in Armenia

N	Dam name	Dam type	Dam failure year	Age of dam	Cause at failure and consequences
1	Agarak	Earth fill	1978	20 years	Leakage, sloughing, crest settlement and overtop ping. One village flooded
2	Marmarik	Earth fill	1974	End of construction reservoir empty	Excessive pore pressure build-up, leakage, sloughing
3	Artik	Earth fill	1994	15 years	Progressive failure of upstream slope and consequent overtopping. Two villages flooded, 2 casualties, many losses
4	Dzorakhpyur	Earth fill	1976	6 years	Leakage, upstream sloughing, overtopping

There were about 30 significant dam-related accidents during exploitation period.

In addition to complete failures several significant accidents have been reported at dam sites at an accelerated rate in very recent period.

The principal point is dam risk assessment.

There are five main questions:

- What departures could be considered as an inadmissible?
- Are these departures having an influence upon the risk degree?
- Are the departures requiring any repair work?
- What departures are making necessary to turn the dam out of maintenance?

Dam risk is a complex concept. The elements having an influence upon the risk stipulated by dam itself are:

- Quality of the design;
- Quality of the foundation and dam body;
- Condition of the spillways and outlets.

The elements having an influence upon the risk stipulated by general condition are:

- Hydrology;
- Seismicity
- Geology;
- Climatic condition;
- Geodynamic processes taking place in the reservoir basin.

The elements having an influence upon the dam risk stipulated by the wastes complex possible in the downstream are:

- Treat of human life;
- Treat of industry;
- Treat of agriculture;
- Treat of infrastructures;
- Availability of the protective and preventive system.

Dam condition and the characteristics are presented in table 2.

Table 2

Rural dam damage

N	Degree of damage	Characteristics
1.	Good state	No damage that will not deteriorate, not partial failure
2.	Not good state	Were deteriorating to bad state if no measures are taken. Over 10% losses of discharge capacity or through leakage.
3.	Bad state	Deteriorating, to Urgent state. Over 20% losses of discharge capacity or through leakage.
4.	Urgent state	Rapidly deteriorating to Alarm state or partial failure of the dam if no measures are taken. Over 30% losses of discharge capacity or through leakage.
5.	Alarm state	Damage resulting in severe danger to life, property or complete or partial failure of the dam. Over 50% losses of discharge capacity or through leakage.

To outline the most vulnerable features of negative displays on rural dams the priority is given to dam behavior in past and partial damage data obtained through field observation and questionnaire.

Table involving the following information has been compiled:

- Dam name
- Region
- Year of construction or reconstruction
- Population in flood area
- Capacity
- Catchment area
- Surface area
- Dam height
- Description of main events or conditions related to dam safety

The results of analysis of rural dam condition revealed that various variations from normal condition of exploitation were recording. The most negative feature is excessive seepage (fig. 2). It is evident that uncontrolled seepage can promptly erode soil resulting in failure of the dam.



Fig. 2 View of downstream area of Kosh dam

Beginning at the downstream side of embankment either in the dam or the foundation the erosion is progressively working toward the reservoir and developing conduit to the reservoir. The piping phenomenon is recognized through the increased seepage flow rate, muddy water, sinkholes on the embankment.

It should be mentioned that frequently occurring displays like cracks, slides and settlement are mostly linked to the seepage. Thus, it could be concluded that the main factor in rural dam risk is connected with negative seepage i.e. piping.

Therefore, having information about the seepage on rural dam and about hazard for the population and hazard for the agriculture, industry and infrastructures, the risk level has been evaluated and recommendations have been made for two tens of rural dams in Armenia.